INSTRUCTIONAL-DESIGN THEORIES AND MODELS

The Learner-Centered Paradigm of Education

Volume IV

Edited by

Charles M. Reigeluth
Brian J. Beatty
Rodney D. Myers

ROUTLEDGE

INSTRUCTIONAL-DESIGN THEORIES AND MODELS, VOLUME IV

Instructional-Design Theories and Models, Volume IV provides a research-based description of the current state of instructional theory for the learner-centered paradigm of education, as well as a clear indication of how different theories and models interrelate. Significant changes have occurred in learning and instructional theory since the publication of Volume III, including advances in brain-based learning, learning sciences, information technologies, internet-based communication, a concern for customizing the student experience to maximize effectiveness, and scaling instructional environments to maximize efficiency.

In order to complement the themes of Volume I (commonality and complementarity among theories of instruction), Volume II (diversity of theories), and Volume III (building a common knowledge base), the theme of Volume IV is shifting the paradigm of instruction from teacher-centered to learner-centered and integrating design theories of instruction, assessment, and curriculum. Chapters in Volume IV are collected into three primary sections: a comprehensive view of the learner-centered paradigm of education and training, elaborations on parts of that view for a variety of K-12 and higher education settings, and theories that address ways to move toward the learner-centered paradigm within the teacher-centered paradigm.

Instructional-Design Theories and Models, Volume IV is an essential book for anyone interested in exploring more powerful ways of fostering human learning and development and thinking creatively about ways to best meet the needs of learners in all kinds of learning contexts.

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INSTRUCTIONAL-DESIGN THEORIES AND MODELS, VOLUME IV

HISTORICITY

The Learner-Centered Paradigm of Education

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DEDICATION

We dedicate this book to all those educators and educational researchers who have pioneered methods and guidance for the learner-centered paradigm of education, often facing huge obstacles, resistance, and skepticism. Their largely unsung Herculean efforts have contributed greatly to the inevitable massive transformation of educational and training systems so sorely needed for post-industrial societies.

– C.M.R., B.J.B., & R.D.M.

I also dedicate this book to my grandchildren—Morgan, Eliza, Jillian, and Dane—and to all other children who so desperately need an educational system designed to meet their needs.

– C.M.R.

I also dedicate this book to my wife Nellie, who sacrificed many hours of time together so that this work could be realized, and to my children Elizabeth, Teresa, Jennifer, Katherine, Angela, and Christopher, who have all benefited from learner-centered practices throughout their formal education. May their experience be more common throughout our education systems.

– B.J.B.

I also dedicate this book to Charlie and Brian for inviting me to join them in piloting this book on its odyssey, and to the crew of authors who helped us to overcome the wrath of gods and monsters and arrive safely on the shores of publication; but mostly it's dedicated to my wife Juliana, for having the patience of Penelope.

– R.D.M.

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PREFACE

How to help people learn better. That is what instructional theory is all about. It describes a variety of methods of instruction (different ways of facilitating human learning and development), and when to use—and not use—each of those methods.

Volume I of *Instructional-Design Theories and Models* (1983) provides a "snapshot in time" of the status of instructional theory in the early 1980s. Its main purpose was to raise awareness of instructional theories, which were largely overlooked in the shadows of ADDIE and other ISD process models. Most of the theories are classics and are still very useful today.

Volume II (1999) provides a concise summary of a broad sampling of work in the late 1990s on a new paradigm of instructional theories for the Information Age. Its main purpose was to raise awareness of the diversity of theories that provide a customized or learner-centered learning experience in all different domains of human learning and development. It also raised awareness of the importance of values in instructional theory.

Volume III (2009) was born out of a concern about the extent to which instructional theorists seemed to be working in relative isolation from each other, building their own view of instruction with little regard to building on what knowledge already existed and what terminology had already been used for constructs they also describe. Therefore, Volume III took some early steps in building a common knowledge base about instruction with a common use of terms. It also described some tools for continuing to build a common knowledge base.

These three volumes cover very different territory. None of them was intended to replace its predecessors. We have made a conscious effort to keep duplication to a minimum, so readers interested in mastering the art and science of designing powerful instruction will benefit from all of them. Each volume includes chapter forewords that summarize their main contributions, to give readers a quick sense of whether or not a chapter addresses their particular interests and needs.

Why a Volume IV?

Our initial thought was to conclude this series with Volume III. However, new instructional methods are continually developed as advances are made in brain sciences, information technology, and other relevant fields. Furthermore, as we have evolved deeper into the Information Age, it has become clear that a change in the paradigm of instruction from teacher-centered to learner-centered requires parallel changes in aspects of education and training systems that are technically beyond the scope of theories of instruction.[1]

Using systems thinking, we recognize that the learner-centered paradigm of instruction is closely interrelated with different paradigms of instructional management, assessment, and even curriculum. First, regarding instructional management, truly learner-centered instruction requires student progress to be based on learning rather than on time. This is an instructional management strategy as defined in Chapter 1 of Volume I (p. 8), and has consequently not been addressed by instructional theories. Second, regarding assessment, truly learner-centered instruction requires student learning to be compared to a standard of achievement (criterion-referenced—to know when the learner is ready to move on) rather than to the learning of one's peers (norm-referenced) and consequently should be integrated with the instruction rather than being a separate activity. Third, regarding curriculum, truly learner-centered instruction requires decisions about what to learn that are responsive to student needs in a society that is much more complex than that of our Industrial-Age forebears.

In sum, decisions about what to teach, how to teach it, and how to assess it must all be dramatically different now compared to those that were appropriate for the Industrial Age, and those decisions should be made together because they are interdependent. That interdependency has not been addressed in

Volumes I–III, but it is addressed here in Volume IV. This Volume provides a coherent, comprehensive set of guidelines for the learner-centered paradigm of education and training that addresses curriculum and assessment, as well as instruction, because effective design must address all three simultaneously.

Challenges with the Learner-Centered Paradigm

Perhaps the greatest challenge with implementing the learner-centered paradigm of education and training is the difficulty that instructional theorists, researchers, educational policymakers, and practitioners face in transcending Industrial-Age mental models or mindsets about instruction in both education and training contexts. It is hard for us to conceive of schools and universities without grade levels, without courses, without tests, without grades, and without terms or semesters (Reigeluth & Karnopp, 2013). To implement the learner-centered paradigm effectively, many stakeholders must come to understand education in a very different way from traditional mental models.

Another challenge with implementing the learner-centered paradigm is the difficulty of transforming Industrial-Age systems, which are designed to make change extremely difficult. If piecemeal reforms are difficult within such a highly politicized and bureaucratic system, paradigm change is an order of magnitude more difficult. It is like trying to transform a railroad system into an air transportation system. It requires fundamental changes in all parts of the system, or at least enough parts to reach the tipping point where more pressure is exerted by the new parts to change the remaining old parts, than the old parts exert on the new ones to change back. This means that the transformation process is more expensive and time-consuming than are piecemeal reforms, but there is good evidence that the new paradigm will be less expensive than the current one (Egol, 2003; Reigeluth & Karnopp, 2013). The good news is that much is known about an effective process for transforming existing school systems on the school, district, and state levels, and there are already hundreds of schools that exhibit many features of the learner-centered paradigm, to serve as examples of what can be (see Reigeluth & Karnopp, 2013).

About this Volume

The primary audience for this volume, like that of the previous three volumes, is instructional theorists, researchers, and graduate students. An additional audience is instructional designers, teachers, and trainers who are interested in guidance about how to design instruction of high quality.

In Unit 1, Chapter 1 provides the top-level description of design theory for the learner-centered paradigm. Chapters 2–5 provide the first level of elaboration on that top-level description, with chapters on competency-based education, task-centered instruction, personalized instruction, and a new paradigm of curriculum. Unit 2 offers the second level of elaboration, with chapters on maker-based instruction, collaborative instruction, games for instruction, instruction for self-regulated learning, instructional coaching, and technology for the learner-centered paradigm. Finally, Unit 3 provides descriptions of steps toward the LCE paradigm—instructional designs that can be done within the constraints of the Industrial-Age paradigm—including instruction for flipped classrooms, gamification in instruction, considerations for mobile learning, and just-in-time teaching.

We have tried to make it easier for the reader to digest the instructional theories in this Volume by preparing the same kind of unconventional **foreword** for each chapter as was done for Volumes II and III. Each chapter foreword outlines the major ideas presented in the chapter. This offers something akin to a hypertext capability for you to get a quick overview of a chapter and then flip to parts of it that particularly interest you. It can also serve preview and review functions and make it easier to compare different theories. We have also inserted **editors' notes** in most chapters to help you relate elements in a chapter to similar ideas presented in other chapters. Finally, there is a **unit foreword** that introduces the chapters in each unit.

It is our sincere hope that this Volume will help instructional theorists and researchers to further advance knowledge about the learner-centered paradigm of education and training. We also hope it will help policymakers and foundations to support transformation to the new paradigm. Finally, we hope this

Volume will help instructional designers, teachers, and trainers to implement learner-centered practices in their educational and training systems.

– C.M.R., B.J.B., & R.D.M.

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Note

1 For an explanation of the urgent need for paradigm change in education and training from teacher-centered to learner-centered and from time-based student progress to learning-based student progress, see Chapter 1 in Volume II (pp. 16–21), Chapter 1 in Volume III (pp. 13–17), and Chapter 1 in Reigeluth and Karnopp (2013).

UNIT 1

Fundamental Principles of the Learner-Centered Paradigm of Education

Unit Foreword

Unit 1 provides a broad yet shallow view of the learner-centered paradigm of education and training. Chapter 1 presents an "epitome" of design theories for this emerging paradigm. Because decisions about how to teach in this paradigm are inextricably intertwined with decisions about how to test and even with decisions about what to teach, this chapter describes design principles for all these aspects of education and training. Chapters 2–5 then present an elaboration on the principles in Chapter 1, and Unit 2 provides yet another level of elaboration.

The learner-centered paradigm is characterized by far more variations than is the teacher-centered paradigm. As theorists attempt to provide more detailed guidance, we find that there are alternative ways (methods) to implement a general principle, and that different ways are preferable in different situations. We therefore asked all authors to describe situational principles as well as universal principles. Also, since design principles are goal-oriented and thus normative, they are based on values. Methods should often vary as one's values vary, so we asked all authors to describe the values that underlie their design theories. In sum, all authors were asked to address the following in their chapters: 1) introduction, including definitions, importance, and underlying descriptive theories, 2) values upon which their design theory is based, 3) universal principles or methods for their design theory, 4) situational principles for their design theory, 5) implementation issues or case description, and 6) conclusion or closing remarks.

In **Chapter 1** Reigeluth, Myers, and Lee present a comprehensive vision of the learner-centered paradigm of instruction, a vision founded on the idea that the current paradigm of instruction—now more than a century old—is no longer appropriate to meet the learning needs of individuals or society. The Industrial Age conception of education as a process of mass production—in which learners all study the same thing at the same time and are assessed in the same way—is no longer adequate in the Information Age. The 21st century is a time of accelerating change, rapidly accumulating knowledge, and dramatically increasing access to that knowledge. Rote memorization and standardized testing are resulting in students whose knowledge and skills are practically obsolete upon graduation. We need graduates who are equipped to embrace change, who are prepared to make sense of the vast amounts of information at their fingertips, and who are curious and eager to communicate, collaborate, innovate, and create new knowledge. To help all learners succeed, the authors describe the learner-centered paradigm as being attainment- (or competency-) based rather than time-based, task-centered rather than content-centered, and personalized rather than standardized. This requires changed roles for the teacher, the learner, and technology. It also requires a different paradigm of curriculum, one that is fundamentally restructured around effective thinking, acting, relationships, and accomplishment.

In **Chapter 2** Voorhees and Voorhees elaborate on the attainment-based nature of the learner-centered paradigm. They address the nature of competency statements, which are largely related to learning goals and criteria for their attainment. They address sequencing and structuring of competencies to accelerate learning, principal among which is basing learner progress on mastery rather than time. And they devote considerable attention to student assessment, which should measure individual skills and knowledge, be criterion-referenced with predefined rubrics, be performance-based, be personalized with student input on their design, and much more. The authors also address the importance of a system to keep track of the competencies that each student has mastered and a system for constantly evaluating and improving the instruction and assessments.

In **Chapter 3** Francom elaborates on the task-centered nature of the learner-centered paradigm. Based on Merrill's "first principles of instruction," he offers guidance for 1) selecting, sequencing, and scaffolding tasks, 2) activating prior knowledge, 3) demonstrating performance of skills (or part-tasks) and providing procedural and supportive information, 4) having learners apply those skills and procedural and supportive information, and 5) providing opportunities for the learners to integrate what they have learned and explore new ways to use it.

In **Chapter 4** Watson and Watson elaborate on the personalized nature of the learner-centered paradigm. Their design principles offer guidance for personalizing each student's long- and short-term instructional goals, creating a personal learning plan for each student, and keeping detailed records of each student's progress. Guidance for personalizing the task environment addresses selecting tasks that are of great interest to the student as well as relevance to the learning goals, and deciding whether tasks should be done individually or collaboratively. Principles for personalizing scaffolding for the task address adjusting the quantity and quality of scaffolding to the student's self-regulation skills and developmental needs. Principles for personalizing assessment include guidance for deciding how to assess both task performance and mastery of individual attainments. And guidance for personalizing reflection address when and how a student should reflect on both the learning process and task performance.

In **Chapter 5**, the last chapter in Unit 1, Prensky elaborates on the nature of curriculum for the learner-centered paradigm. He describes a truly different paradigm of curriculum, one designed to prepare all people for a useful and successful life. It has some of the content from the current curriculum, which is organized around the four main subjects of Math, English, Science, and Social Studies (MESS), but it totally reorganizes them under the four main subjects of thinking effectively, acting effectively, relating effectively, and accomplishing effectively. He describes many sub-skills for each of these four main subjects, and he describes how traditional subject areas are needed as vehicles for learning them. It is our view that the four new subjects are equally relevant for K-12 education, higher education, and corporate and government training.

In Unit 2 this fairly general set of design theories is elaborated for more detailed and varied guidance about what methods to use and when to use them in the learner-centered paradigm of education and training. Then Unit 3 offers design theories that are intended for use in the teacher-centered paradigm as steps toward the learner-centered paradigm.

– C.M.R., B.J.B., & R.D.M.

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THE LEARNER-CENTERED PARADIGM OF EDUCATION

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EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *All kinds of content.*

Learners

- *All kinds of learners.*

Learning environments

- *Learner-centered rather than teacher-centered.*
- *Attainment-based learner progress rather than time-based progress.*
- *Customized rather than standardized instruction and assessment.*

Instructional development constraints

- *Requires well-designed resources in the form of tasks and instructional support.*

Values (opinions about what is important)

About ends (learning goals)

- *Development of intrinsic motivation and love of learning are highly valued.*
- *Development of learner self-regulation skills (how to learn) is highly valued.*
- *Mastery of knowledge and skills is highly valued, including transfer to varied and real-world contexts.*
- *Development of collaboration skills is highly valued.*
- *Emotional, social, and character development are highly valued, including empathy and desire to contribute to one's community.*

About priorities (criteria for successful instruction)

- *Effectiveness and intrinsic motivation of the instruction are more important than efficiency.*

About means (instructional methods)

- *The instruction should be customized regarding pace, content, methods, and assessment.*
- *Intrinsically motivated learning and love of learning are highly valued.*
- *Learning by doing (active learning) is highly valued.*
- *Just-in-time instructional support while learning by doing is highly valued.*
- *Learning from peers through collaboration is highly valued.*
- *Self-regulated learning is highly valued.*
- *Self-reflection and self-evaluation are highly valued.*
- *Both formative and summative assessment should occur throughout instruction.*

About power (to make decisions about the previous three)

- *Empowering learners to make decisions about ends, priorities, and means is highly valued.*

Universal Principles

1. Attainment-based instruction

- *Attainment-based learner progress: Each learner's progress should be based on reaching the learning goals, rather than based on time.*
- *Attainment-based learner assessment: Each learner should be assessed through comparison with the criteria for mastery (criterion-referenced assessment) rather than through comparison with other learners (norm-referenced assessment).*
- *Attainment-based learner records: Each learner's records should be a list or map of individual attainments, rather than a traditional report card with names of courses and letter or number grades.*

2. Task-centered instruction

- *Task environment: Most instruction should be organized around the performance of a task that is of great interest to the learner, aligned with the learner's goals, of significant duration, within an immersive environment, and authentic or realistic.*
- *Scaffolding: Three types of scaffolding should be used whenever the task is too difficult for the learner: adjusting, coaching, and instructing.*

3. Personalized instruction

- *Personalized goals: Long-term life goals and short-term learning goals should be personalized.*
- *Personalized task environment: The task selection should be personalized. Decisions about collaboration (teammates) should be personalized. And the nature and amount of self-regulation should be personalized.*
- *Personalized scaffolding: The nature and amount of coaching and instructing should be personalized.*
- *Personalized assessment: The choice of assessor and format for the assessment should be personalized.*
- *Personalized reflection: The way the learner reflects on the process and product (or performance) of the task should be personalized.*

4. Changed roles

- *The teacher's roles should be: a) to assist learners in setting goals, b) to assist learners in designing or selecting tasks, c) to facilitate task performance, d) to facilitate learning, e) to help evaluate performance and learning, and f) to mentor the learner.*
- *The learner's roles should be: a) to be an active learner, b) to be a self-regulated learner, and c) to be a teacher of one's peers.*
- *Technology's roles should be: a) to support recordkeeping for learning, b) to assist planning for learning, c) to provide or support instruction for learning (both the interactive task environment and the just-in-time scaffolding), and d) to provide or support assessment for and of learning fully integrated with the instruction.*

5. Changed curriculum

- *Expanded curriculum: Many important kinds of learning that are currently absent from the curriculum should be added (and some removed).*
- *Fundamentally restructured curriculum: The curriculum should be organized around the four pillars of effective thinking, acting, relationships, and accomplishment rather than math, science, literacy, and social studies.*

Situational Principles

1. Task environment

- *An inauthentic task environment might be preferable: a) when it is more motivational for the learner than an authentic environment, b) when it can prevent cognitive overload associated with an authentic environment, or c) when it can be sufficiently safer or less expensive than an authentic environment.*
- *A learner-designed task might be preferable: a) when the available tasks from which to choose are inadequate given the learner's learning needs and interests, b) when there is sufficient time for the learner and teacher to design it, and/or c) designing a task is itself an important learning goal.*
- *The task may be project-based, problem-based, inquiry-based, or maker-based, depending mostly on the nature of what is to be learned.*

2. Scaffolding

- *Scaffolding can be universal (initiated at a predetermined point in the performance of a task), or triggered (when a certain learner action indicates it is needed), or requested (when the learner asks for help).*
- *Scaffolding can be offered by the teacher, another learner, an expert in the task, or technology.*
- *Scaffolding can be in the form of a leading question, or information, or a hint, or an explanation (developing an understanding).*

3. Learner roles

- *The kinds and amounts of self-direction given to the learner should vary with the kinds and levels of self-regulated learning skills the learner has developed.*

– C.M.R., B.J.B., & R.D.M.

THE LEARNER-CENTERED PARADIGM OF EDUCATION

I. Introduction

Definition of Learner-Centered Education

The learner-centered paradigm of education stands in contrast to the teacher-centered paradigm. Based on the work of the American Psychological Association's Presidential Task Force on Psychology in Education, McCombs and Whisler (1997) define learner-centered as:

> The perspective that couples a *focus on individual learners* (their heredity, experiences, perspectives, backgrounds, talents, interests, capacities, and needs) with a *focus on learning* (the best available knowledge about learning and how it occurs and about teaching practices that are most effective in promoting the highest levels of motivation,

learning, and achievement for all learners). (p. 9) [emphases added]

Furthermore, that task force (American Psychological Association Presidential Task Force on Psychology in Education, 1993) produced a report that identified 12 learner-centered psychological principles (see Table 1.1). Research upon which those principles are founded is reviewed by McCombs (1994) and Lambert and McCombs (1998). Additional supporting research is reviewed by Bransford, Brown and Cocking (2000).

Importance of Learner-Centered Education

So, why is the learner-centered paradigm of education important? There are two major reasons, one on the personal level and one on the societal level (Reigeluth & Karnopp, 2013). On the personal level, since learners learn at different rates, time-based learner progress forces slower learners to proceed to new material before they have mastered the current material, so they accumulate gaps in their learning that make it more difficult for them to learn related material in the future, virtually condemning them to fail. It also holds faster learners back, squandering their talents. Learner-centered education is the only way to maximize every learner's learning—to help all learners reach their potential.

TABLE 1.1 Learner-Centered Psychological Principles

Metacognitive and Cognitive Factors	1. The nature of the learning process: Learning is a natural process of pursuing personally meaningful goals, and it is active, volitional, and internally mediated; it is a process of discovering and constructing meaning from information and experience, filtered through the learner's unique perceptions, thoughts, and feelings.
	2. Goals of the learning process: The learner seeks to create meaningful, coherent representations of knowledge regardless of the quantity and quality of data available.
	3. The construction of knowledge: The learner links new information with existing and future-oriented knowledge in uniquely meaningful ways.
	4. Higher-order thinking: Higher-order strategies for "thinking about thinking" – for overseeing and monitoring mental operations – facilitate creative and critical thinking and the development of expertise.
Affective Factors	5. Motivational influences on learning: The depth and breadth of information processed, and what and how much is learned and remembered, are influenced by (a) self-awareness and beliefs about personal control, competence, and ability; (b) clarity and saliency of personal values, interests, and goals; (c) personal expectations for success or failure; (d) affect, emotion, and general states of mind; and (e) the resulting motivation to learn.
	6. Intrinsic motivation to learn: Individuals are naturally curious and enjoy learning, but intense negative cognitions and emotions (e.g., feeling insecure, worrying about failure, being self-conscious or shy, and fearing corporal punishment, ridicule, or stigmatizing labels) thwart this enthusiasm.
	7. Characteristics of motivation-enhancing learning tasks: Curiosity, creativity, and higher-order thinking are stimulated by relevant, authentic learning tasks of optimal difficulty and novelty for each learner.
Developmental Factors	8. Developmental constraints and opportunities: Individuals progress through stages of physical, intellectual, emotional, and social development that are a function of unique genetic and environmental factors.
Personal and Social Factors	9. Social and cultural diversity: Learning is facilitated by social interactions and communication with others in flexible, diverse (in age, culture, family background, etc.), and adaptive instructional settings.
	10. Social acceptance, self-esteem, and learning: Learning and self-esteem are heightened when individuals are in respectful and caring relationships with others who see their potential, genuinely appreciate their unique talents, and accept them as individuals.

TABLE 1.1 *(continued)*

Individual Differences	11.	Individual differences in learning: Although basic principles of learning, motivation, and effective instruction apply to all learners (regardless of ethnicity, race, gender, physical ability, religion, or socioeconomic status), learners have different capabilities and preferences for learning mode and strategies. These differences are a function of environment (what is learned and communicated in different cultures or other social groups) and heredity (what occurs naturally as a function of genes).
	12.	Cognitive filters: Personal beliefs, thoughts, and understandings resulting from prior learning and interpretations become the individual's basis for constructing reality and interpreting life experiences.

On the societal level, as we have evolved from the Industrial Age to the Information Age (Toffler, 1970, 1980, 1990). Manual labor is giving way to knowledge work as the predominant form of work, requiring that many more people be educated to higher levels than ever before. Only learner-centered education can meet this need, which will benefit our economic competitiveness in a "flat" world (Friedman, 2005), as well as our political system (through better informed voters and leaders) and individual citizens' ability to thrive in an increasingly complex digital world.

However, it is also important to keep in mind that there are situations where the sorting focus is appropriate, such as when we want to select learners for special awards or programs that have limited space like the Navy Seals. The learner-centered paradigm needs to become the predominant, rather than the exclusive, paradigm. For more about this paradigm change, see Wagner and Dintersmith (2015).

Theoretical Foundations of Learner-Centered Education

At the core of learner-centered education is the belief that humans make sense or make meaning out of information and experience in their own way. Because each person is unique in his or her nature (a combination of DNA) and nurture (experiences), we each perceive, feel, and think about things differently. The theoretical foundations of this belief stem from cognitivism, constructivism, and humanism.

Cognitivism

Cognitivist theories such as information processing theory, schema theory, and mental models provide a foundation that each learner has her or his own way to process information based on prior experience and knowledge. Information processing theory tells us that how information is received and structured within learners' minds is subject to learners' mental processes. Learners selectively pay attention to incoming information, encode it within their short-term memory in their own ways, store it in long-term memory in their own ways, and retrieve the information based on the way it was encoded (Miller, 1956; Miller, Galanter, & Pribram, 1986). Thus, selecting, encoding, and retrieving information vary by individual learners.

Schema theory states that knowledge is organized into units and structured based on their relationships with other units. When new information comes in, learners use their own schema to process the information. This schema is continuously and actively developed as learning occurs. Therefore, every learner with different schemata has a unique way to process, store, and retrieve information (J.R. Anderson, 1983; Ausubel, 1968; Schank, 1982; Schank & Abelson, 1977).

A mental model is a representation of the relationships between various parts in the surrounding world. People selectively choose concepts that are important to them, symbolize the concepts in their own ways, and create relationships among them according to how they perceive them. Therefore, internalization of incoming information largely depends on individual learners and is affected by learners' prior experience and knowledge (Johnson-Laird, 1983).

Constructivism

Based on the epistemological belief that knowledge is subjectively and individually constructed rather than that it exists external to the learner, constructivism lays down the fundamental theoretical foundation of learner-centered education (Jonassen, 1999; Lambert & McCombs, 1998). Constructivists such as Piaget and Vygotsky state that knowledge is constructed while learners are engaged in social interaction on the learning topic by experiencing disequilibrium, negotiating and finding an equilibrium through assimilation and accommodation (Littleton & Häkkinen, 1999; Palincsar, 1998). Therefore, learning should be designed to facilitate individual knowledge construction by helping learners engage in an authentic task and meaningful conversation around the task.

Humanism

Carl Rogers (1951), one of the foremost psychologists of the 20th century, argued that the role of therapists should be to free the client to solve his or her own problems, thereby realizing one's full organismic potential, rather than prescribing solutions that develop a false, ideal self based on the expectations of others. He advocated applying this person-centered approach to education. Rogers argued that humans have an innate desire to learn, but that a person cannot be taught directly; rather, one can only facilitate the learning of another (Rogers, 1969). Therefore, learning must be self-initiated and self-regulated, motivated by the person's natural desire to learn those things that are necessary to maintain and develop the self (Rogers, 1959). Consequently, the act of learning requires the full participation of the learner, which means that the learner "chooses his own directions, helps to discover his own learning resources, formulates his own problems, decides his own course of action, [and] lives with the consequences of each of these choices" (Rogers, 1969, p. 162).

Early Pioneers

In this section, we introduce three early educational movements that led the way to learner-centered education. We briefly present only key figures and ideas from these movements.

Dewey's Progressive Education

John Dewey was a principal figure in boosting American public schools and leading educational reform from the 1880s. Dewey presented his educational theories in several books (e.g., Dewey, 1899, 1938; Dewey & Small, 1897). Throughout his books, he maintained that learners learn when they are allowed to experience, observe, and reflect on their own past and current experience, and all human experience involves social interaction. Thus, education should be based on experience through a social process, and the teacher should play the role of facilitator of the process rather than a dictator. He placed a heavy emphasis on learners' active participation and ownership in the learning process.

Montessori Education

In the 1900s, Maria Montessori, an Italian physician and educator, pioneered the Montessori education system. Her educational philosophy places a heavy emphasis on development of a child's independence, children taking initiative, and development of natural ability through practical play. This educational philosophy is based on the four distinct phases of child development that she observed from infants. She developed appropriate educational methods and environments that can maximally realize natural child development in each phase (Montessori, 1917, 2013). Some empirical studies on Montessori education have revealed equivalent or higher educational outcomes compared to traditional education (Borman, Hewes, Overman, & Brown, 2003; Dohrmann, Nishida, Gartner, Lipsky, & Grimm, 2007; Lopata, Wallace, & Finn, 2005). A recent study that compared two Montessori programs with different levels of implementation fidelity to a traditional program found that high-fidelity Montessori programs were associated with positive effects in several academic outcomes (Lillard, 2012).

Carroll's and Bloom's Mastery Learning

In the 1960s, Carroll and Bloom criticized time-based learner progress of the traditional schooling system (Bloom, 1968; Carroll, 1963). They argued that having all learners spend the same amount of time on the same tasks would result in failing learners with low aptitude for the subjects. Therefore, individual differences in aptitude should be taken into account by allowing individual learners to spend as much time as they need to reach mastery.

Bloom's famous synthesis of empirical research on mastery-based learning supported the effectiveness of this approach. In his synthesis, when learners were given sufficient time to master the current topic by checking their understanding through ongoing formative assessments and being given an opportunity to address their learning deficiencies before moving on to the next topic, the achievement level of the average learner in the mastery group was two sigmas higher than the average learner in the conventional group, known as the 2-sigma effect. Other studies to date have reported consistent positive outcomes for competency-based learner progress (S.A. Anderson et al., 1992; Kulik, Kulik, & Bangert-Drowns, 1990; Light, Reitze, & Cerrone, 2009; Research & Policy Support Group, 2010).

II. Values of LCI

The learner-centered paradigm of education is founded on the following values:

About ends (learning goals)

- Development of intrinsic motivation and love of learning is highly valued.
- Development of learner self-regulation skills (how to learn) is highly valued.
- Mastery of knowledge and skills is highly valued, including transfer to varied and real-world contexts.
- Development of collaboration skills is highly valued.
- Emotional, social, and character development are highly valued, including empathy and desire to contribute to one's community.

About priorities (criteria for successful instruction)

- Effectiveness and intrinsic motivation of the instruction are more important than efficiency.

About means (instructional methods)

- The pace of instruction should be customized to each learner (attainment-based learner progress).
- The content of instruction should be customized to each learner (individual needs, interests, talents, and goals).
- The methods of instruction should be customized to each learner (individual learning preferences).
- The methods of assessment should be customized to each learner (individual needs, interests, talents, and goals).
- Intrinsic motivation and love of learning should be cultivated.
- Learners should typically learn by doing (task-centered instruction).
- Learners should receive just-in-time support while learning by doing (instructional scaffolding).
- Learners should learn much from peers through collaboration.
- Learners should be taught to set their own goals and manage their own instruction as much as

possible (self-determination, self-regulated learning).
- Learners should be involved in assessing their own learning (self-reflection, self-evaluation).
- Both formative and summative assessment should occur throughout instruction (continuous, integrated assessment).
- Learners should make decisions about ends, priorities, and means.

About power (to make decisions about the previous three)

- Empowering learners to make decisions about ends, priorities, and means is highly valued.

III. Universal Principles

There are some principles of education that we propose should always be manifest in truly learner-centered education, while there are others that we believe should be present in some situations but not others. We describe the universal principles here, followed by the situational principles in the following section.

One of the key characteristics that distinguishes the Information Age from the preceding Industrial Age is holism (integration of tasks) replacing compartmentalization (division of tasks). Consequently, it is inappropriate to try to address instructional theory in isolation from other kinds of educational theories, such as those for curriculum, learner assessment, recordkeeping, planning, and the proper use of technology in education. Hence, we address universal principles in all these areas when appropriate.

We propose five foundational educational principles or guidelines for learner-centered education:

1. **Attainment-based instruction**: Learner progress should be based on learning rather than time.
2. **Task-centered instruction**: Instruction should be organized around the performance of authentic tasks.
3. **Personalized instruction**: Instruction during task performance should be personalized.
4. **Changed roles**: The roles of the teacher, learner, and technology should be transformed.
5. **Changed curriculum**: The curriculum should be extended and reorganized.

The universal principles for learner-centered education are grouped into these five main categories.

1. Attainment-Based Instruction

To be truly learner-centered, instruction must be structured so that learner progress is based on learning rather than on time (Bloom, 1968, 1981; Carroll, 1963; Reigeluth & Karnopp, 2013). While commonly called competency-based instruction, there are important kinds of learning besides competencies, such as dispositions (e.g., attitudes, values, morals, and ethics) and emotional development. Hence, we prefer the more comprehensive term, *attainment-based instruction*. For learner progress to be based on attainments, learner assessment must be criterion-referenced rather than norm-referenced, and learner records must also be lists (or maps) of attainments rather than lists of courses with grades. Chapter 2 focuses on this principle.

Attainment-based instruction ensures that learners fully master the current topic before moving on to the next topic. It helps learners to move at their own pace by allowing them to spend as much or little time as they need on the current topic, which improves efficiency in the learning process by not making fast learners wait for the rest of the class before they can move on, and by not forcing slow learners to move on before they have mastered the material, so they don't accumulate deficits in their learning that make it more difficult for them to learn related material in the future. Attainment-based instruction entails three components: attainment-based learner progress, assessment, and learner records.

1.1 Attainment-based learner progress

Each learner's progress should be based on reaching the learning goals (standards and criteria for mastery), rather than based on time.[*] This ensures that learners are not forced to move on to the next topic without mastering the current one. It helps learners to effectively construct their new knowledge based on pre-existing or pre-required knowledge and facilitates deep understanding of the subject matter (American Psychological Association Presidential Task Force on Psychology in Education, 1993; Bransford et al., 2000).

1.2 Attainment-based learner assessment

Each learner should be assessed through comparison with the criteria for mastery (criterion-referenced assessment) rather than through comparison with other learners (norm-referenced assessment). The purposes of assessment in attainment-based instruction are to check learners' understanding, identify learning deficiencies, and make sure learners reach a high enough level of mastery on the topic before moving on. Criterion-referenced assessment is more appropriate than norm-referenced to serve these purposes, as the domain to be tested is more narrowly and precisely defined, and there should be enough items to thoroughly cover the content (Thorndike & Thorndike-Christ, 2010).[*]

1.3 Attainment-based learner records

Each learner's records should be a list or map of individual attainments, rather than a traditional report card with names of courses and letter or number grades. The traditional report card does not provide information about learners' competencies on specific topics and does not inform about the learners' learning needs. Having a domain map of individual attainments helps teachers track learner progress towards their learning goals, identify learning needs,and select appropriate instructional materials (Miliband, 2006; Sturgis & Patrick, 2010).[**]

None of these three principles falls under what is typically thought of as instructional design theory. In Volume I of *Instructional-Design Theories and Models*, Reigeluth identified five major categories of educational theory: instruction, curriculum, counseling, administration, and evaluation (see Fig 1.1 in Reigeluth, 1983). Within instructional theory, he identified design, development, implementation, management, and evaluation as additional categories for theory. The term "instructional theory" is generally thought to address only the instructional design category. However, the three principles described here, which belong in the instructional management category, may have a greater impact on learning than most instructional design strategies.

2. Task-Centered Instruction

To foster intrinsic motivation, instruction should be centered on authentic, collaborative tasks that are interesting to the learner and appropriate to her or his levels of development. These include projects, problems, inquiries, and other forms of learning by doing. However, scaffolding should be provided within the task environment when possible, to accelerate learning and make it more motivating. Chapter 3 focuses on this principle. Chapters 6–10, 12, 14, and 15[*] provide multiple examples of specific instructional strategies that elaborate this principle.[**]

Task-centered instruction situates learners in an authentic environment in which they are likely to use the new knowledge, and helps learners to better see connections with other knowledge and skills (American Psychological Association Presidential Task Force on Psychology in Education, 1993; Bransford et al., 2000; Merrill, 2013). Much research has revealed several educational benefits of task-centered instruction, such as development of critical thinking, problem solving, creative thinking, collaboration, communication, and meta-cognitive skills, as well as learners becoming more motivated and self-directed (Barrows, 1986; Bell, 2010; Blumenfeld et al., 1991; Duch, Groh, & Allen, 2001;

Gijbels, Dochy, Van den Bossche, & Segers, 2005; Hmelo-Silver, 2004; Jonassen, 2000, 2004; Savery, 2006; Savery & Duffy, 1996; Şendağ & Ferhan Odabaşı, 2009; Torp & Sage, 2002).

2.1 Task environment

Most instruction should be organized around the performance of a task. The task should be:

- of great interest to the learner—relevant to the learner's life—preferably either designed or selected by the learner, with teacher and parent input;[***]
- aligned with the learner's learning goals (which are typically selected by the learner based on standards, with teacher and parent input);[†]
- of significant duration—lasting for weeks or even months;
- within an immersive environment—real or virtual;[††]
- authentic or realistic, which typically makes them interdisciplinary.[†††]

2.2 Scaffolding

Three types of scaffolding should be used whenever the task is too difficult for the learner: adjusting, coaching, and instructing.[*]

- **Adjusting.** The complexity of the task should be adjusted to be neither too challenging nor too easy for the learner. This is done by identifying conditions that make some real-world versions of the task simpler than others. The learner's record of attainments can then be used to select the most appropriate level of complexity for the task.[**]
- **Coaching.** When the learner lacks some relatively easy-to-learn information to perform the task well, the information should be provided just-in-time. However, that information should be tested later for retention and possibly transfer, depending on the learning goals.[***]
- **Instructing.** When the learner lacks an attainment that is difficult to learn through a single coaching experience, then time on the task should be paused, and instruction (tutoring) should be provided just-in-time until the attainment is mastered, at which point the learner resumes work on the task, using the newly acquired attainment. Since this instruction is piggybacked onto the task environment, it is often called "instructional overlay."[‡] Merrill (2013) is an outstanding resource for designing such just-in-time tutorial instruction.

3. Personalized Instruction

To maximize learning, instruction should be personalized, with respect to the goals, the nature of the tasks used to achieve the goals, the nature of the scaffolding provided during the task performance, the nature of assessment of the learner's learning and task performance, and the nature of reflection on the learner's learning and task performance. The principles for each of these five aspects of personalized instruction are described here. Furthermore, instruction should be personalized based on learners' competency level, learning or career goals, interests, and other characteristics. Chapter 4 focuses on these principles. Instructional theories described in Chapters 6, 7, 10, and 14 implement many of these principles.[††]

3.1 Personalized goals

Two kinds of goals should be personalized:[*]

- **Long-term goals.** Career and life goals should be discussed and established by each individual learner, even though they are likely to change often. They provide extra motivation and direction for learning.[**]

- **Short-term goals.** The learning goals to be pursued for the next project period should be discussed and established by each individual learner. They provide the basis for task selection (see 3.2 below).[***]

3.2 Personalized task environment

Several aspects of the task environment should be personalized:[†]

- **Task selection.** The task itself should be personalized to the learner's learning goals, interests, and prior learning. This includes adjusting the task complexity to the level appropriate for the learner's development.[††]
- **Collaboration.** The decision about whether to have teammates and who to have as teammates should be personalized to the learner's needs and preferences.[†††]
- **Self-regulation.** The nature and amount of self-regulation should be personalized to the learner's self-regulation skills and developmental needs.[‡]

3.3 Personalized scaffolding

Two aspects of the coaching and instructing should also be personalized:[‡‡]

- **Quantity.** The amount of coaching and instructing should be personalized to the learner's needs.[‡‡‡]
- **Quality.** The nature of the coaching and instructing should be personalized to the learner's needs and learning styles.

3.4 Personalized assessment

Two aspects of assessment should be personalized:[*]

- **Assessor.** The choice of assessor of the performance (teacher, peer, computer system, or external expert) should be personalized.
- **Representation.** The choice of representation or format for the demonstration of competence should be personalized.

3.5 Personalized reflection

Two aspects of reflection should be personalized:[**]

- **Learning process.** The way the learner reflects on the process by which he or she learned during the task should be personalized.
- **Learning outcome.** The way the learner reflects on the product or performance that results from completion of the task should be personalized.[***]

4. Changed Roles

To implement the above principles of learner-centered instruction, the teacher's role must change dramatically, from the "sage on the stage" to the "guide on the side" (Reigeluth & Karnopp, 2013). The teacher must be a co-designer (or co-selector) of learner work, a facilitator of learner work (provider of scaffolding), and a caring mentor. The learner's role must change from passive and teacher-directed to active and self-directed (which is not an easy change for older learners). And technology's role must change from primarily a tool for the teacher to primarily a tool for the learner.[†] This includes four major functions: planning for learning (selecting tasks and creating a personal learning plan for each learner), instruction for learning (often providing an immersive task environment and a virtual pedagogical agent for just-in-time scaffolding), assessment for/of learning (criterion-referenced and integrated with the instruction, as in the Khan Academy), and recordkeeping for learning (a list or map of individual attainments). These transformed roles are addressed throughout most of the chapters in this volume.

It is unusual for roles to be specified by instructional design theory, yet roles are critical for successful implementation of any instructional strategy. Therefore, it is important to offer design guidelines for the roles of the teacher, learner, and technology.

4.1 Teacher roles

The teacher's role should be dramatically different in the learner-centered paradigm, as follows:

- **Assist learners in setting goals**. The teacher should help the learner to select long-term career goals ("What do you want to be when you grow up?") and short-term learning goals, both those that meet state standards and those that are of greatest personal interest to the learner.[*]
- **Assist learners in designing or selecting tasks.** The teacher should help the learner design or select appropriate tasks to pursue his or her learning goals or, when appropriate, should do the designing or selecting for the learner.[**] The teacher should also assist in decisions about whether to work in a team and who the teammates should be. This work results in creating a personal learning plan or learning contract.
- **Facilitate task performance.** The teacher should coach the learners as they work on their tasks. This may occur on the level of individual skills needed to perform the task, or the level of higher-order thinking skills such as self-direction and reflection, or the level of project management, team-building, interpersonal relationships, and emotional development.[***]
- **Facilitate learning.** The teacher should ensure that instruction is provided just-in-time when needed. This goes beyond coaching by providing tutorials, including practice with immediate feedback, as well as demonstrations and explanations. Often, such instruction is provided by technology or peers, with monitoring by the teacher.[†]
- **Help evaluate performance and learning.** The teacher should ensure that both formative and summative evaluation are provided within both the task environment and the instructional overlay (in the scaffolding).[*] Again, such evaluation is often provided by technology or peers, with monitoring by the teacher, and the results of the summative evaluations are recorded.
- **Mentor the learner**. Every learner should have a caring mentor who motivates and guides the learner in all aspects of her or his development. This is particularly beneficial for learners who do not receive much emotional support at home.[**]

4.2 Learner roles

The learner's role should include the following:

- **Active learner.** The learner should be an active rather than passive learner. This means learning by doing rather than learning by listening, watching, or reading.[***]
- **Self-regulated learner.** The learner should be self-directed rather than teacher-directed, as much as possible, given the learner's self-regulation skills. The teacher should devote considerable effort to developing those skills, including goal setting and designing or selecting tasks.[†]
- **Learner as teacher.** The learner should engage in teaching things that she or he has just learned, for this is as great a benefit to the one teaching as to the one being taught.[††]

4.3 Technology roles[‡‡‡]

To support learner-centered instruction, technology should be used whenever appropriate to serve the following functions:

- **Recordkeeping for learning.** Provide a list or map of all standards that are possible to learn (not just a "common core"), broken down to the level of individual skills, understandings, and other kinds of attainments. Provide the capability to mark all of those attainments that have been mastered by each individual learner (as is done by the Khan Academy).[‡] And provide an inventory of each learner's characteristics that should influence the nature of the instruction for that learner, including interests, learning styles, learning strategies, multiple intelligences, and much more.
- **Planning for learning.** Provide a tool to help each learner, in collaboration with his or her teacher and parents, to select career goals, select short-term learning goals (e.g., for the next project period), select tasks as vehicles for meeting those learning goals, select teammates (if any) for each task, and create a personal learning plan or contract.
- **Instruction for learning.** Provide either an immersive, authentic, virtual, task environment or suggestions for engaging in a real, local, task environment. Also, either provide virtual, just-in-time coaching and instruction ("instructional overlay" or scaffolding), preferably through a virtual pedagogical agent, or provide guidance for just-in-time peer and/or teacher coaching and instruction.
- **Assessment for and of learning.** Provide for formative evaluation for learning through immediate feedback on learner performances in the instructional overlay. Also, provide for summative evaluation of learning through immediate determination of whether the learner has met the criterion for mastery in the instructional overlay (e.g., the last 10 practice items correct without assistance). Finally, provide for formative and summative assessment of team performance in the task environment.

5. Changed Curriculum

What to teach is considered curriculum theory, in contrast to instructional theory, which is concerned with how to teach it. Yet, this is an aspect of paradigm change that is arguably as important as instructional theory, assessment theory, and other dimensions of educational theory (educational superstructure) such as attainment-based learner progress and new roles for teachers, learners, and technology. Therefore, it is important to offer principles about what should be taught.

To be truly learner-centered, instruction must address all important aspects of each individual learner's development, including emotional, social, and character development, as well as cognitive and physical development. It must also be reorganized in a way that is more closely related to people's lives and more interdisciplinary, such as thinking effectively, acting effectively, relating effectively, and accomplishing effectively. Chapter 5 focuses on this principle. Chapters 6, 7, and 14, focused on production-oriented instruction, describe the implementation of instruction that is not constrained by current academic curriculum alignment.

5.1 Expanded curriculum

The Partnership for 21st Century Skills (n.d.) has identified particular attainments that fall into these categories: 1) core subjects (the 3 Rs) and 21st-century themes; 2) learning and innovation skills (creativity and innovation, critical thinking and problem solving, and communication and collaboration; 3) information, media and technology skills (information literacy, media literacy, and technology literacy[*]); and 4) life and career skills. Furthermore, Daniel Goleman (1995, 1998) popularized the understanding that emotional development is more important than cognitive development to a person's success in life. Emotional and social development, largely overlooked in the teacher-centered paradigm of education (and training), should therefore be addressed. Mental and physical health is equally important to the individual and society. And attitudes, values, morals, and ethics are also important to the success of individuals, families, communities, and entire countries. However, adding so much to the curriculum would be problematic, even with the considerably greater efficiency of learner-centered instruction, so paradigm change is needed within the curriculum and some elements of the current curriculum should no longer be required of all learners.

5.2 Fundamentally restructured curriculum

Prensky (2014) has proposed a fundamental redesign of the P-16 curriculum, from being organized around the four pillars of math, science, literacy, and social studies, to being organized around the four pillars of effective thinking, effective acting, effective relationships, and effective accomplishment. Many elements of the current curriculum would still be taught, but they would be reorganized. For example, effective thinking would include mathematical thinking and scientific thinking, as well as critical thinking, problem solving, design thinking, systems thinking, and self-knowledge of one's passions, strengths, and weaknesses, among others.[**]

IV. Situational Principles

In Chapter 1 of Volume III of *Instructional-Design Theories and Models*, Reigeluth and Carr-Chellman (2009) described that methods (and therefore the principles that encompass them) exist on a continuum ranging from high generality (universal, used in all situations) to low generality (local, or only used in rare situations). The authors also described that methods (and therefore principles) exist on a continuum ranging from highly imprecise to highly precise in the guidance they provide. The more precise a principle or method, the more useful yet local (narrow) it is likely to be. The principles described above are highly imprecise but serve to provide a useful "big picture" of learner-centered education.

The remaining chapters in this volume provide greater precision and thereby greater usefulness to designers, educators, and trainers. However, we also offer here some situational variables (situationalities) that call for variations in the methods described in the above principles. Of course, there are many more situationalities not described here, with correspondingly more detailed descriptions of the methods and guidance for each. Here we just identify ones we believe are most important.

Principle 2.1: Task Environment. One aspect of this principle is that the task should be authentic or realistic. However, some fantasy task settings can be powerful vehicles for learning. The universal aspect of this principle is that the nature of the performance should be authentic, so the cognitive processing will be authentic and thereby transfer to real settings. However, the task environment within which the learning occurs does not always have to be authentic. Some situations in which an inauthentic environment would be preferable include: a) when it is more motivational for the learner than an authentic environment, b) when it can prevent cognitive overload associated with a truly authentic environment, or c) when it can be sufficiently safer or less expensive than an authentic environment.[*]

Principle 2.1: Task Environment. Another aspect of this principle is that the task should be of great interest to the learner. This can be accomplished in different ways: by helping the learner to select a task or by helping the learner to design his or her own task. Designing might be preferable: a) when the available tasks from which to choose are inadequate given the learner's learning needs and interests, b) when there is sufficient time for the learner and teacher to design it, and/or c) designing a task is itself an important learning goal.

Principle 2.1: Task Environment. The task may be project-based, problem-based, inquiry-based, or maker-based. The selection of each of these variations depends mostly on the nature of the task needed, which in turn depends on the nature of what is to be learned. For example, in medical school, problems are much more common than projects, whereas in instructional design programs, projects are much more common than problems. Inquiry-based tasks tend to be more appropriate for basic science (descriptive theory), whereas maker-based tasks tend to be more appropriate for applied science (design theory).

Principle 2.2: Scaffolding. Just-in-time coaching and instructing can be universal (initiated at a predetermined point in the performance of a task for all learners), or triggered (when a certain learner action indicates it is needed), or requested (when the learner asks for help). Triggered is likely preferable when efficiency of learning is more important than developing self-regulated learning skills. Universal is likely only preferable when cost or logistical factors are paramount.[**]

Principle 2.2: Scaffolding. Just-in-time coaching and instructing can also be offered by the teacher, another learner (peer), an expert in the task, or technology. In a classroom situation, it may be preferable for it to be offered by another learner (because this tends to help the other learner as well, to build relationships among learners, and to be least expensive). If that doesn't work, then it will likely be best for it to be offered by the teacher. But if an outside expert in the task is available and the difficulty the learner is having is of sufficient magnitude, the outside expert is usually the best option. In a computer system (simulation or virtual learning environment), it is preferable to use a virtual coach if the number of learners justifies the expense of creating the virtual coach and sufficient budget is available.

Principle 2.2: Scaffolding. Just-in-time coaching can be in the form of a leading question or information or a hint or an explanation (developing an understanding). This depends largely on the kind of learning and kind of learning problem the learner has. Questions and hints tend to cause deeper cognitive processing and better understanding and retention. Providing information and explanations tends to be quicker (more time efficient). Information tends to be useful for lower levels of learning, while explanations are more useful for higher levels.

Principle 4.2: Learner roles. The kinds and amounts of self-direction given to the learner should vary with the kinds and levels of self-regulated learning skills the learner has developed.

These are but a few of the many situational principles that can be identified as we provide more detailed guidance for each of the universal principles. The remaining chapters in this volume provide additional guidance within this big-picture view of the learner-centered paradigm of education.

V. Closing Remarks

The learner-centered paradigm of education is fundamentally different from the teacher-centered paradigm. The universal principle of attainment-based instruction means that grade levels, grades, and even classrooms as we know them are inappropriate and detrimental to learner success. Consequently, best practices for the teacher-centered paradigm typically bear little resemblance to best practices for the learner-centered paradigm. Furthermore, to be useful, research on design theory for the learner-centered paradigm needs to be conducted within that paradigm, or the results will be suspect.

This means that there is a strong need for researchers and theorists to work in school systems that conform to the basics of the learner-centered paradigm. Fortunately, there are many such systems already. In 2012 a research team at Indiana University[1] identified over 140 such systems (see Appendix A in Reigeluth & Karnopp, 2013).

There is also a strong need for educators to recognize that the features of a learner-centered school system cannot be adopted one at a time. This would akin to trying to transform a railroad into an airline one feature at a time. Fundamental changes in just a few features makes those features incompatible with the rest of the system, which consequently tries to change them back. A "critical mass" of features must be changed all at once, so that they will exert more pressure on other features to change than the other features will exert on the transformed features to change back. For more about the transformation process, see Chapter 4 in Reigeluth and Karnopp (2013).

It is our sincere hope that readers of this book will join the effort to advance knowledge about the learner-centered paradigm and contribute to the transformation process for the benefit of our children, their communities, and their country.

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Notes

* *Editors' note: This is addressed by Principle 3 in Chapter 2, Principles for Competency-Based Education; by Principle 5 in Chapter 10, Designing Instructional Coaching; and by several principles in Chapter 9, Designing Instruction for Self-regulated Learning. While none of the approaches in Unit 3 explicitly advocates this principle, all seem compatible with attainment-based approaches.*

* *Editors' note: This is elaborated by Principles 4-6 in Chapter 2, Principle 4.8 in Chapter 8, Designing Games for Learning, Principle 3 in Chapter 9, and Principles 1.1 and 4.2 in Chapter 11, Designing Technology for the Learner-Centered Paradigm of Education.*

** *Editors' note: This is addressed by Principle 7 in Chapter 2 and Principle 1.2 in Chapter 11.*

* *Editors' note: The just-in-time instruction described in Chapter 15 specifies engagement in tasks that may be simpler and shorter in duration than tasks as described in this chapter and Chapter 3.*

** *Editors' note: Content gamification of instruction as described in Chapter 13 emphasizes engaging learners in activities that offer meaningful choices and foster a sense of autonomy. These activities could be structured as a series of increasingly challenging tasks with scaffolding and feedback.*

*** *Editors' note: This is elaborated by Principle 1 in Chapter 6, Designing Maker-Based Instruction, Principle 1 in Chapter 7, Designing Collaborative Production of Digital Media, and Principle 1 in Chapter 9.*

† *Editors' note: This is elaborated by Principle 3 in Chapter 6 and Principle 1 in Chapter 10.*

†† *Editors' note: This is elaborated by Situational Principle 1 in Chapter 6, Principle 1.2 and Principle Category 2 in Chapter 8, and Principle 3 in Chapter 14.*

††† *Editors' note: This is addressed by Principle 1 in Chapter 3, Principle 5 in Chapter 6, and Principle 1.2 in Chapter 8.*

* *Editors' note: This is elaborated by Principle 4 in Chapter 6 and Principle Category 3 in Chapter 8.*

** *Editors' note: This is elaborated by Principle 3.1 and Situational Principal 5.1 in Chapter 8.*

*** *Editors' note: This is elaborated by Principle 3.2 and Situational Principle 5.2 in Chapter 8.*

† *Editors' note: This is elaborated by Principles 2–5 in Chapter 3 and Principle 3.3 in Chapter 8.*

†† *Editors' note: While Chapter 12, Designing Instruction for Flipped Classrooms, does not directly address personalizing instruction, it embraces the idea that a community of learners will adapt designed instruction to meet its needs. Similarly, in the just-in-time approach discussed in Chapter 15, learners exert great influence on in-class instruction because it is adapted based on the learners' pre-class activities and expressed understandings.*

* *Editors' note: These are both elaborated by Principle 1 in Chapter 4, Principles for Personalized Instruction, Principle 2 in Chapter 9, and Principle 1 in Chapter 10.*

** *Editors' note: This is elaborated by Principle 2.1 in Chapter 11.*

*** *Editors' note: This is elaborated by Principle 2.3 in Chapter 11.*

† *Editors' note: These are elaborated by Principle 2 in Chapter 4, Principle 1 in Chapter 7, and Principle 3.1 in Chapter 11.*

†† *Editors' note: This is elaborated by Principles 1 and 3 in Chapter 6, Principle 1.6 in Chapter 8, Principle 2 in Chapter 10, and Principle 2.4 in Chapter 11. Aspects of gamification discussed in Chapter 13 could apply personalization by structuring the content so that many paths through a variety of increasingly difficult tasks are available to learners.*

††† *Editors' note: This is elaborated by Principle 1.6 in Chapter 8 and Principle 2.5 in Chapter 11.*

‡ *Editors' note: This is elaborated by the third situational principle in Chapter 9.*

‡‡ *Editors' note: These are elaborated by Principle 3 in Chapter 4, Principle 6 and Situational Principle 3 in Chapter 6, most of the principles in Chapter 10, and Principle 3.2 in Chapter 11.*

‡‡‡ *Editors' note: This is elaborated by Principle 1.4 in Chapter 8.*

* *Editors' note: These are elaborated by Principle 4 in Chapter 4, Principle 3 in Chapter 6, Principle 3 in Chapter 7, Principle 5 in Chapter 10 and Principle 4.1 in Chapter 11.*

** *Editors' note: These are elaborated by Principle 5 in Chapter 4, Principle 2 in Chapter 7 and Principle 6 in Chapter 10.*

*** *Editors' note: This is elaborated by Principle 7 in Chapter 6.*

† *Editors' note: The approach to mobile learning discussed in Chapter 14 emphasizes these changed roles, with teachers being much more facilitative, learners being much more self-regulating, and the affordances of mobile technology being a critical factor in the learning experience.*

* *Editors' note: This is elaborated by Principle 1 in Chapter 4, throughout much of Chapter 5, Principle 3 in Chapter 6, and Principle 1 in Chapter 7.*

** *Editors' note: These are elaborated by Principle 2 in Chapter 4, Principle 4 in Chapter 6, Principle 2 in Chapter 9, and Principles 2 and 3 in Chapter 14.*

*** *Editors' note: These are elaborated by Principle 1 in Chapter 3, Principle 3 in Chapter 4, Principle 5 in Chapter 6, Principle 1 in Chapter 9 and Principle 2 in Chapter 10.*

† *Editors' note: These are elaborated by Principles 1–5 in Chapter 3, Principle 3 in Chapter 4, Principle 6 in Chapter 6, and Principles 3, 4, and 5 in Chapter 10.*

* *Editors' note: These are elaborated by Principles 5 and 6 in Chapter 2, Principle 4 in Chapter 3, Principle 4 in Chapter 4, and Principle 2 in Chapter 7.*

** *Editors' note: This principle is not addressed by many theories in this volume, due to their focus on academic learning to the exclusion of educating the whole learner. However, Principle 4 in Chapter 7 does address academic mentorship.*

*** *Editors' note: This is elaborated by virtually all the chapters in this volume.*

† *Editors' note: This is elaborated in greatest depth by all of Chapter 9.*

†† *Editors' note: This is elaborated by Principles 3 and 4 in Chapter 4 and Principles 2–4 in Chapter 7.*

††† *Editors' note: This is elaborated in detail in Chapter 11.*

‡ *Editors' note: This is addressed by Principle 3 in Chapter 13, Gamification Designs for Instruction.*

* *Editors' note: These skills are a particular focus on Chapter 14, Design Considerations for Mobile Learning.*

** *Editors' note: This is elaborated extensively by all of Chapter 5.*

* *Editors' note: Chapter 8 provides an illustration of this situational principle, since many game-based instructional environments create immersive yet inauthentic environments that are instructionally effective.*

** *Editors' note: This is elaborated by Principle 6 in Chapter 6.*

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2

PRINCIPLES FOR COMPETENCY-BASED EDUCATION

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Richard A. "Rick" Voorhees engages in innovative education practice, drawing on purposefully varied experiences as a faculty member, senior administrator, policy analyst, and consultant to colleges, foundations, state agencies, and national organizations. He has authored works in competency-based learning, student retention, strategic planning, and use of actionable data for decision making. He chaired the first federal taskforce focused on competency-based learning in higher education and the workplace that produced *Defining and Assessing Learning: Exploring Competency-Based Initiatives* (2002). Dr. Voorhees also edited the sourcebook *Measuring What Matters: Competency Based Learning Models* (2001).

Alice Bedard-Voorhees is the founder of the Constant Learning Organization. For more than two decades she has guided and evaluated curriculum and competency-based initiatives, including development of a learning repository for delivery of competency-based career and technical education, training faculty competency writing teams, and evaluating course and assessment designs for two- and four-year institutions and the workplace. She is the author or co-author of other chapters focusing on competency and assessment, *Letting Them Show What They Know: Digital Assessment Strategies* (2011), *Assessment of Online Education: Policies, Practices, and Recommendations* (2004), and *Creating and Implementing Competency-Based Learning Models* (2001).

EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *CBE can guide the mastery of all content.*

Learners

- *Self-motivated and older learners tend to do better in CBE, as do students with previous CBE experience.*

Learning environments

- *CBE is easier to implement in environments where time is flexible.*

Instructional development constraints

- *Individual competencies must be identified, which requires significant development time.*

Values (opinions about what is important)

About ends (learning goals)

- *Learning is both explicit and measurable.*
- *Each individual student's successful learning is highly valued.*
- *The learning experience should be driven by a documented gap between what the learner knows and what she or he needs to know.*

About priorities (criteria for successful instruction)

- *Effectiveness is more important than efficiency or appeal.*

About means (instructional methods)

- *Time is only a proximal measure of learning.*
- *Allowing each student sufficient time to learn is highly valued.*
- *Demonstration provides proof that learning has occurred.*
- *The instructor's role should be transformed from the keeper and purveyor of information to facilitator of learning.*

About power (to make decisions about the previous three)

- *Learners should play a critical role in establishing assessment expectations.*

Universal Principles

1. State competencies based on desired learner performance

- *The statement of each competency should indicate its domain (cognitive, affective, or psychomotor); its level in Bloom's taxonomy; its measurement context; its criteria and threshold for learner mastery; and how it should be adjusted to the prior experiences, traits, characteristics, and needs of the learner.*
- *Each competency statement should use active and specific language unambiguously.*
- *Competency statements should be clear, with tight definitions of what the learner needs to demonstrate, and compatible with other competency statements. This requires consensus on vocabulary and performance assessment.*
- *Complex competencies should be decomposed into observable behaviors and measurable competency statements.*
- *The learning outcomes and expected performance should be clearly understood by the learner and teacher before the instruction begins.*

2. Use scaffolding to support achievement of an entire set of competencies

- *Scaffolding should be used to demarcate a clear pathway or map showing alternative sequences for the learner to achieve a set of competencies, as well as linkages among the competencies.*
- *The sequence of competencies should be adjusted based on learner experience.*

3. Structure competencies to accelerate learning

- *Learner progress should be based on mastery rather than time.*
- *Competencies should be customized to fit the preexisting knowledge of each individual learner.*
- *The structure of the CBE program should not be too elaborate. Exclude superfluous steps to mastery of a competency.*

4. Competency assessments should be criterion-referenced, personalized, and flexible

- *Competency assessments should be criterion-referenced rather than normative (comparing students to each other).*
- *The methods and techniques by which competencies are assessed should be flexible, be designed to fit the individual, and provide teachers and learners a framework in which to experiment.*

5. Competency statements determine appropriate assessments

- *Learners should know* a priori *how they will be assessed. This will help them to direct their own learning.*
- *Competencies should be assessed frequently to inform the learner and teacher.*
- *Assessments should be guided by predefined rubrics that specify the level of performance required.*
- *Assessment (including by self and peers) should be done through demonstrations of learning.*
- *Higher levels of learning should be assessed by decomposing them into part tasks that can be demonstrated and measured.*
- *Learners should participate in determining how they will be assessed.*
- *CBE should assess the extent to which learners can generalize or transfer a given competency to diverse situations.*

6. Balance the use of locally and commercially developed assessments

- *Commercial assessments may not provide guidance to improve student learning. In such cases, faculty-developed assessments should be developed and used.*
- *Commercial assessments should only be used if they accurately and meaningfully measure mastery of the student's education goals.*

7. Implement a CBE tracking system

- *Systematic recording of each learner's mastery of competencies is critical and more difficult than recording accumulated credit hours and clock hours.*
- *Try to find or create technology tools to use for competency tracking.*

8. Successful CBE instruction requires evaluation

- *Evaluation of the CBE instruction should be an integral part of the instructional process and used to improve the instruction*
- *Frequent assessment of competencies should guide the recalibration of competencies based on previous learner performance.*

Situational Principles

- *When only part of a program changes to CBE, some features cannot be implemented, such as organizing instruction around tasks instead of courses, student progress based on learning rather than time, student records in the form of lists of competencies attained rather than norm-referenced grades, and use of direct rather than indirect assessment.*
- *The assessment of a higher-order competency may make it unnecessary to assess its sub-competencies. Conversely, continuous assessment of sub-competencies as they are learned may make it unnecessary to have a final, higher-order assessment.*

Implementation Challenges

- *CBE requires changes to the traditional instructional and business models in education.*
- *Teachers' mental models, knowledge, skills, and desire to engage in the change all need to be developed for successful CBE.*
- *Full implementation of CBE requires significant resources, leadership, and other capabilities.*
- *Learners and faculty may resist the shift to CBE.*
- *Continuous improvement will be an important element in CBE implementation.*
- *Administrative support is key to CBE implementation and whether CBE can be scaled or sustained.*
- *When an organization decides to move toward locally developing assessment, formal training of faculty and staff are required.*
- *It may become necessary to rearrange or streamline the course structure.*
- *It may be difficult to strike the right balance between granularity (unique competencies) and interoperability (general competencies).*
- *Insufficient technological tools are available to support the student and teacher in CBE.*
- *Accurate measurement will require teacher training.*
- *Given the complexity of implementing CBE, periodic use of an organizational evaluation checklist may be helpful.*

– C.M.R., B.J.B., & R.D.M.

PRINCIPLES FOR COMPETENCY-BASED EDUCATION

I. Introduction

This chapter explores the connections between instructional design and competency-based approaches to education, especially how these connections can help people learn more effectively. Chapter 1 in this volume makes the case for attainment-based education, an approach that not only incorporates what most practitioners have in mind when referring to competency-based education, but extends the paradigm somewhat to consider other concepts including dispositions, values, and emotional development. While these two terms may eventually become synonymous to many practitioners, we use the more ubiquitous term, competency-based education, throughout this chapter.

Our focus is to recognize the designer's role in organizing content, activities, and assessments to improve learning. We do so by presenting and reviewing principles for the effective design of competency-based education, principles that can also be used to develop and improve attainment-based education. An instructional designer is frequently a team member working with subject-matter experts, assessment experts, graphic specialists, and/or instructors who facilitate desired learning. Each role will benefit from clear design principles that can improve the effectiveness, efficiency, and appeal of instruction. While most of this chapter's discussions center on postsecondary education, the principles and practices explored here are also applicable for K-12 education as well as the wider non-credit and workplace training arenas.

Competencies challenge century-old traditions for measuring and reporting learning progress. That is to say that educators have become accustomed to relying on time spent on structured learning activities as a proxy for documenting learning. In 1910, the Carnegie Foundation for the Advancement of Teaching developed the standard units of time for higher education (credit hour) and secondary education (student hour) as the preferred form of academic currency. However, this standardization moved the instructional focus to "the efficiency and productivity of educational institutions in a manner similar to that of industrial factories" (cited in Barrow, 1990, p. 67).

The Imperative and Context for Competencies

Competency-based education (CBE) provides a fresh look at learning because it shifts the focus from seat time as a passive activity to active and intentional demonstrations of learning. While its history is now more than five decades old, recent recognition of its utility in demystifying educational processes by linking learning to measurement has brought CBE increasingly to the forefront. In K-12 education, adoption of the Common Core State Standards by 42 states and the District of Columbia has accelerated interest in measuring student learning.[1] New Hampshire, for example, has established a CBE system that translates the new core standards into actual skills (Education Week, 2015). Higher education periodicals and the national press document CBE's potential and actual impact on policymakers, academic leaders, foundations and institutions, chiefly as a perceived faster route to completion of degrees and certificates. It is now estimated that 500,000 students across 750 colleges will be enrolled in CBE programs by the year 2020 (Eduventures, 2015). The federal government recently reminded postsecondary institutions that it is permissible to award student financial aid for programs that are not directly tied to the credit hour (U.S. Department of Education, n.d.).

At the K-12 level, a handful of states are using CBE to reinvent secondary education. New Hampshire is initiating high school redesign that replaces the time-based Carnegie unit with a competency-based system focused on personalized learning (U.S. Department of Education, n.d.). Oregon has a long history in CBE that culminates at the secondary level in a Certificate of Initial Mastery (CIM), Certificate of Advanced Mastery (CAM) and Proficiency-based Admissions Standards System (PASS) for entry into that state's public higher education system (Oregon Department of Education, n.d.). Most institutions of higher education have some experience in providing options for students to receive credit for learning occurring outside of the college classroom. The Council for the Advancement of Experiential Learning (CAEL) has advocated for CBE since the early 1970s (CAEL, n.d.). CAEL pioneered the concept of

Prior Learning Assessment and established guidelines for the evaluation and assessment of an individual's life learning for college credit, certification, or advanced standing toward further education or training. The American Council of Education's College Credit Recommendation Service connects workplace learning to college credit by publishing equivalency guides for formal courses and examinations taken outside traditional higher education degree programs (American Council on Education, n.d.).

What is now different at the postsecondary level is the adoption of direct assessment by a handful of institutions. The traditional process for exchanging competencies for credit meant mapping a set of competencies from students' learning experiences to time-linked courses and programs, a process known as indirect competency assessment. In direct assessment, the award of credit is based entirely on assessed learning, not indirectly on time spent in existing courses. Northern Arizona University recently created a competency-based personalized learning program for which students are issued two transcripts. The first is a traditional academic transcript, and the second directly describes their proficiency in pre-defined competencies and concepts required for their degree.

Resurgent interest in competencies is accompanied by important cautions. Situationally, some students may be more likely to succeed in CBE than others. Recent literature suggests that self-motivated learners are a better match for CBE than are younger, less mature, or less motivated individuals (Wang, 2015). CBE models fit the lifestyles of older students[*] who are beset with other non-collegiate obligations and for whom time is a premium. There are exceptions, of course, to generalized findings; it would seem logical that students in K-12 education that have experience in mastery learning might succeed in a higher education CBE program at a higher rate than former K-12 students without this background. There is a paucity of research, however, that connects student backgrounds, dispositions, and experiences to eventual success in CBE, meaning that precise guidance about what types of learners are the best match for CBE and under which circumstances is not immediately available to designers and instructors.

Competencies in other contexts

In addition to traditional education providers and K-12 educators, CBE is found in both mature and new contexts.

Unique classes, training sessions, or self-directed learning. CBE can animate one or more learning experiences within a given course or training session not linked to a full CBE program or curriculum. Particularly valuable to the learner is the practice of combining these competencies into one or more bundles that may have currency with employers, institutions of higher education, and other walks of life that require the demonstration of specific skills.

Industry-defined certifications. Certifications may also be earned apart from postsecondary education providers, including private certifiers, corporations, professional societies, and trade groups. Certifications are portable across the same industry or other allied industries, and since they are earned against a recognized standard, they are attractive to employers. Postsecondary certificate and degree programs can embed competencies required for industry certification within their curriculum, preparing the learner for the option of taking the certifying exam.

Learning as badges. Learning opportunities designed around a competency-based approach may result in the award of academic credit from an accredited higher education institution, may generate noncredit certificates of completion, or can result in "badges." Typically issued by organizations outside of traditional postsecondary providers, badges have become visible symbols of competency attainment. There is no current national or international standard for badges, which, in turn, raises questions of legitimacy among traditional education providers.

Theoretical Foundations

Defining competencies

Conflicting definitions of competencies and competency-related concepts and vocabulary abound. Differences in terminology and constructs also plague the larger field of instructional design (Reigeluth & Carr-Chellman, 2009a). The touchstone U.S. Department of Education report, *Defining and Assessing Learning: Exploring Competency-Based Initiatives* (Jones, Voorhees, and Paulson, 2002), lamented the definitional nuances and personal vocabulary choices that impede competency-based practice. This semantic stew includes many variations: competencies, goals, skills, traits, characteristics, objectives, domains, proficiencies, attainments, and outcomes. In a work nearly four decades old, Spady identified tension between practical and theoretical definitions of the CBE movement as "a bandwagon in search of a definition" (1977, p. 9).

Overlap and dissimilarities punctuate other educational approaches that make use of competencies. For example, outcomes based education (OBE), mastery learning, proficiency-based learning, and performance-based education are either directly subsumed by CBE or, to many observers, are synonymous. The vocabulary of mastery learning is most prevalent in elementary schools, less common in middle and senior high schools, and infrequently used at the college level (McCowan, 1998). While practitioners use mastery learning and CBE interchangeably, an important distinction should be observed. Competencies incorporate not simply an outcome, but also an *expected level of performance* so that the learner can demonstrate her or his mastery. In that light they are key to "performance based learning systems that document that a learner has attained a given competency or set of competencies" (Voorhees, 2001, p. 8).

By moving the emphasis from outcome to performance, we suggest that competencies define themselves by the uses to which they are put, rather than a narrow definition based on personal choice or even tradition. The reader requires some guidance, and to that end we favor the straightforward definition offered by the 2002 U.S. Department of Education report that one of the present authors co-authored (Jones et al., 2002). Namely, a competency is "the combination of skills, abilities, and knowledge needed to perform a specific task" (p. 8).

Accenting the practical, Figure 2.1 depicts the relationship among the concepts and vocabulary used in this chapter. Each rung is thought to influence those rungs above and beneath. The first rung consists of prior experiences, traits, and characteristics that form the foundation for learning upon which further experiences can be built. Differences in prior experience, traits, and characteristics can be used to explain why people pursue different learning experiences and acquire different levels and kinds of skills, abilities, and knowledge. These are developed through learning experiences, broadly defined to include, among other possibilities, not only classroom instruction, but also work and participation in community activities. Competencies in this figure are the result of integrative learning experiences in which skills, abilities, and knowledge interact to form combinations of learning germane to the task for which they have been assembled. Finally, demonstrations of competency attainment form the apex of Figure 2.1.

Bloom's Taxonomy and mastery learning

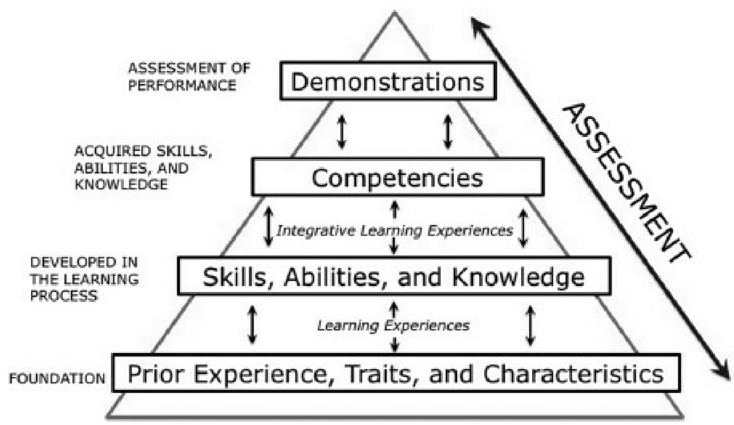

FIGURE 2.1 A Competency Hierarchy

(Adapted for this chapter from Jones, Voorhees, and Paulson, 2002)

If the structure of Figure 2.1 looks familiar to instructional designers, it could be because of its similarities to Bloom's (1956) classification of learning behaviors. Bloom's Taxonomy also is depicted as a pyramid with knowledge at the lowest level and evaluation at the top. Bloom identified three types of learning: cognitive (knowledge), affective (attitude), and psychomotor. Six major categories define Bloom's cognitive domain. Starting from the simplest to the most complex, with increasing degree of difficulty and behaviors required, these categories are: knowledge, comprehension, application, analysis, synthesis, and evaluation. Lower-level categories are normally mastered before the learner can proceed upward to the next category.[*]

The affective domain includes how learners deal with emotions, such as feelings, values, motivations, and attitudes. Krathwohl, Bloom, and Masia (1964) array affective categories hierarchically from bottom to top: receiving phenomena, responding to phenomena, valuing, organization, and internalizing values.[2] The psychomotor domain is characterized by progressive levels of physical skill development from observation to mastery. Beyond the traditional classroom, Bloom's work is influential in the training world. Trainers frequently refer to Bloom's cognitive, affective, and psychomotor domains as KSAs (knowledge, skills, and attitudes). In other countries, especially within the European Union, Bloom's Taxonomy and similar frameworks are subsumed under the label of KSC, short for knowledge, skills, and competences (see, for example, Winterton, Delamare-Le Deist, & Stringfellow, 2006). Bloom's Taxonomy has also been subject to suggested revisions to incorporate active learning strategies (Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, Raths, & Wittrock, 2001).

Learner-centered approaches and competencies

The foundations set by Dewey (1902), Taylor (1903), Thorndike (1918), Skinner (1957, 1958), and Gagné (1985) support the tasks of describing, analyzing, and measuring learning, the basis of competency-based approaches. The common ties among the learner-centered paradigm, those researchers' advocacy for the scientific method applied to education, and leadership for assessing learning propel the competency-based movement.

CBE lends specificity to the learning experience by identifying not just key learning tasks, but also a framework for learner progression toward a desired outcome. In other words, CBE meets learners where they are on a predefined set of learning expectations and follows them along the entire sequence they need to succeed. This learner-centered approach is transparent and simultaneously provides learners a firm idea of the expectations before them and a map to navigate the journey. A visible system of intended progression for competency attainment helps learners to distinguish with greater precision which competencies they have attained, thereby defying the notion that learning happens by osmosis and spreads only by happenstance. When learners understand that a given competency or set of competencies leads, in turn, to other competencies, they can more actively engage in their own educational experiences.

II. Values Underlying Competency-Based Education

A series of interrelated values underpin the design of CBE. In our experience these values are inherent in competency-based instruction.

- The individual and her or his successful learning is the focus.
- Learning is both explicit and measureable.
- Learners are a critical element in establishing assessment expectations.
- A documented gap between what the learner already knows and what she or he needs to know drives the learning experience.
- Demonstration provides unambiguous proof that learning has occurred.
- Time is critical, especially for individuals with other life obligations.

- Time is an imperfect measure of learning.
- The transformation in instructor role from purveyor of information to facilitator of learning is healthy for learners as well as instructors themselves.

III. Universal Principles

Table 2.1 is a distillation of design principles for the development or strengthening of competency-based instruction drawn from our practical experience and from synthesizing sources found in this chapter's reference section. We believe there are "many paths to the river" for assessing and measuring learning that can speed learner progress. Excellent competency-based instruction will make use of clear principles to fulfill its promise. Table 2.1 summarizes the principles we propose.

Principle 1: State competencies based on desired learner performance

Learners advance through a competency-based curriculum when they demonstrate mastery of explicit skills and knowledge needed for success. Fully formed competency statements set the stage for this mastery. A first and fundamental part of any competency statement is whether the learner will be required to demonstrate cognition, affective behavior, or psychomotor skills for a given competency statement. The second part is to locate expected learner performance along the continuum from recall to synthesis found in Bloom's Taxonomy or its suggested revisions (see for example, Krathwohl, 2002). For example, will the learner be expected only to demonstrate rote memory (as in recall), to apply a skill correctly, or will she or he be expected to integrate and synthesize concepts that suggest a higher-order mastery? A third part of the statement is to determine the measurement context. For example, will the learner be asked to write a paper or essay? Will she or he be required to make a verbal presentation? Is a physical demonstration necessary? Will a role-playing exercise be the context in which performance is judged?

A fourth part of a competency statement is to identify the threshold for learner mastery. For example, will she or he be asked to correctly recite eight of ten items in a list? Should the threshold be higher or lower? For another example, if mastery of a given competency requires synthesis, what weight is given the correct introduction of underpinning knowledge or concepts? Should the learner identify three of four facts upon which to lay the foundation for an argument or all four? For yet another example, if the learner is expected to assemble a circuit board, how many circuits must be correctly soldered before mastery is conferred? A fifth and critical part is how the expected performance matches the prior experiences, traits, and characteristics the learner brings to the instruction. That is, should the bar be set higher for those whose background may be more amenable to a higher level of performance? Or, alternatively, should careful analysis of the learner's background lead to waiving one or more specific performance requirements?*

TABLE 2.1 Design Principles for Competency-Based Instruction

1. State Competencies Based on Desired Learner Performance
2. Use Scaffolding to Support Achievement of an Entire Set of Competencies
3. Structure Competencies to Accelerate Learning
4. Competency Assessments Should Be Criterion-Referenced and Flexible
5. Competency Statements Determine Appropriate Assessments
6. Balance the Use of Locally and Commercially Developed Assessments
7. Implement a CBE Tracking System
8. Successful CBE Instruction Requires Evaluation

Successful competency-based instruction carries the obligation to define *a priori* the learning outcomes and expected performance that will be developed as a result of the learning experience (Wiggins & McTighe, 2005). This is much simpler to say than to do. CBE instruction is demarcated by a front-end investment that provides facilitators and learners alike with definitions and realistic levels of learner performance. These are necessary so that instruction occurs systematically and provides a fully developed scheme for competency attainment. That is even more important in multi-course and program designs to avoid duplication between or among learning experiences and courses, and to determine integrated assessments like capstones.

Learners know that they have reached a pre-defined level of competency when they demonstrate an expected level of performance, although it is also possible that a facilitator will need to serve as a final arbiter. Well-crafted competency statements illuminate the learning process. In contrast, loose definitions of what a learner will know or be able to demonstrate only add to ambiguity. Tight definitions that benefit the learner require consensus about vocabulary and performance measurement among those charged with developing CBE before a meaningful set of competency statements is created. Accurate description and labeling also help ensure compatibility with competency statements that have been previously developed.

Measurement is always nettlesome. A visible (and hence measurable) competency might be, for example, "Perform a series of events needed to pilot an airplane." On the other hand, a trait such as "honesty" should be decomposed into observable behaviors and competency statements. Some may argue that complex learning cannot be measured. To that stance we respond that, while in some instances measurement may be imperfect, all learning and underlying learner traits can be assessed given careful articulation of underlying behaviors and associated measurement of those behaviors. Complex behaviors can and should be decomposed and measurement strategies developed to capture learning that some may previously have thought to be impossible to measure.

Because a competency statement is based on learner performance, it also seems wise to consider learner characteristics carefully in setting desired performance levels. While attainment of a set of competencies may be expected of all individuals across an organization, different performance levels also could be set for different responsibility levels. Job responsibilities in a complex organization, for example, may require higher performance on some competencies for back-office workers than for front-line workers. Differences in expected performance should be clearly articulated for each level of responsibility.

A competency statement should begin with a present tense, active verb because it implies action (performance). For example, verbs such as apply, integrate, implement, differentiate, and formulate imply deeper engagement with the instructional content, while verbs such as "enhance" and "improve" imply hope but are largely meaningless. The expression of the level of learner performance required for mastery should reflect the learner's background.

Given specificity as a goal for describing competency statements, certain qualifying words should be avoided: good, effective, appropriate, quickly, slowly, immediately. Instead, the competency statement should have words that can be quantified so that the learner can see the required level of learner performance necessary to master a given competency. In the same vein, avoid qualifying phrases within competency statements. For example, the phrase "reading with renewed insight," can only obscure what the learner or facilitator might expect from their efforts. Competency statements require only words that are necessary and provide clarity. For example, hackneyed phrases such as "in terms of," "so as to say," and "with respect to" add nothing of value to competency statements.

Principle 2: Use scaffolding to support the achievement of an entire set of competencies

A collection of competencies placed before learners may be overwhelming if not accompanied by clear scaffolding.* Such scaffolding would demarcate a clear pathway for the learner to achieve a set of competencies, including a clear overview of how each is linked to achieve overall learning as well as which competencies, when mastered, lead to mastery of other, higher-order competencies along that pathway. In designing for higher-level competencies, instructional objectives should define the learning that is required at lower levels of Bloom's Taxonomy to master a higher-level competency. Domain maps (Bunderson, Wiley & McBride, 2009) can be created that indicate all competencies and how they are qualitatively and quantitatively related to each other (different kinds of competencies and different levels of competency).[**]

Competency maps depict sequenced and integrated competencies, providing the instructor and learner with clear learning alternatives. Scaffolding illustrates how individual competencies can be placed along the continuum from recall to synthesis in Bloom's Taxonomy.[3] Key to success are the systematic sequence of how learners can most productively progress through the intended scaffolding and the capability to adjust sequencing based on learner experience.

Instructional objectives within units of a course[*] and how they are sequenced can also play a role in creating scaffolds. Each learner in a given experience may seek or be guided along unique pathways, necessitating correspondingly unique assessments of their learning that would be posed along her or his pathway that may, in turn, trigger new learning experiences. We urge that learner choices of pathways be developed in purposeful ways.[4]

Principle 3: Structure competencies to accelerate learning

Learner progress should be based on mastery rather than time.[**] Adult learners with competing demands are likely to seek opportunities to speed or accelerate their learning experiences as a result. The extent to which learning is accelerated depends in no small part on whether instruction is customized to fit the preexisting knowledge of each individual learner.[***] The promise of CBE is found in understanding what the learner needs to demonstrate at the conclusion of a learning experience and what she or he brings to that experience so that individual learning gaps can be accurately identified and addressed. Pre-assessment is therefore a key instructional task.[†]

The use of pre-assessment to determine individual learning gaps does not ensure that learning can be accelerated, however. The structure of the CBE program itself may pose a hindrance if care is not exercised to ensure that it is not over-complicated nor unwieldy. It is important that the learner not become ensnarled in steps unnecessary to the ultimate goal, mastery of selected competencies. At the same time, hard-headed thinking about the necessity for each competency is needed, since human nature holds that it is easier to add competencies within a structure than to eliminate them. Elaborate and multi-faceted competency structures can stymie efficient progress through a CBE program.

Principle 4: Competency assessments should be criterion-referenced and flexible

Competency assessments are inherently criterion-referenced and should be linked directly to a specific skill or attribute. This is a very different paradigm of assessment requiring precision that is often missing in conventional assessment. Traditional methods for judging learning are normative in nature and seek to compare learners with one another so as to assign letter grades that signify a quantity of learning. In contrast, competencies should ideally be designed to fit the individual and not the group, resulting in multiple and unique pathways for each learner to demonstrate mastery.[*] The methods and techniques by which they are assessed should be flexible and provide learning facilitators and learners a framework in which to experiment. When it comes to designing instruction or assessment, there can be no "one size fits all." Ultimately, the flexibility for both learner and facilitator to approach construction and assessment of competencies toward a recognized learning goal underlies this chapter's theme, "many paths to the river."

Principle 5: Competency statements determine appropriate assessments

As discussed above (in Principle 1) a complete competency statement contains criteria and a threshold for learner mastery. In other words, a competency statement cannot exist without spelling out its accompanying assessment component. Creating these two sides of the same coin—competency statements and assessment criteria—is time and labor intensive, but the rewards are many. When learners can see *a priori* how they will be assessed, the entire set of competencies, or system, can be nearly self-automating, since learners and learning facilitators alike will know the steps required to reach mastery of one or more competencies. Given this information, learners can act independently and will be less dependent on the facilitator to decide when and how to undertake next steps. It also follows that, if their perceptions are actively sought about the appropriateness of competencies and assessment, they will be more engaged.

Frequent assessment of competencies should be used to inform both the facilitator and learner of the exact status of learning at defined points along the learning continuum.** To make assessment transparent to learners and facilitators, it should be guided by pre-defined rubrics that specify the level of performance that learners are to meet to master a given competency or set of competencies. Assessment should be done through student demonstrations of learning, during which they should also assess their own learning, which, in turn, can be shared with other learners engaged along the same or similar pathways.

Assessing higher-order competencies. We have heard often from some colleagues that the higher levels of learning (analysis, synthesis and evaluation in Bloom's original taxonomy) or (analyzing, evaluating, and creating in Anderson et al.'s revision) defy measurement or assessment. We argue that they can and should be assessed by decomposing the activities underneath each level into tasks that can be demonstrated and measured.* Within different instructional contexts, types of demonstration may include playing musical compositions, writing essays, doing research projects, creating business plans, designing website designs, and generating prototypes. Capstone projects are a frequent vehicle for demonstrating and combining higher-order competency attainment.

Learners and competency assessment. We also believe that learners should be drawn into the process of determining how they will be assessed and by which technique or techniques when possible.** We recommend that this conversation should be convened very early in the CBE process. Having a choice of assessment can ensure learner buy-in for competency assessment.

Assessing Degree and Breadth of Learning Transfer. CBE should also assess the extent to which learners can generalize or transfer a given competency to diverse situations. This requires instruction that addresses the general applicability of the competencies at hand in other contexts, coupled with either a direct measurement scheme that can follow the learner through future contexts in which she or he must apply acquired competencies, perhaps even beyond completion of the CBE program. Less ideally, generalizability to other contexts could be estimated by an indirect scheme that relies on comparison of competency statements and patterns of competency statements across CBE programs.

Principle 6: Balance the use of locally and commercially developed assessments

Jones et al. (2002) point to the paradox created when faculty and institutions move away from commercial assessment instruments and toward locally developed assessments to determine competencies. Faculty and staff who use commercially developed assessment methods produced by national testing companies frequently rely on these organizations to document that their testing methods are reliable and valid. On the other hand, some dissatisfied faculty have found that commercial tests do not accurately or meaningfully measure whether students have achieved the education goals specific to their academic program or institution. In addition, many find that these instruments provide neither direction nor guidance about where and how to improve student learning. For example, Jones et al. observe that students may perform poorly on a publisher's critical thinking test, but such results do not tell faculty which dimensions of critical thinking need to be improved.

Educators have all experienced assessment, and we often return to those experiences in selecting or designing assessments. Instructional designers may incorporate faculty test items or a publisher test bank in project based-designs as a vehicle for learner demonstration. By whatever avenue or combination of avenues, the challenge for competency-based assessment design is the selection of assessments that measure the competencies, and not extraneous knowledge, skills, or abilities.

Given the general inability of commercially developed instruments to match the potential range of competencies within a CBE program, we recommend development of local assessments, especially in writing.[*] To do so well requires addressing reliability issues, including training assessors extensively about how to score student work consistently over time. Unfortunately, at this stage of CBE evolution there is a dearth of published reports on the results of faculty-developed efforts to grapple with reliability and validity of faculty-developed assessments that can serve as a guide.

Principle 7: Implement a CBE tracking system

Because competencies are criterion-referenced statements of learning, it follows that their tracking will be quite unlike traditional academic recordkeeping and transcription of credit in which the accent is upon how students' grades compare to other students' grades in a normative paradigm. Reigeluth, Myers, and Lee, in Chapter 1 of this volume, discuss the need for student recordkeeping for attainment-based learning. This issue is also currently a focus of several national higher education workgroups who are pursuing pilot testing of new and adapted software with student information system software vendors.[5] In the meanwhile, workarounds within existing student information systems have been a necessary short-term solution for institutions implementing CBE.

Tracking competency attainment is critical to understanding not just how individual learners are progressing in a CBE, but also to evaluate how the entire CBE system is functioning. A time-honored vehicle for recording learner progress is the grade book, in which a teacher manually keeps track of assignments and student performance on those assignments. Tracking competencies requires either a more voluminous grade book and tenacity from the learning facilitator to manually capture learner performance, or a software solution.[*]

Principle 8: Successful CBE instruction requires evaluation

Any innovation requires careful evaluation of its inputs, throughputs, outputs, and outcomes. In addition to tracking patterns of competency attainment, qualitative and other quantitative analyses should guide CBE learning experiences to aid in their continuous improvement.[**] The use of aforementioned tracking software will help to identify systematic gaps in the program. These data and analyses should be supplemented by other quantitative data gathering as well as qualitative techniques. Focus groups and surveys administered near mid-stream of an individual learner's experience in CBE can help identify instructional practices that are helping or frustrating student learning processes.

A well-crafted feedback mechanism can help to create better competency statements, including their potential recalibration. For example, if consistent feedback indicates that learners perceive that demonstrated mastery of a specific competency is overly simple or even boring, one of two factors may be in play. First, that competency statement might be misspecified and does not match learner characteristics; perhaps learners have already mastered the competency prior to entry in the CBE program. While pre-assessment of a set of competencies should at least minimize redundancy, it is wise not to view pre-assessment as an ironclad guarantee. The facilitator will want to consider whether the competency itself is necessary or whether the mastery threshold has been set too low to challenge the learner. At the opposite extreme, a consistent pattern of learner failure to demonstrate mastery may indicate the assessment bar has been set unrealistically high or may signal that alternate pathways for learner mastery should be developed.

IV. Situational Principles

The eight general design principles we present above are intended to explore the intertwined components of CBE at a high level. These principles do not provide detailed guidance. Reigeluth and Carr-Chellman (2009b) note that general (universal) principles of instruction are not sufficiently precise (or detailed) for practitioners to create high quality instruction. It is not possible in this chapter to offer detailed guidance for all our principles. The current paucity of detailed CBE research mitigates against guidance for *overall* instruction and certainly against exceptions to universal principles. We expect reports of CBE practice to become more abundant if research interest in CBE accelerates in coming years. We are hopeful that emerging CBE literature will focus more fully on learner experiences that may, in turn, provide a research base that can more fully inform successful instruction. At this juncture in CBE's evolution, and drawing from our work in the area, two situational principles are paramount: CBE program structure and content and the totality of competency assessment.

CBE Program Structure and Content

Choices made in the organization of a CBE program determine a range of factors that, in turn, shape subsequent instruction. If the program is based solely on competencies, instruction will be unlike the traditional face-to-face classroom. There also will be no imperative to segment the instructional day into hours and to shift academic subjects at different points in a term.* This frees CBE to span academic terms and even years. Learners could start at different times and could end their experiences at different times depending on their individual pace (as well as program structure, as discussed above). Depending on their maturity and need for supervision, learners in a CBE program could conceivably come and go given their learning proclivities.

Full CBE instruction is still the exception rather than the rule, however. Among schools and colleges experimenting with CBE, it is more than likely that only one or a small handful of programs will be offered via CBE. It may be even more likely that only a small part of a program is offered through CBE. For example, a particular subject such as biology might be offered through CBE, while the remainder of the program might be offered in traditional face-to-face, teacher-centric formats. In both instances, traditional scheduling of the instructional day, term, and year would prevail.

Another important instructional situationality is whether the program will use direct or indirect assessment. Indirect assessment equates competency attainment to credit or clock hour equivalents. In this case, student learning gained through CBE is documented by issuance of a traditional grade report or transcript and categorized by letter grades (A, B, C, D, and F). Direct assessment, in contrast, moves beyond the credit hour as a unit of instruction, and learning attainment is recorded most often in a narrative transcript. Direct assessment requires learning facilitators to engage with learners perhaps more often than instructors in indirect assessment, with the goal of creating a narrative record of formative and summative student progress.

Direct assessment also carries important accreditation considerations that, in turn, bear directly on how instruction looks. In higher education, for example, institutions seeking approval for direct assessment from a regional accreditor must demonstrate faculty oversight and prescribed engagement with the program. The Southern Association of Colleges and Schools Council on Colleges stipulates, for example, that institutions show that, "qualified faculty with subject matter expertise design the competency-based program's curriculum, this faculty or other similarly qualified faculty or instructors also regularly engage with students during the course of the program, provide expert assistance and support to students in the program, and have a meaningful role in directing and reviewing the assessment of competencies" (SACSCOC, 2013).

Totality of Competency Assessment

Another important situationality concerns the decision whether to assess all competencies and sub-competencies in a given set. It may well be that demonstration of mastery for an overarching competency would make assessment of each sub-competency unnecessary. Conversely, slavish incorporation of a final or summative assessment into all CBE may be both cumbersome and unwarranted. On the other hand, continuous and successful interaction by the learner with sub-competencies that support a higher competency may be preferable to requiring a final demonstration of that higher competency.

V. Implementation Challenges

When an organization commits to the learner-centered paradigm, it is difficult to identify a learning environment in which CBE could not work, in no small part, to provide learners with customized or personalized learning plans. At the same time, the timeworn adage, "if it were easy, everyone would be doing it," certainly applies to the implementation of CBE. While it is likely that a typical instructional designer may possess a firm grasp of competencies and how they can accelerate learner mastery, it is equally likely that those who are on the frontlines of learning do not. This creates the obligation for the instructional designer to educate her or his colleagues and may even mean that significant "unlearning" will have to occur before CBE can be implemented.

An institutional choice to offer some or all of a program through CBE will depend on that institution's resources and capabilities to fully implement CBE. Organizations with a history of innovation are more likely to be receptive to CBE and understand the changes to a traditional instructional and business model it would require. Strong organizational leadership is required to implement and sustain CBE. The wholesale conversion of an existing education institution and its prevailing culture to a total CBE institution may be more difficult to achieve than the invention of a new CBE organization.

Shifting Roles for Faculty and Learners

It is nearly trite to say that CBE fundamentally shifts the role of faculty. Faculty do not operate fully in isolation, however. Implementation of CBE also challenges learners and administrators. Learners, for example, may resist the shift away from their well-known credit hour system to a system that seemingly requires much more effort. Faculty may also perceive that much more effort is required to engage with CBE. The shift to CBE, in which faculty are no longer the sole arbiter of learning, is daunting.

Most faculty in higher education have not been formally trained in instructional pedagogy, having only learned how to teach from their graduate school mentors and other faculty (see, for example, Brownell & Tanner, 2012). It certainly is difficult to tell faculty that methods they have been using in the classroom over many years may not be the most effective approach. Teachers in K-12 classrooms may or may not have had specific training in CBE in their teacher preparation; and where they haven't, the learning curve may also be steep. In any event, Brownell and Tanner (2012) argue that the historical use of individual, subjective, and inconsistent methods and lack of established conceptual frameworks for instruction perpetuate the problems in both educational and practice settings.

Asking faculty to engage in CBE often means that new skills need to be developed. Because CBE may be new to their organizations, it may also be likely that they need to keep the "old" teaching and learning paradigm (teacher-centered instruction) alive while finding the time and energy to create competency-based learning experiences. This can easily create overload. Whether or not they accept the premise that a course is a collection of competencies that can be assessed, faculty may view CBE as threatening their autonomy. To be successful, instructional designers would do well to identify where faculty are along these continua and to secure their good will and cooperation in the implementation process (Rogers, 1983). Instructional designers can also model continuous quality improvement by engaging faculty with other professionals from the beginning stage of CBE program development, through its initial implementation, researching its benefits for learners and faculty alike, and through modifying the program prior to redeployment.

Administrative Support

Administrators can add much to an organizational shift to CBE by supporting its implementation and, afterward, supporting whether it is taken to scale and sustained. CBE challenges routine operations while presenting a range of issues for resolution, most of which will be new. Foremost is how to accommodate faculty workload in the new CBE paradigm. This is especially the case for direct assessment programs in which there is little time referent. Should teachers be compensated based on enrollment in CBE programs or the number of learners who complete a pre-defined number of competencies? Further, because faculty participation in program design is a *sine qua non* for accreditation, should they be compensated for development time and, if so, at what rate? Beyond financial support, does the administrative structure support the risk-taking that accompanies the CBE paradigm? For example, will learning facilitators be accorded the flexibility to create student-centric CBE programs even if the original reason they were hired was to deliver traditional teacher-centered instruction? When administrative support is lukewarm, instructional involvement in CBE is likely to follow the same trajectory.

Training Faculty to Develop Local Competency Assessments

When an organization decides to move toward locally developing assessments, it is almost certain that formal training of faculty and staff will be required. Such training can start with instructional designers but should also make appropriate use of institutional researchers and assessment staff, as well as faculty members with experience in statistics or educational psychology. These experts can help faculty create strong, locally developed instruments and then track their reliability and validity over time. In future work, faculty can explore ways to design local assessments that are increasingly reliable and valid. The process of establishing inter-rater reliability among faculty creating CBE learning experiences can be, in turn, a useful learning experience that helps improve competency statements and assessments. While it may not be the instructional designer's role to create the content of the assessment, asking questions of other team members about validity and reliability provides guidance for creating accurate assessments.

Managing Competencies at the Organizational Level

Using competencies to describe and analyze existing curricula and programs carries distinct advantages for educational organizations. Mapping an organization's intended learning competencies can pay large dividends. CBE increases the organization's capability to identify where redundant learning occurs. Although learners may be aware of where their efforts are duplicated, faculty and administrators may not be aware of specific techniques to rearrange or streamline a program's structure. Describing and mapping competencies across programs and curricula provides a macro-level view that allows the organization to see what competencies it may be missing as well as those competencies that should be emphasized to match the organization's vision of its overall learner outcomes. Mapping competencies also provides a factual basis for determining where any overlap may be appropriate to reinforce learning.

Interoperability Versus Granularity

In our experience, managing competencies is best approached at a granular level. At the same time, there are natural tensions between granularity—a detailed description of a given competency—and interoperability—ensuring that the purpose of that competency can be adapted across more than one instructional program or context. The former tack may be necessary to ensure that a competency or group of competencies fits within a local context, and that may, in turn, lead to faculty buy-in as the competency is adopted. A skillful instructional designer, however, should acknowledge the impact of program decisions while striking a balance between unique competencies and general competencies that can be applied across courses or other learning experiences. A reasonable goal for CBE is to help the learner to generalize or transfer a given competency or set of competencies to other contexts. Granular competencies set deeply within a specialized field would appear not to serve this goal well. One potential solution is to leave a space in the course for an additional competency or two to be added by the instructor to provide the basis for generalization of course outcomes to other situations.

Software Solutions to Track Competency Attainment

Traditional software systems in use at schools, colleges, and universities are administrator-centric and largely unresponsive to student-centric CBE. Existing student data systems capture course titles, beginning and ending dates, and a letter grade for each student within those courses, but they almost never operate at the granular level of detail necessary to capture competency attainment. Because they are mostly aligned with the Carnegie unit and credit hours, nearly all student information systems exist to generate a traditional transcript, to calculate tuition bills, and to generate auditable reports for funding agencies. Student information systems are also bounded by academic terms, making it a special instance to record instructional activity that occurs across traditional academic terms.

Implementers of CBE will want to keep pace with emerging software solutions and to engage others in the organization, especially the organization's information technology unit, to determine whether existing systems can accommodate CBE (doubtful) and the compatibility of any new software solution with the organization's existing system. While it is beyond the scope of the present chapter to review the expanding number of software solutions, we note that at this writing there appears to be no single or wholly satisfactory solution.

Measurement Error, Reliability, Validity, and Competency Assessment

Accurate measurement is a ubiquitous challenge to all types of assessment, competency-based learning included. It falls beyond the scope of this chapter to provide even a wide overview of measurement theory and the selection of appropriate statistics to estimate measurement error. At the same time, some key measurement concepts and terms are important to the instructional process.

Competencies that are simple in structure, those that assess a single performance task and have been rigorously constructed with a clear rubric and criteria, lend themselves well to measurement. In reality, however, competency statements are seldom monotonic; most often their measurement is tied to more than one task that demand different levels of performance. A writing competency, for example, might involve researching the topic at hand, organizing salient points to be covered, composing iterative drafts, and reaching a point at which the facilitator and the learner agree that the writing competency has been mastered. More complex competencies, such as leadership, personal efficacy, and interpersonal communication, present much more complicated measurement challenges. Such constructs represent high levels of abstraction requiring the instructional designer to reach agreement with her or his colleagues about the parameters of the construct and, in turn, to decompose that construct into manageable components that can be observed and measured. The difference between what is observable and an underlying and unobservable concept is the basis for measurement error.

Understanding sources of measurement error can help the instructional designer create better competencies, including setting clearer criteria for mastery, and create correspondingly better measures. Measurement error will never disappear, but being armed with knowledge of basic concepts that underlie error can go a long way to ensure credible work. The concepts of reliability and validity are key concepts in accurate assessment and should be part of every instructional designer's practice.

Reliability refers to the internal consistency of a measure. Carmines and Zeller (1979) identify four techniques for judging reliability in competency assessments: test-retest, alternative form, split half, and internal consistency. Of these techniques, internal consistency or inter-rater reliability is most critical, especially in developing consistent competency measures. Inter-rater reliability estimates the degree of agreement between two or more raters in their appraisals of learner performance. Unlike multiple-choice test items, open-ended questions typically have multiple correct solutions. Learner demonstrations of complex behaviors, such as role playing exercises, may also have more than one correct solution. Each case requires that raters evaluate responses consistently, the *sine qua non* of inter-rater reliability. While the designer may not be involved in the practice of inter-rater reliability, the creation of a rubric that requires inter-rater reliability provides good assessment practice at the design level.

Validity, on the other hand, asks the question: "Are we measuring what we think we are measuring?" (Kerlinger, 1966, p. 444). Tests and assessments may indeed be reliable, but they may not align with the knowledge, skills, and abilities the instructional designer should measure. Validity is concerned with accuracy while reliability is concerned with precision (Carmines & Keller, 1979).

Organizational Evaluation

Many units within an organization contribute to a successful shift to competency-based instruction. Bedard-Voorhees (2001) recommends the use of a checklist for organizations and units within those organizations to evaluate gaps and opportunities brought about by competency-based instruction. Updated for this chapter, this checklist can aid those interested in creating competency-based instruction to avoid its pitfalls and maximize opportunities (see Table 2.2).

TABLE 2.2 A Checklist for Evaluating Implementation of Competency-Based Education

Faculty Preparation
Have faculty been oriented to the shift from teacher-centered delivery to learner-centered performance?
Have faculty been involved in conceptualizing, identifying, and delivering program and course competencies?
Have faculty participated in training to write measurable competency statements?
Do faculty understand the levels of mastery expressed by Bloom's Taxonomy for the creation of competencies and related instructional objectives?
Can faculty implement classroom assessment techniques to evaluate student learning?
CBE System Preparation
Does the competency-based system relate to and further the institution's stated mission?
How do industry-related competencies draw from state and national standards and credentials?
Are all competencies assessable?
What provisions are there within the system to ensure that competencies are valid and reliable?
Does the institution have a publicized statement on expectations for student learning? If so, are competencies aligned with that statement?
What is the life cycle of competencies within the system? Is there a replacement schedule that aligns with new developments in knowledge or career areas?
Student Advisement
How are learners trained or oriented to the competency-based system?
Are learners made aware of how they might import their preexisting demonstrations of competency into the system?
Administration
Is there commitment at the top of the organization to CBE?
Are adequate resources available to implement and sustain the system?
How will competencies be tracked and recorded?
What steps have been taken with other organizations and entities to ensure that competencies are portable?
What mechanisms are in place for formative evaluation? For summative evaluation?

VI. Closing Remarks

More than a decade ago one of the authors argued that CBE was a "necessary future" even despite uncertainty that the challenge would be met (Voorhees, 2002). Now, more than a decade later, green sprouts are showing through years and layers of traditional educational practice. The principles described in this chapter provide the tools and foundation to make learner-centered approaches to improving education a reality. For learners, CBE promise a transparent mechanism to meet their learning needs. For teachers and faculty, CBE—although requiring a heavy initial investment—holds the promise to transform their role from learning arbiters to facilitators and supporters.

At the same time, most of what is now known about the effectiveness of CBE comes from medical training. K-12 and other higher education disciplines, in general, suffer from a paucity of hard research data that document improvements in student learning resulting from CBE. Published research documenting the effects of CBE is rare. Evans and King's (1994) observations several decades ago that existing evidence was largely perceptual, anecdotal, and small-scale persists more than two decades later. We fully agree with their summation, that "testimonials, speeches, and narrative descriptions may be inspirational and helpful, but they provide little solid ground on which to build a reform movement" (Evans & King, 1994, p. 12). One explanation for the dearth of needed data about CBE in public databases is economic; education dollars are not allocated to schools and colleges based on the learning outcomes they produce. In the interim, we are left largely with anecdotal data suggestive of dramatic improvements in learner-centered practice but little in the way of replicable studies.

Implementing learner-centered models should not be mistaken for easy and uncomplicated work. As Reigeluth notes, careful selection and extensive training of staff is required because few people in a given organization will have had experience with the new roles required in the learner-centered paradigm of education (Simsek, 2013). The design and implementation processes for implementing CBE undoubtedly will be more extensive than past practice within a given organization. In our experience, a missing element in competency-based undertakings is collaboration. The effort required to describe, develop, and record student learning in specific competencies requires focus and commitment across many roles in an organization. In meeting the challenge, instructional designers will play a pivotal role in positioning their organizations to successfully implement and refine CBE.

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Notes

1 Number of participating states is accurate as of October 2015. See Common Core State Standards Initiative (n.d.), retrieved October 26, 2015 at http://www.corestandards.org/standards-in-your-state/

* *Editors' note: It is interesting that Montessori schools have long used CBE with children as young as three years old, with great success (Dohrmann, Nashida, Gartner, Lipsky, & Grimm, 2009; Lillard, 2012; Lopata, Wallace, & Finn, 2005).*

* *Editors' note: Unlike Gagné's, Bloom's Taxonomy is not a learning hierarchy depicting learning-prerequisite relationships. Rather, it depicts complexity relationships. For example, one can learn to apply a skill without first acquiring knowledge or understanding, even though a skill (application) is typically more complex.*

2 Krathwohl, Bloom, and Masia's (1964) hierarchy of affective development can be used to map the key learning components in the attainment-based approach (dispositions, values, and emotional development) advanced by Reigeluth, Myers, and Lee in this volume's first chapter.

* *Editors' note: This principle is about personalizing the goals for each learner. For more about this, see Principle 1 in Chapter 4, Personalized instructional goals.*

* *Editors' note: The scaffolding described here is but one of many kinds of scaffolding. For more about scaffolding, see Principle 3 in Chapter 4, Personalized scaffolding of instruction.*

** *Editors' note: For more about sequencing instruction, see Chapter 3, Principle 1, and Chapter 4, Principle 1.*

3 Reigeluth's (1999) Elaboration Theory is a useful guide that can inform decisions about selecting and sequencing content.

* *Editors' note: It seems likely that in most cases instruction will be organized around tasks (projects, problems, inquiries, etc.) rather than courses. The Minnesota New Country School is a good example of this (see Aslan &*

Reigeluth, in press; Thomas, Enloe & Newell, 2003).

4 Wiley (2000) edited a comprehensive overview that can help designers more efficiently embed learning objects in curricula.

** *Editors' note: This is Principle 1.1 in Chapter 1, Attainment-based learner progress.*

*** *Editors' note: This is similar to Principles 1 and 2 in Chapter 4, Personalized instructional goals and Personalized task environment.*

† *Editors' note: Of course, if CBE has been used in prior instruction, pre-assessment may not be necessary because the learner's current competencies are already known.*

* *Editors' note: This is similar to Principle 4 in Chapter 4, Personalized assessment of performance and learning.*

** *Editors' note: A powerful way to do this is to fully integrate teaching and testing by using the notion of practice until perfect, as is done in the Khan Academy (see Chapter 11, Principle 4, Assessment for/of student learning).*

* *Editors' note: This is the issue of granularity of competencies and assessments. National and state standards are typically clusters of related competencies. There is a natural tension between assessing individual skills and understandings and assessing an integral set of competencies as a whole, including their interrelationships. Perhaps the best approach is to do both, with formative assessment the focus of the former and summative assessment the focus of the latter.*

** *Editors' note: This is similar to Principle 4 in Chapter 4, Personalized assessment of performance and learning, and Chapter 9 on self-regulated learning.*

* *Editors' note: As described in Chapter 9, Principle 3, students should play a role in designing and carrying out their own assessment (self-assessment) to develop self-regulation skills.*

5 IMS Global, in conjunction with the American Association of Collegiate Registrars and Admissions Officers, is leading the development of a prototype extended transcript designed to support competency-based programs. See, for example, https://www.imsglobal.org/initiative/enabling-better-digital-credentialing.

* *Editors' note: See Chapter 11 for more about the design of a technology system to help with student tracking in CBE.*

** *Editors' note: While this principle does not strictly indicate what the instruction or assessment should be like, it does identify an important method for gathering formative data about what the instruction should be like. Technically, this is ISD process knowledge rather than instructional theory, but we nevertheless feel it warrants inclusion here.*

* *Editors' note: These fundamental changes are part of what makes learner-centered education a different paradigm from teacher-centered education, rather than just another reform within the current paradigm.*

3

PRINCIPLES FOR TASK-CENTERED INSTRUCTION

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EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *The content entails application and transfer, not just memorization.*

Learners

- *All students.*

Learning environments

- *Learner-centered rather than teacher-centered (learning is more important than "covering" content).*

Instructional development constraints

- *Minimal.*

Values (opinions about what is important)

About ends (learning goals)

- *Construction of specific knowledge and skills is highly valued.*
- *Transfer of learning to a diversity of real-world situations is highly valued.*
- *Development of higher-order thinking skills (critical thinking, problem solving, and so forth) is highly valued.*
- *Self-regulation skills and group-process skills are highly valued.*

About priorities (criteria for successful instruction)

- *Effectiveness, efficiency, and intrinsic motivation of the instruction are all highly valued.*

About means (instructional methods)

- *Learning by doing (active learning) is highly valued.*
- *Learning from peers through collaboration is highly valued.*

About power (to make decisions about the previous three)

- *Empowering learners to make decisions about ends, priorities and means is highly valued.*

Universal Principles

1. Learning tasks

- *Center all learning around whole, complex, ill-defined, real-world tasks.*

- *Sequence those tasks from simple to complex to match the advancing level of the learners.*
- *Provide additional scaffolding in the form of support and guidance, and gradually fade them out over time.*

2. Activation of prior knowledge

- *Remind learners of their prior knowledge by having them share relevant previous experiences and thinking.*

3. Demonstration/modeling

- *Show learners how to perform parts of the complex learning task and provide procedural and supportive information, and gradually fade them out over time.*

4. Application

- *Have learners practice the desired skills for parts of the learning task.*
- *Provide coaching and feedback on the practice, and gradually fade them out over time.*
- *Encourage learners to self-monitor their performance.*

5. Integration/exploration

- *Provide opportunities for the learners to explore new ways to use what they have learned in everyday life.*
- *Provide opportunities for the learners to reflect on or teach what they have learned and to critique what their peers have done.*

Situational Principles

Variations in learning tasks

- *Compromise on fidelity when there is a lack of authentic resources.*
- *Adjust the complexity of tasks to match learner expertise.*
- *Use part-task instruction when needed.*
- *Adjust amount of support to student needs.*

Variations in activation

- *Vary the methods of prior knowledge activation depending on the kind of learning: physical skill, intellectual skill, or attitude.*

Variations in demonstration/modeling

- *Attainments that take a long time to demonstrate should be broken into parts that are demonstrated separately.*
- *For an intellectual skill, the demonstration should show the actual performance, not just the result.*
- *Media format varies depending on several factors (described in the chapter).*
- *Demonstrations in the affective domain should primarily be done through role-play, case study, and/or real-world observation.*
- *The timing for presenting supporting information varies depending on several factors*

(described in the chapter).

Variations in application

- *Frequency of coaching and feedback vary with the needs of individual learners.*
- *Speed of fading of coaching varies with the needs of individual learners.*
- *For complex new skills needed during task performance, part-task practice should be used with additional coaching and feedback, if needed by individual learners.*
- *When the nature of faulty performance is not known, the student should think aloud during performance.*
- *When a learner has encountered difficulties in task performance, reflection activities should be used.*

Variations in integration/exploration

- *Constraints such as time and resources might restrict the methods used to transfer learning to real-world situations. Having fewer resources typically requires simpler methods, such as discussion, reflection, and case study.*

Implementation issues

- ***Identification of learning tasks**. It is difficult to identify good learning tasks.*
- ***Resources.** In the teacher-centered paradigm, there may not be sufficient instructional time, equipment and technologies for the number of students.*
- ***Content coverage.** Since content is learned in a deeper and more transferable manner in TCI, it may be difficult for teachers to cover as much content as they are used to.*
- ***Ensuring mastery.** In collaborative work on learning tasks, different students may play different roles and not learn all the desired competencies.*

– C.M.R., B.J.B., & R.D.M.

PRINCIPLES FOR TASK-CENTERED INSTRUCTION

I. Introduction

One main focus of the learner-centered paradigm of education involves centering learning on real-world tasks to support intrinsic motivation and collaboration in learner-centered instruction. Many different task- or problem-centered models for learning have been proposed over the years, with various names such as problem-based learning, problem-centered learning, discovery learning, task-centered learning, task-centered instruction, task-based learning, and more.

Of the many different models for centering learning on real-world tasks or problems, one main area in recent literature attempts to balance the effectiveness of learning by completing real-world tasks with the efficiency of providing adequate learner support. The models within this area of practice are referred to as task-centered instruction (TCI) in this chapter.

In this chapter, I introduce the concept of TCI and differentiate it from other forms of problem-centered learning. I discuss the values of TCI. Universal principles for TCI are presented based on previous work, along with a summary of research studies related to these universal principles. I discuss the connections between TCI and the learner-centered paradigm of education and provide situational instructional design principles that relate to the implementation of TCI. Finally, several pertinent issues surrounding the implementation of TCI are presented.

Task-Centered Instruction

TCI is a task-centered approach to learning that prescribes the use of five main elements (Merrill, 2002b, 2009): learning tasks, activation, demonstration/modeling, application, and integration/exploration (Francom & Gardner, 2014). TCI stems from such theories and models as cognitive apprenticeship (Brown, Collins, & Duguid, 1989; Collins, Brown, & Holum, 1991), elaboration theory (Reigeluth, 1979, 1999), the four-component instructional design model (van Merriënboer, 1997; van Merriënboer & Kirschner, 2013), and first principles of instruction (Merrill, 2002b, 2007; Merrill & Gilbert, 2008).

TCI can be differentiated from other forms of problem- or task-centered learning models through its epistemologies, goals, and prescriptions (Francom & Gardner, 2013). For instance, "pure" problem-based learning is based mainly on constructivist views about learning (Hung, Jonassen, & Liu, 2008; Savery & Duffy, 1995), while TCI comes from cognitive information processing, andragogy, motor learning, and cognitive apprenticeship-based beliefs about learning (Merrill, 2002b; van Merriënboer & Sluijsmans, 2009). Based on these differing epistemologies, the goals of problem-based learning and TCI also differ in important ways. TCI goals tend to value application and transfer of knowledge to realistic contexts as well as effective and efficient learning (Francom & Gardner, 2013). By contrast, problem-based learning goals tend to be more concerned with developing flexible knowledge, deep understanding, problem solving skills, self-directed learning skills, effective collaboration, and self-directed motivation (Barrows, 1996; Jonassen, 2000).*

TCI adds on several important prescriptions for learning that are not necessarily present in "pure" problem-based learning, including scaffolding (Masters & Yelland, 2002) that is faded out over time (Francom & Gardner, 2013) to help with task performance. These important elements of support and guidance—which are not prescribed in a "pure" problem-based learning approach—help to make learning more efficient and increase the chances that target concepts and skills will be gained by learners (Francom & Gardner, 2013, 2014).

Many researchers today argue for the importance of centering learning on real-world problems to support knowledge construction and offer a meaningful, relevant learning experience in the Information Age (Anderson, 1993; Barrows, 1996; Bender, 2012; Hung et al., 2008; Jonassen, 2011; Merrill, 2002b; van Merriënboer, 1997). However, some of the main problems that have come out of this approach include a lack of learning efficiency for gaining target skills and knowledge outcomes (Reigeluth, 2012; Spector, 2004). TCI provides a possible middle ground in which learning is centered on real-world tasks, but the learner receives support and guidance to learn to perform these tasks. This allows for efficiency of learning while still enhancing motivation and enabling meaningful knowledge construction among learners through meaningful experience with learning tasks (Francom & Gardner, 2014).

The importance of TCI also lies in its connection to the learner-centered paradigm of education as a learner-centered approach that matches the learning needs of the Information Age. TCI focuses on learning by doing, rather than learning through teacher presentation, and allows for self-directed rather than teacher-directed learning. TCI can take advantage of intrinsic motivation among students and is particularly well suited to the idea that student progress should be attainment-based instead of time-based (Reigeluth, 2012).

In addition, the Information Age is characterized by abundant information sources, providing the user with facts and procedures on almost any subject. In the Information Age, skills for finding this information become much less important than skills for applying this information to the completion of a specific problem or task (Francom, 2014; Francom & Gardner, 2013). Because of these key characteristics, TCI plays a prominent role in the learner-centered paradigm of education (Reigeluth, 2012; Reigeluth & Karnopp, 2013).

II. Values for Task-Centered Instruction

The goals of TCI include the application and transfer of knowledge to realistic contexts, and effective and efficient learning (Francom & Gardner, 2013). These goals help drive decisions about which types of learning and instructional goals to pursue with this method.

The focus on application and transfer of knowledge leads the instructional designer or instructor to use TCI when it is important to gain specific and transferable knowledge and skills. TCI requires the possibility to have learners apply their knowledge within a course or designed learning experience. Because tasks can take a longer time to complete, TCI may not be the best choice for learning objectives that require the memorization or drill and practice of many specific terms, ideas, or repetitive problems. The types of learning objectives chosen for TCI are usually practical skills that are transferable to everyday life.

TCI experiences tend to make the instructor and learners think more clearly about ways in which what is being learned is actually useful in outside-of-school settings. With each learning task, learners may focus on the attributes of the learning task that transfer to real-world settings, and they also learn how to perform the task like it might be performed outside of school or training.

TCI is especially useful in situations where a learner-centered experience is desired, and motivational and authentic learning elements are also required, but a "pure" problem-based learning approach without some kind of learning structure, guidance, and support, is not plausible. In most cases, a "pure" problem-based learning approach is not plausible because of time constraints, student frustrations, and a lack of mastery assurance (Kirschner, Sweller, & Clark, 2006; Mayer, 2004). Experience has shown that the addition of learner support and guidance is needed to make discovery learning forms like problem-based learning more effective and efficient (Kirschner et al., 2006; Mayer, 2004; Merrill & Gilbert, 2008; Spector, 2004). TCI prescribes the addition of this type of support and guidance (scaffolding) for learners who are performing a learning task, and this support and guidance is faded out over time as learners gain expertise.

III. Universal Principles for Task-Centered Instruction

Four main models have influenced TCI in important ways (Francom & Gardner, 2014). These models include cognitive apprenticeship (Brown et al., 1989; Collins et al., 1991) and elaboration theory (Reigeluth, 1979, 1999), which have influenced more recent conceptions of TCI, as well as Merrill's first principles of instruction (Merrill, 2002b) and van Merriënboer's four-component instructional design model (van Merriënboer, 1997; van Merriënboer & Kirschner, 2013). All four of these models have been synthesized into prescriptive principles for TCI that fall into five main areas: learning tasks, activation of prior knowledge, demonstration/modeling, application, and integration/exploration (see Francom & Gardner, 2014). I will discuss each of these areas in turn.

1. Learning Tasks

Learning tasks are easily the most central element of TCI. Students should be engaged in completing learning tasks as a central aspect of the TCI experience. These tasks are meant to be real-world, so that learners use knowledge and skills in much the same way that knowledge and skills would be used in outside-of-school settings. In TCI, learners apply their knowledge and skills to complete whole tasks from start to finish (Merrill, 2002b). The learning tasks should be matched to the ability level of the learners to start out, and then they should progress to be more complex as learners gain knowledge and skill (Merrill, 2002b, 2007; Reigeluth, 1999; van Merriënboer & Kirschner, 2013).

To implement a TCI approach, an instructor or instructional designer must have a task-centered rather than topic-centered focus (Merrill, 2009). This means that—rather than determining topics to be covered and presented to learners in a course of study—the instructor or instructional designer should identify tasks that would require learners to apply their knowledge of important course concepts and skills in realistic ways. These tasks must be modeled after real-world tasks the learner will face after instruction, and should include as many of the same aspects of the real-world tasks upon which they are modeled as possible within the constraints of the learning situation (Merrill, 2009; van Merriënboer & Kester, 2008). Some characteristics of such tasks include that they are ill-defined enough to allow for more than one correct way to complete them, and that artifacts or activities of task completion can take various forms (Merrill, 2002a, 2007). Simple tasks that do not require the learning of a variety of related skills —or that can be completed by learners in a short amount of time with little skill or cognitive activity—may not qualify as learning tasks in TCI. However, there are no hard and fast rules about exactly how complex a task must be or how long it must take to complete it, since these variables depend on the knowledge and skill of learners and other situational constraints.

In TCI, sequences of learning tasks are identified that are related to required course topics, so that learners must learn and apply these topics to complete the tasks (Merrill, 2007). The sequences of tasks should be developed so that increasingly more knowledge of course topics is required to complete additional learning tasks (Reigeluth, 1979, 1999). In TCI, sequences of tasks that vary in the ways that they vary in outside-of-school performance should be designed and implemented (Merrill, 2007; van Merriënboer & Kirschner, 2013). From these sequences of tasks, learners can master relevant information and cognitive strategies from the experience and then transfer these strategies for future experiences (van Merriënboer, 1997; van Merriënboer & Kirschner, 2013).

TCI makes use of scaffolding, in which learner support and guidance are faded out over time. The first learning task in a sequence should be a simple version of a real-world task so that learners are able to complete it without much prior skill and knowledge (Reigeluth, 1999). This simplification can be accomplished through selecting a version of the task that has a reduced number of variables associated with it and, if necessary, having some of the task elements completed before learners must finish it. Learning tasks at the beginning of a learning experience should be accompanied with higher levels of support and guidance, which fades away as learners gain more expertise in completing learning tasks.

Current research supports the use of real-world tasks or problems at the center of the learning experience (see Hmelo-Silver, 2004; Hung et al., 2008; Jonassen, 2011), yet a large body of research also supports the need for carefully structured learning tasks along with an appropriate level of guidance for learners (see Kirschner et al., 2006; Mayer, 2004). Several studies also support the use of whole-task learning, in which more complex and integrative learning tasks are implemented (see van Merriënboer & Kester, 2008). For example, Lim, Reiser, and Olina (2009) compared a whole-task learning experience to part-task learning and found superior learning performance in the whole-task learning group. Wightman and Lintern (1985) found similar results in a study of tracking skills for manual control. Overall, studies support the use of carefully structured learning tasks along with coaching and guidance for task completion for better transfer of learning (see van Merriënboer, 1997; van Merriënboer & Kester, 2008).

Learning tasks are the pivotal aspect of TCI. The four following principles— activation, demonstration/modeling, application, and integration/exploration—relate to the use of learning tasks in TCI (Francom & Gardner, 2014).

2. Activation of Prior Knowledge

Activation of prior knowledge means activating cognitive structures that relate to the topics and tasks to be studied and completed. The activation principle comes from the cognitive information processing view of learning in which relevant mental structures must be prepared to receive new information and experiences (van Merriënboer & Kester, 2008). Effective activation is based on an understanding of learners' prior knowledge, which can be obtained through learner analysis methods including observation, pre-testing, questionnaires, expert review, and more[*] (Dick, Carey, & Carey, 2009; Morrison, Ross, Kemp, & Kalman, 2010).

Activation is an integral part of TCI, and prior knowledge can be activated by having learners share relevant previous experiences with each other or recall a structure for organizing new knowledge (Merrill, 2009). This provides an opportunity for learners to prepare to process complex information and procedures, and also gives the instructor a chance to provide remedial instruction if needed (Collins et al., 1991; Merrill, 2009). Activities that might support activation include written assignments, whole-class discussions, presentations, or small-group explanations that introduce learners' prior knowledge.

Much of what we believe about activation of prior knowledge comes from earlier experimental studies, which have found that relevant prior knowledge activation leads to better recall of information (Bransford & Johnson, 1972; Dooling & Lachman, 1971). Subsequent research on the importance of prior knowledge activation has continued to support this practice (Elbro & Buch-Iversen, 2013; Gurlitt & Renkl, 2008; Schmidt & Patel, 1987; Spires & Donley, 1998). This research has also sought to determine best practices for prior knowledge activation methods and techniques, studying several different methods including note taking during activation (Wetzels, Kester, van Merrienboer, & Broers, 2011), concept mapping (Gurlitt & Renkl, 2008), small group discussion of prior knowledge (Schmidt & Patel, 1987), and advance organizers (Gurlitt, Dummel, Schuster, & Nuckles, 2012). Activation of prior knowledge in these studies has led to improved learning outcomes on recall, near transfer, and far transfer tests.

3. Demonstration/Modeling

Demonstration/modeling in TCI includes showing learners how to perform a learning task and also providing procedural and supportive information relevant to the learning task. The term "demonstration" comes from Merrill's (2002b, 2009) first principles of instruction, and the term "modeling" comes from cognitive apprenticeship (Collins et al., 1991). The amount of demonstration/modeling that is presented to learners fades over time as learners gain expertise.

In TCI, learners must see how to perform learning tasks. This demonstration/modeling is more than just presenting about learning tasks or giving task requirements. It involves showing how knowledge of course topics and task procedures can be applied to perform the task.

Demonstration/modeling also plays a part in the presentation of information that is relevant to the completion of learning tasks. In order to demonstrate and model, an instructor should show the process for performing a part of a complex learning task, while making particular mention of generalities or other information that are required for task completion (Collins et al., 1991; Gardner, 2010; Merrill, 2009). Some information pointed out by an instructor during demonstration/modeling might include categories, concepts, or procedures that relate to the learning task. The instructor shares how the learning task relates to these categories, concepts, or procedures (Merrill, 2002b, 2009). Finally, demonstration/modeling should be done with relevant media, which follows cognitive principles of multimedia learning (Clark & Mayer, 2011; Merrill, 2009).

Information related to learning tasks is presented prior to or during an actual demonstration showing how to perform the learning task. This information can be separated into two categories: procedural information and supportive information (van Merriënboer, 1997; van Merriënboer & Kirschner, 2013). Procedural information is defined as information about the general steps that should be taken to perform a learning task. Supportive information includes topics or concepts that are relevant to the learning task but do not include the steps for completing the learning task. Subject-matter concepts that can be applied to the learning task are considered supportive information. Learning tasks fall on a continuum from procedural to heuristic (Reigeluth, 1979, 1999). For tasks that are more heuristic in nature, learners more heavily rely on supportive information to help them perform the tasks. For tasks that are more procedural in nature, learners more heavily rely on procedural information. For most learning tasks, learners apply a combination of procedural and supportive information as they perform learning tasks.

Extensive research has long supported the effectiveness of demonstration techniques in learning activities (Bandura, 1965, 1975; Bandura & Kupers, 1964). The area of motor learning provides a rich research base showing that demonstration/modeling is effective for supporting learning in whole- and part-task learning situations (McCullagh, Law, & Ste-Marie, 2012; van Merriënboer & Kester, 2008). More recent research continues to support the effectiveness of demonstration/modeling over lecture presentation (Balch, 2012; Corpus & Eisbach, 2005). Further research has focused on the effectiveness of different types of demonstration, including face to face, video, and peer demonstration (Katsioloudis, Fantz, & Jones, 2013; Martineau, Mamede, St-Onge, Rikers, & Schmidt, 2013).

4. Application

In TCI, learners apply their knowledge to perform learning tasks. Unlike many learning experiences, which are designed to assume that application of the learning will take place after a course of study is over, application in TCI happens as part of the actual course learning experiences. Application must be consistent with the desired skills to be learned, so learning tasks must be designed to support learners in practicing the desired skills for a learning objective.

In application, learners perform learning tasks by applying the procedural and supportive information that they have learned, and they also receive coaching and feedback on their task performance. This coaching and feedback might include corrections for task performance, guidance on how to proceed, and feedback about how well learners are performing (Collins et al., 1991; Merrill, 2009; Reigeluth, 1999; van Merriënboer & Kirschner, 2013).

As mentioned in Principle 1, learners complete learning tasks in carefully designed sequences. The tasks are designed to go from simple to complex, and to vary in ways that tasks vary outside of school, giving learners an opportunity to develop higher-order thinking skills and transfer these skills for future experiences (Merrill, 2009; van Merriënboer & Kirschner, 2013). As learners apply their knowledge to complete tasks in a sequence, the coaching and feedback they receive for task performance gradually fade away.

Application of learning provides a built-in performance-based assessment opportunity. The level of support and coaching for task performance is faded until a learner no longer needs external support to perform the task. At this point it can be determined that the learner has mastered this type of learning task and is therefore ready to move on to other tasks. As long as the learning task that has been mastered correlates with a target competency, then it can be assumed that the learner has achieved the competency.

Application should include active personal monitoring of performance by learners as they determine ways that they can improve their own performance. Models of cognitive apprenticeship advocate having learners verbalize their own thought processes as they perform learning tasks (Brown et al., 1989; Collins et al., 1991). This allows the instructor to point out information or ideas that the learner has missed or correct any misunderstandings that the learner may have.

Based on extensive research, practice activities in which learners apply their knowledge are essential to effective learning. Findings to this effect are described in research reviews of problem-based learning (Barrows, 1996; Hmelo-Silver, 2004; Hung et al., 2008), motor learning (Twining, 1949; Walker, Brakefield, Morgan, Hobson, & Stickgold, 2002; Wulf & Schmidt, 1997), and in a variety of TCI-related approaches (e.g., Gardner, 2011b; Melo & Miranda, 2014; Sarfo & Elen, 2007; Snyder, 2011). Also, research reviews support the idea that application or learning practice should be accompanied with some guidance and coaching in order to be successful (Kirschner et al., 2006; Mayer, 2004). The idea of scaffolding—in which extra support and guidance are provided at the beginning of a learning experience and then faded out over time—also has an extensive research base of support (see Masters & Yelland, 2002).

5. Integration/Exploration

Integration/exploration also happens as part of a TCI experience (Francom & Gardner, 2014). This is a phase of learning in which learners use their new knowledge and skill in everyday life, or explore new ways and ideas for using the new knowledge and skills. The term “integration” comes from Merrill’s first principles of instruction (Merrill, 2002b), and the term “exploration” comes from cognitive apprenticeship (Collins et al., 1991). Integration/exploration means taking what has been learned through the completion of learning tasks to the next level, either by applying it to new tasks or by further exploring new options and ideas (Collins et al., 1991; Merrill, 2009; van Merriënboer & Kirschner, 2013).

Research studies have supported the concept of integration/exploration. Research and practice reviews have long advocated supporting the transfer of learning through activities in which learners show their understanding in new ways by discussing, reflecting upon, defending, and applying their knowledge to unique situations (Brown et al., 1989; Collins et al., 1991; Merrill, 2009; Perkins & Salomon, 1994). Transfer of learning depends on the learner being able to mindfully search for connections and abstractions (Perkins & Salomon, 1994). Reflection practices like those that are involved in integration/exploration have long been found effective learning tools (see Boud, Keogh, & Walker, 2013; Mezirow, 1990), particularly in authentic, work-based learning situations (Boud, Cressey, & Docherty, 2006). Activities in which learners enhance their learning and transfer by creating new projects based on what they have learned are also well substantiated in research studies (see Bender, 2012; Harel & Papert, 1991).

Research on Task-Centered Instruction

Prior research conducted on the design of TCI environments that include principles of activation, demonstration/modeling, application, and integration/exploration within the context of real-world learning tasks has shown strong relationships with increased student learning (see Frick et al., 2009; Frick, Chadha, Watson, & Zlatkovska, 2010; Gardner, 2011b; Lee, 2013; Merrill, 2002a; Sarfo & Elen, 2007). Additional studies have been conducted that implemented TCI approaches in educational situations (see English & Reigeluth, 1996; Francom, 2011; Francom, Bybee, Wolfersberger, & Merrill, 2009; Gardner, 2011a; Gardner & Jeon, 2009; Mendenhall, 2012; Mendenhall et al., 2006; Snyder, 2011). Although more research is certainly needed on how to effectively implement TCI in learning situations—and on the effectiveness of TCI as a learning method—the overall body of current research is positive. The research suggests that TCI, properly designed, can be an effective way to support authentic and relevant learning of target knowledge and skills.

Task-Centered Instruction and the Learner-Centered Paradigm of Education

Reigeluth and colleagues have described a new learner-centered paradigm of education for the Information Age (Chapter 1 of this volume; Reigeluth, 2009, 2012; Reigeluth & Karnopp, 2013). TCI has been suggested as a central learning method in this new paradigm of education because of its compatibility with learner-centered instruction. Some of the other main ideas of the new paradigm of education include attainment-based learner progress, personalized instruction, changed roles for teachers and students, and collaborative learning (Reigeluth, 2012; Reigeluth & Karnopp, 2013).

Attainment-based learner progress

TCI can be designed to support attainment-based learner progress. In TCI, learning tasks are designed in sequences that support learner development of skills and knowledge as they complete tasks that become more complex over time. These tasks are carefully designed to build upon one another and to vary so that all of the desired knowledge and skills that students should learn are required for task completion.

Criterion-referenced assessment—a hallmark of the learner-centered paradigm of education (Reigeluth, 2012)—is especially compatible with a TCI approach. Application in TCI is an authentic way for students to prove that they are proficient with authentic criteria standards by completing learning tasks that require knowledge and skills in relation to specific criteria (see MacAndrew & Edwards, 2002; Oh, Kim, Garcia, & Krilowicz, 2005).

Personalized instruction

Another hallmark of the learner-centered paradigm of education is personalized instruction. To support this type of learning, TCI can be adapted to individual learners, and scaffolding can be adapted to their needs. For instance, more advanced learners can work on more advanced learning tasks with less guidance and coaching, while less advanced learners can complete simpler tasks with more guidance and coaching. Tasks that are well designed can allow more capable students to work somewhat independently so that the instructor has time to provide coaching and feedback to other students on a differentiated basis.

Technological and information resources that are abundantly available in the Information Age can be used to support more personalized instruction in TCI (Reigeluth, 2012; Reigeluth & Karnopp, 2013). Learners can view or read resources that are available online, such as instructional videos, websites, and media presentations, to help them perform learning tasks.

Changed roles

The learner-centered paradigm of education also features changed roles for teachers and students. In the Information Age, the instructor serves as a designer of learning experiences, and a facilitator of learning, among other roles (Francom, 2014; Reigeluth, 2012; Reigeluth & Karnopp, 2013).

As a **designer** of learning experiences, the instructor in TCI identifies learning tasks that require students to apply their knowledge and skills. Sequences of learning tasks are developed which provide an appropriate level of challenge for learners. The instructor may also determine how to personalize and differentiate tasks based on students' prior knowledge.

In TCI, the teacher serves as a **facilitator** by explaining the learning task and demonstrating how parts of the task are to be performed or to help students learn this on their own. During application in TCI, the instructor continues to serve in a facilitator role by recommending appropriate resources and providing coaching and feedback to students as they work on learning tasks.

The roles of students in the learner-centered paradigm of education also change to self-directed and collaborative learners, among other things (Reigeluth, 2012; Reigeluth & Karnopp, 2013). In TCI, students play the role of **self-directed learner** by managing their own learning processes as they perform learning tasks. TCI helps students to gradually take more and more ownership of their learning as they gain more knowledge and skill.

Finally, students in the learner-centered paradigm of education are **collaborative learners** who teach and learn from each other (Reigeluth & Karnopp, 2013). TCI provides a natural framework for collaborative learning activities, which include discussions, teamwork, presentations, and peer-critique (Merrill & Gilbert, 2008).

IV. Situational Principles for Task-Centered Instruction

In Volume III of *Instructional-Design Theories and Models* Reigeluth and Carr-Chellman (2009) discuss principles of instruction that apply only in some situations. Learning methods such as TCI can be made more precise by describing kinds, parts, and/or criteria for their use in different situations (Reigeluth & Carr-Chellman, 2009). Though TCI models and prescriptions have always been presented in a general way, there are some situational principles that can be applied to TCI. These situational principles are presented, while recognizing that it is impossible to provide prescriptions for all possible learning situations.

Variations in Learning Tasks

Learning tasks are central to TCI; however, several general prescriptions might vary based on different learning situations: base tasks on real-world performance, adjust the complexity of tasks to match learner expertise, use whole tasks, and fade out support for learning over time (see Francom & Gardner, 2014).

First, for **basing tasks on real-world performance**, the degree of fidelity depends on the amount of equipment and resources that are available in the educational setting. Ideally the same resources and equipment that are used in the real world should be available in the learning situation; however, this may not always be the case. For instance, a learning task designed to mimic a real biologist taking and analyzing water samples may have to be made lower fidelity because a nearby body of water is not available or because a field trip experience is not possible. Instead, students could receive water samples already taken from the body of water in question and then analyze them in the classroom or lab. By contrast, in another situation, fidelity could be high. Students working on computers with a spreadsheet application might authentically perform a learning task designed to mimic a real accountant working in the same spreadsheet application.

As mentioned previously, the **complexity of each task** in a TCI experience should match the level of learners' prior knowledge and skill. Therefore, the instructor must adapt the complexity and difficulty of each learning task to provide an appropriate level of challenge for learners. When students do not have sufficient knowledge to start on a more complex whole task, it is necessary to use a simpler version of the task. Because there is a need for flexibility for determining the complexity of a task or how long it must take to complete it, some tasks could conceivably be completed in a day or few hours, while other tasks might last much longer.

Within TCI a universal principle is to keep the "wholeness" or authenticity of the tasks intact. This requires occasional use of **part-task instruction**. For instance, there may be parts of tasks that cannot be completed unless students have first gained sufficient automaticity of a skill. In such situations, learners may have to pause to receive just-in-time instruction that includes specific knowledge and skills needed to perform a learning task (Reigeluth, 2012; van Merriënboer & Kirschner, 2013). When this part-task instruction is finished, the learner returns to the whole task.

Different students need different amounts of **support for learning**. The instructor should increase support for students who struggle to learn a part of the learning task, or fade support more quickly for students who have little difficulty. An instructor, or technologies such as adaptive learning systems or media demonstrations, may be able to more immediately adjust support levels for learners during the just-in-time learning process.

Variations in Activation

Different kinds of learning might lend themselves better to different methods of prior knowledge activation. For instance, physical skills, such as learning how to swing a golf club, would better lend themselves to activation of prior knowledge through methods that require students to demonstrate their knowledge through physical activity or through visual methods. In contrast, intellectual skills may require activation of prior knowledge through visual demonstration, discussion, or a combination of these methods. Attitudes may better lend themselves to activation of prior knowledge through the sharing of case studies, scenarios, and personal experiences.

Variations in Demonstration/Modeling

In TCI, learners receive a demonstration showing how to perform a learning task. For tasks that can be performed over a short period of time, this demonstration may show how to perform the whole task. For tasks that take a longer time period to complete, demonstration may comprise a series of part-task demonstrations.

There are several different types of demonstration methods that could be implemented within different skill domains. For instance, if a learning task involves an intellectual skill like writing and sending a properly formatted business letter, then demonstration should show the actual processes of writing and sending this letter.

Different relevant media formats could be used to demonstrate this task, including a live instructor-led demonstration, a video, or a screencast. The live demonstration would work best for a smaller face-to-face class; the video or screencast would be needed for distance learning or for classes too large for all students to see.

In contrast, a demonstration method for a task in the affective domain might require the use of a role-play, case study, or real-world observation in combination with procedural and supportive information presented visually in order to help students succeed.

The methods for presenting procedural and supportive information in TCI may also vary according to the situation. Procedural information is usually made available to students just in time, as they are performing learning tasks. However if it is determined that students must memorize the steps of a learning task, then this information may not be made available throughout the application phase. Supportive information is normally presented before learners perform learning tasks as long as these tasks are not too complex. However, if a learning task is complex, or will take a long time to complete, then supportive information may be presented sequentially during key points as students perform the learning task. In addition, if supportive information is too complex to remember, or if students may not recall this information sufficiently, supportive information could be provided just in time as learners perform a learning task.

Variations in Application

Application of learning in TCI means that students complete learning tasks as part of their learning experience and learners receive coaching and feedback on their performance that fades away over time. Application of learning also may include part-task practice for learners. The fading away of coaching may occur more quickly or slowly depending on the needs of individual learners. For instance, if learners are truly struggling with a learning task, the frequency of coaching and feedback might be increased to help them. Alternatively, coaching and feedback might be quickly faded out if learners are able to complete a learning task without much difficulty or if they have become too dependent on the instructor and must learn to practice on their own.

For more complex learning tasks, application activities will include instances where learners must pause task performance, focus on knowledge and skill development, and then resume task performance (Reigeluth, 2012). These types of activities, called part-task practice, are necessary when learners must gain a high level of automaticity, or when there is a need for repetition to help learners internalize a skill (van Merriënboer & Kirschner, 2013). Situations in which the learner needs to apply skills in diverse circumstances, or in which a particular complex learning task does not sufficiently support the development of a specific skill among learners may also warrant the implementation of part-task practice. Part-task practice usually includes additional instruction and coaching that helps learners gain key knowledge and skills so that they can return to and continue to perform the learning task (Reigeluth, 2012; van Merriënboer & Kirschner, 2013).

Also during application, if a learner makes a misstep and the instructor doesn't know the reason, the learner should be directed to share his or her thought processes while completing the task. Reflection activities, such as journaling and group and class discussion might also need to be implemented in TCI when learners need help on their learning task performance. Also, if learners are not able to remember the steps for learning task completion, they may need to be reminded of the procedural information that they had previously learned during demonstration/modeling.

Variations in Integration/Exploration

In TCI, learners transfer their new knowledge into everyday life. A variety of methods could work to support integration/exploration in a course of learning. The instructor could set up sessions where learners demonstrate their new knowledge or skill to a public group. Learners might be required to discuss or defend new and different ways to perform a task or solve a problem as part of a reflection activity. Learners could critique each other on their task performance to support integration/exploration (Merrill, 2009). Integration/exploration tasks might include showing new skills to others, reflecting on new skills and knowledge, and creating new ideas and projects based on knowledge and skills learned (Collins et al., 1991; Merrill, 2002b).

The method that is used to help learners integrate or explore their knowledge should vary according to the type of learning task implemented and available resources in the learning situation. Constraints such as time and resources might restrict the extent to which learners are able to transfer their learning to real-world situations. If there are not sufficient time and resources to allow learners to go to realistic settings and perform the learning task there, then more simple learning methods could be used such as discussions, reflections, and case studies. In these activities, learners could discuss how a learning task might be different if performed outside of school, reflect upon and share different methods for completing a learning task, or become involved in a case study showing how the task might be different in a real-world setting. If many learning tasks have been implemented in a TCI approach and these tasks have included much variability, then integration/exploration may already be embedded in the overall learning experience.

V. Implementation Issues for Task-Centered Instruction

In the implementation of a TCI approach, there are several different issues to consider. These issues generally fall into four main categories, including identification of learning tasks, resources available versus number of students, breadth versus depth of learning, and ensuring mastery. I will discuss each of these in this section.

Identification of Learning Tasks

It is difficult for even experienced instructional designers to identify and design appropriate learning tasks that will provide real-world experience, cover all of the required knowledge and skill, and match the skill level of the learners. In a study by Mendenhall (2012), many instructional designers in a university setting felt that they didn't have a sufficient understanding of TCI to fully implement this learning method. Gardner and Jeon (2009) faced a similar difficulty in designing web-based learning. After studying how award-winning professors use TCI in higher education, Gardner (2011a) discussed the difficulties of determining the size and amount of learning tasks to implement. He lamented that little guidance is available for effectively determining the right amount and complexity of learning tasks.

In many cases those who are designing or identifying learning tasks have limited instructional design experience, which can lead to uneducated learning task choices (see Francom et al., 2009; Mendenhall, 2012). Learning tasks must be chosen that help learners get enough practice using the target knowledge and skills, yet remain authentic and relevant. Identifying these learning tasks requires an extensive but rare combination of prerequisite knowledge, including knowledge of the subject area, knowledge of TCI, an understanding of learners' prior knowledge, and an understanding of the content required to complete a prospective learning task.

Resources Versus Number of Students

The resources for implementing TCI, which include instructional time, equipment, and technologies, can be greatly diminished when there are large numbers of students in a learning situation. In my experience implementing TCI in higher education settings (see Francom, 2011; Francom et al., 2009), sufficient instructional and learning time for completing learning tasks has been difficult to find. In one TCI implementation, for instance, there were over 300 students working in small groups in a general education biology class (Brickman et al., 2012; Francom, 2011). The number of students and the short time they had working together greatly restricted the time the instructor and teaching assistants could spend designing, implementing, and assessing learning tasks.* In this situation, a compromise was made in which only part of the class was a fully implemented version of TCI.

Though sufficient time is usually made available for activities like demonstration/modeling in TCI, time for activation of prior knowledge and coaching and feedback is often severely limited. Instructors in larger classes are often forced to simply make an educated guess to determine each student's learning gaps and to match learning tasks to learner needs (Francom, 2011; Francom et al., 2009). Instructor coaching and feedback is also limited as the instructor likely cannot be available to observe and help every student in a large class as they perform learning tasks. TCI is much better suited to the new learner-centered paradigm of education in which students work as individuals or teams within smaller class sizes.

One potential technological solution to this problem is to make use of online Information-Age resources to provide learning task support such as demonstration/modeling, coaching, and scaffolding. For example, instructional time can be conserved if learners watch tutorial videos or presentations showing how to perform tasks on their own time. Some resources that have great potential for demonstration/modeling include the Khan Academy, university open courseware, and instructional videos on YouTube, SchoolTube, and TeacherTube. TCI software applications that have scaffolding and coaching functions could also be developed to guide learners through the process of performing tasks.**

Breadth Versus Depth of Learning

The TCI method tends to favor depth of learning over breadth of learning. TCI is certainly not as efficient at getting students to memorize and recite a large list of concepts and ideas, and time limitations may make it difficult to cover all important knowledge and skills. However, the smaller range of skills and concepts that are learned and applied to learning tasks are much more likely to be internalized and transferred by learners in TCI than they are in other types of learning that do not include application of concepts and skills.

This issue connects back to the previous issue of identifying learning tasks. There is a need to identify learning tasks that cover a wide enough range of desired concepts and skills, yet still include activities that are whole, real-world, and relevant to support depth of learning. This is a balance that has not yet proven to be an easy job for instructional designers, let alone instructors (Francom, 2011; Francom et al., 2009; Mendenhall, 2012).

If there is a need to cover a wider range of concepts and skills than can be supported in identified learning tasks, a potential solution is to make use of Information-Age technological and media resources. For instance, students could view online instructional videos and presentations or participate in interactive activities to help them more effectively learn and memorize key concepts. Because there are many effective instructional resources freely available, learners can gain a wider range of skills and concepts without sacrificing a great deal of instructional time.

Ensuring Mastery

Ideally, each student must master every target concept and skill. Collaboration is often a major element in TCI, as learners work together to perform learning tasks. In collaborative activities, it is often difficult to ensure that all learners master target concepts and skills. Group members may take on different roles in the learning process, and different members of each group may perform different elements of a learning task, thereby applying different concepts and skills.

In order to help ensure that all learners gain the target knowledge and skills in TCI, the instructor might have to add further structure to the collaborative work that each group performs. Some structure that could be added to the collaborative work might include rotating group member roles so that each group member has opportunities to apply the same knowledge, or assessing students individually to determine their knowledge. One way to assess the progress and quality of learning is to assess the whole group on learning task completion and separately assess individuals for key concepts and skills.*

As mentioned previously, Information-Age media resources can play a role in the acquisition of target skills. Online videos, presentations, and articles can be assigned so that each learner in a group is able to learn target concepts and skills, even if they play different roles as they perform a learning task. Learners can develop knowledge and skills as they pause from performing a task in order to participate in part-task practice.

The majority of issues related to the implementation of TCI will likely continue to fall into these categories: identification of learning tasks, resources available versus number of students, breadth versus depth of learning, and ensuring mastery. Determining and overcoming TCI implementation issues will be an important pursuit in the learner-centered paradigm of education. Information-Age technology and media resources are likely to play an important role in improving and overcoming these issues. Technology and media resources will continue to proliferate and improve, allowing more and more TCI learners to build skills independently, while instructional time can be conserved for learning-task activities.

VI. Conclusion

TCI is an approach to learning that centers on learning tasks, with activation, demonstration/modeling, application, and integration/exploration as major components. This type of learning stems from several different learning theories and models, including cognitive apprenticeship (Brown et al., 1989; Collins et al., 1991), elaboration theory (Reigeluth, 1979, 1999), the four-component instructional design model (van Merriënboer, 1997; van Merriënboer & Kirschner, 2013), and first principles of instruction (Merrill, 2002b, 2007; Merrill & Gilbert, 2008).

Learning tasks in TCI are modeled from real-world performance, and learners complete carefully designed sequences of learning tasks that progress from simple to complex. Activation of prior knowledge is also an essential element of TCI as the instructor or instructional designer must address learning gaps among learners and match learning tasks to learners' prior knowledge. In TCI, learners see a demonstration showing how to perform a learning task, and they receive supportive and procedural information that will help them learn how to perform the task. Learners also use their knowledge to perform learning tasks as part of the learning experience while receiving coaching and feedback. Finally, learners integrate and explore new ways to use their knowledge and skills.

TCI can be differentiated from problem-based learning because it prescribes the use of structure, guidance, and coaching that is faded out over time as learners gain expertise. It is especially appropriate for learning objectives that are performance based and lend themselves to practice and transfer of learning to authentic situations. TCI is particularly well suited to the learner-centered paradigm of education because it is compatible with attainment-based learner progress, personalized instruction, and changed roles for teachers and students.

There are some situational principles that may vary in TCI. These include the authenticity of the learning tasks, the wholeness of the learning tasks, the rate at which tasks progress from simple to complex, the methods for activating prior knowledge, demonstration/modeling methods, application methods, and integration/exploration methods. Also, implementation issues for TCI fall into four major categories: identification of learning tasks, resources available versus number of students, breadth versus depth of learning, and ensuring mastery. Many Information-Age technological and media resources can be used to improve and overcome issues surrounding the implementation of TCI.

Research to date supports the use of TCI and its various components, including learning tasks, activation, demonstration/modeling, application, and integration/exploration. Future research is still needed, however, to continue to improve the effectiveness of TCI for different situations, to study implementation issues for TCI, and to further connect TCI to other aspects of the learner-centered paradigm of education.

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Notes

* *Editors' note: As with most terms in instructional theory, TCI has different meanings for different people. Francom and Gardner (2013) contrast TCI from PBL, with TCI focusing primarily on application and transfer and effective learning, and PBL focusing primarily on the other items listed here. In contrast, in Chapter 1, we defined TCI as a generic term that encompasses problem-based learning, project-based learning, inquiry learning, hands-on learning, maker learning, and other forms of learning by doing authentic tasks. This highlights the importance of making extra effort to understand an author's definitions rather than assuming they are the same as yours. Other chapters in this volume that address some form of task-centered instruction include Chapter 6, Designing Maker-Based Instruction, Chapter 7, Designing Collaborative Production of Digital Media, Chapter 8, Designing Games for Learning, Chapter 12, Designing Instruction for Flipped Classrooms, Chapter 13, Gamification Designs for Instruction, and Chapter 15, Designing Just-in-Time Instruction, though all the chapters assume a task-centered approach.*

* *Editors' note: When competency-based student progress is used, records are kept on individual competencies, making learner analysis unnecessary.*

* *Editors' note: This illustrates the difficulty of trying to fit aspects of the learner-centered paradigm into the prevailing structures of the teacher-centered, time-based paradigm. Effective implementation requires fundamental structural changes.*

** *Editors' note: See Chapter 16 for design specifications for such a software application.*

* *Editors' note: This separate assessment could be fully integrated into the instruction by using a system like the Khan Academy that requires practicing a skill until a criterion of the last 10 items in a row correct unaided.*

4

PRINCIPLES FOR PERSONALIZED INSTRUCTION

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EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *All kinds of content.*

Learners

- *All kinds of students.*

Learning environments

- *Learner-centered rather than teacher-centered.*

Instructional development constraints

- *Minimal.*

Values (opinions about what is important)

About ends (learning goals)

- *Development of student self-regulation skills is highly valued.*
- *Development of intrinsic motivation and love of learning is highly valued.*
- *Mastery of knowledge and skills is highly valued.*

About priorities (criteria for successful instruction)

- *Effectiveness and intrinsic motivation of the instruction are more important than efficiency.*

About means (instructional methods)

- *Choices that foster intrinsic motivation are highly valued, including student goals, learning tasks, assessments, and reflection.*
- *Learning through social interaction is highly valued.*

About power (to make decisions about the previous three)

- *Empowering learners to make decisions about ends, priorities, and means is highly valued.*

Universal Principles

1. Personalized instructional goals

- *Learners should set and periodically revisit their long- and short-term learning goals with appropriate amounts of guidance through social interaction with their teacher and parents.*
- *The development of a personal learning plan should be structured around long- and short-term*

goals and required and optional standards.

- *The teacher should help students to identify strengths and interests they were unaware of.*
- *Motivational whole-task projects should be selected in a way that encompasses competencies that are less engaging to the learner.*
- *A detailed record should be kept of the student's progress on his or her personal learning plan.*

2. Personalized task environment

- *Selection of the instructional task should be personalized to align with the learner's interests, goals, and prior learning.*
- *An instructional agent should offer subsets of potential tasks for the student to choose from or design.*
- *The degree of collaboration on tasks should be personalized, with the teacher and student a) negotiating which tasks will best be done individually and which through collaboration, and b) negotiating the students with whom to collaborate.*

3. Personalized scaffolding of instruction

- *The quantity and quality of instructional scaffolding should be personalized to the student's self-regulation skills and developmental needs through a combination of embedded scaffolds and scaffolding from teachers and peers.*

4. Personalized assessment of performance and learning

- *The assessors of task performance and attainments should be personalized by choosing among the teacher, external experts, peers, and computer systems.*
- *The means of assessing task performance and attainments should be personalized to align with the student's goals and interests through choice of the nature of the product or activity and its representation.*

5. Personalized reflection

- *When and how a student reflects on her or his learning process should be personalized.*
- *Personalization should occur regarding when and how a student reflects on how her or his resulting product or performance met and did not meet expected outcomes.*

Situational Principles

Personalized instruction in time-based systems

- *Students could choose to master a subset of a course's objectives in exchange for a lower negotiated grade.*
- *Teachers could integrate learning tasks across courses to provide additional time for learning and more authentic, whole-task learning approaches.*
- *Teachers could give students incompletes until they master all required learning objectives.*
- *Goals could be lowered from mastery to competence, or grades could be awarded based on where the student lies on the continuum between novice and expert.*

Personalized instruction without supporting technology

- *A paper-based system should be implemented to plan for, track, store, and report on student* *learning.*

Personalized instruction for traditional students

- *Special attention should be paid to developing self-regulated learning skills in students from teacher-centered schools, with significant scaffolding early in their personalized learning process.*
- *Teachers should work with families to help them fully understand and reinforce the culture and philosophy of personalized learning.*

Personalized instruction for online learning

- *A strong communication process should be used to ensure frequent communication among teachers, students, parents, and collaborators.*
- *Students should be given more scaffolding and structure.*
- *A strong sense of learning community should be established.*
- *Greater advantage should be taken of collaborators from around the globe.*

Case Description

- *The Decatur Enrichment Center*

– C.M.R., B.J.B., & R.D.M.

PRINCIPLES FOR PERSONALIZED INSTRUCTION

I. Introduction

Definition

The information-age paradigm of instruction is customized rather than standardized, learning-focused rather than content-delivery focused, student-directed (or jointly directed) rather than teacher-directed, and entails active learning rather than passive learning, as described in Chapter 1 of this volume and Chapter 1 of Volume II (Reigeluth, 1999). While the theoretical underpinnings of personalized instruction share a number of commonalities with other frequently utilized terms, such as customized, learner-centered, individualized, self-directed, and independent, this chapter describes the nature of personalized instruction specifically for the realization of an information-age, learning-based paradigm.

Related concepts, such as learner-centered (which was precisely defined in Chapter 1), have been broadly defined and used to describe a variety of different instructional methods. S.L. Watson and Reigeluth (2008) review the framework of learning-centered research, including the American Psychological Association's 12 learning-centered psychological principles (1997), as well as McCombs and Whisler's (1997) two features for learner-centered schools and classrooms: a focus on individual learners and their characteristics, and a focus on the best available knowledge on learning and teaching.

S.L. Watson and Reigeluth (2008) also describe similar terms, including personalization. Keefe (2007) describes the origins of personalized learning, tracing it to the 1970s with the National Association of Secondary School Principals (NASSP) and the Learning Environments Consortium (LEC) International, and notes how the special education field adopted it (such as in the form of individualized education plans). Keefe (2007) goes on to describe the 40 (now 50) year history of personalization in education and synthesizes a number of definitions to create his own that assimilates the common concepts in this literature, writing that:

> Personalization . . . is a systematic process for organizing a school for success. It is an attempt to achieve a balance between the characteristics of the learner and those of the learning environment, between what is challenging and productive and what is beyond the student's present capabilities. It is a systematic effort on the part of a school to take into account individual student characteristics and effective instructional practices in organizing the learning environment. It is a learning process in which schools help students assess their own talents and aspirations, plan a pathway to meet their own purposes, work cooperatively with others on challenging tasks, maintain a record of their explorations, and demonstrate their learning against clear standards in a wide variety of media, all with the close support of adult mentors and guides. (p. 221)

Despite decades of promotion in the literature by a core set of authors, personalized learning has recently gained increasing cachet as a concept. However, it still lacks a specifically defined and widely accepted definition. Recently, one group of philanthropists and educational technology advocates published a definition of personalized learning, identifying four attributes: competency-based education, flexible learning environments, personal learning plans, and learner profiles (Bill & Melinda Gates Foundation et al., 2014). The United States' Department of Education (2010) defined personalization in its 2010 National Education Technology Plan report: "Personalization refers to instruction that is paced to learning needs, tailored to learning preferences, and tailored to the specific interests of different learners. In an environment that is fully personalized, the learning objectives and content as well as the method and pace may all vary (so personalization encompasses differentiation and individualization)" (p. 12).

Bray and McClaskey (2015) also define personalization by contrasting it with differentiation and individualization in a chart that demonstrates the learner-centered and learner-driven nature of personalization, and they review some of the relevant research on personalization. In seeking a common language for personalized learning, they define it as meaning that learners:

- know how they learn best, are co-designers of the curriculum and the learning environment
- have flexible learning anytime and anywhere
- have a voice in and choice about their learning
- have quality teachers who are partners in learning
- use a competency-based model to demonstrate mastery
- self-direct their learning
- design their learning path for college and career. (p. 34)

The role of technology in personalized learning has also become a more prevalent component of the concept and its definition, as the use of data mining to support personalized learning is another aspect in the literature (Keeffe, Brady, Conlan, & Wade, 2006; Lin, Yeh, Hung, & Chang, 2013). We have proposed a vision for a learner-centered learning management system that we call the Personalized Integrated Educational System (PIES). It calls for four primary functions: record-keeping for student learning, planning for student learning, instruction for student learning, and assessment for student learning, in addition to some secondary functions, for the systemic application of technology to support personalized learning (Reigeluth, et al, 2008; Reigeluth, Watson, & Watson, 2012; Reigeluth, et al., in press; W.R. Watson, Watson, & Reigeluth, 2012; W.R. Watson, Watson, & Reigeluth, 2015).

Ultimately, personalized learning should refer to a process or model of education and not be limited to a specific tool, whether that tool is educational data analysis or competency- or project-based education, all of which could be tools implemented to support personalization. Furthermore, personalized learning should truly focus on learning, meaning that it should move beyond the systematized approach of system-driven customization for learners and instead incorporate learner-control in order to develop self-regulated learning skills and not just knowledge.

Importance

Personalized learning has taken on an increased importance in modern society that has not yet been reflected in actual substantive changes to our educational systems. Reigeluth (1994) describes how the time-based system of education was appropriate for meeting the needs of industrial-age societies that sought to sort students into factory-line workers and their managers by holding instructional time constant and therefore forcing variations in performance. Conversely, current information-age societies require critical thinkers and life-long learners, educational outcomes less likely to be developed in a time-based system and therefore requiring a system of education focused on student learning and mastery of skills and knowledge (McCombs & Whisler, 1997; Reigeluth & Watson, 2008). Such transformation of education requires personalization of instruction.

Theoretical Foundations

The personalization of instruction is founded on established and widely accepted learning theory and psychological frameworks, including constructivism, goal-orientation theory, self-regulated learning, self-determination theory, and flow theory.

Constructivism

Constructivism grew from prior learning theories such as Piaget's cognitive and developmental views, situated cognition's focus on the contextual nature of learning, and Bruner and Vygotsky's emphasis on interaction and culture (Driscoll, 2005). Bruner (1961) argued that the goal of education is to support the development of autonomous and self-driven thinkers. He stressed the importance of instruction being suitable for the developmental stage of the individual learner and recommended discovery learning through the solving of culturally appropriate and realistic problems. Vygotsky (1978) highlighted the importance of social interaction for the creation of higher mental processes and described the zone of proximal development as what a learner is able to learn with collaboration or scaffolding from a peer or teacher. Driscoll (2005) identifies constructivist conditions for learning as embedding learning in complex and realistic environments, incorporating social negotiation, supporting multiple perspectives, using multiple modes of representation, encouraging ownership of learning, and nurturing self-awareness of knowledge construction.

Goal-orientation theory

Goal-orientation theory argues that learners should have their own goals for learning, and conceptualizes student motivation as mastery- or performance-based (Ames & Archer, 1988). Mastery goals represent the desire to develop understanding or a new skill (criterion-referenced), while performance goals represent the desire to appear competent when compared with peers (norm-referenced) (Ames & Archer, 1988). By focusing on students' mastery goals, instruction can highlight individuals' progression in learning rather than producing negative perceptions of ability that can arise when comparing students' performance to their peers.

Self-regulated learning

Self-regulated learning describes the process wherein students actively participate in their own learning through metacognition, behavior, and motivation (Zimmerman, 2002). Self-regulated students are equipped to set their own learning goals, plan for meeting those goals by identifying appropriate strategies, implement and evaluate the efficacy of the strategies, and reflect on their learning progression (Zimmerman, 2002).*

Self-determination theory

Self-determination theory argues that the nature of a goal, whether it is determined by the student and is thus intrinsically motivated or whether it is set by someone else and therefore extrinsically motivated, impacts the likelihood that the goal will be attained (Deci, Ryan, & Williams, 1996).

Flow theory

Flow theory is another motivational theory that describes attributes of activities that are conducive to motivation and deep engagement. Csikszentmihalyi (1990) identifies such attributes as clear goals, individual control, tasks that the individual is capable of successfully completing, and skills that must be learned.

Guiding Models for Universal Principles

As previously described, personalized instruction is foremost an attempt to realize a learner-centered paradigm of education by focusing on the individual student and supporting active student control of the learning process. Despite its long history, there are limited formal models in the literature for personalizing instruction. This is perhaps due to the challenges of implementing personalized approaches to instruction within the current time-based, instructor-driven system of education. Nevertheless, several models have been put forth, representing both the long history of personalized instruction as a targeted ideal in education and the continued relevancy and desire to realize personalized instruction, as well as significantly different approaches to achieving personalized instruction. We first review relevant models in the literature that informed the identification of universal principles.

Personalized system of instruction (PSI)

Interestingly, the first broadly used model for a personalized approach to instruction arose out of a focus on implementing the tenants of behaviorism rather than the underlying theory of constructivism that was previously identified as supporting personalized approaches. PSI is primarily attributed to Keller (1968) who sought to implement Skinner's behaviorist approaches, particularly programmed instruction.

It included the following five elements: 1) personalized pacing allowing students to progress through a course at their own pace; 2) a focus on mastery learning where students progress only after they have mastered content that has been divided into smaller packages; 3) the use of peer proctors for frequent formative assessing, proving immediate feedback, tutoring, and offering social support; 4) limited lectures utilized primarily for motivation; and 5) the use of text for course communications. Through this system, Keller (1968) found that he could personalize learning for his undergraduate students despite large enrollment numbers, and that student learning and satisfaction were improved.

Interest in and implementation of PSI peaked in the 1970s before declining despite positive reports of its efficacy in the literature (Cracolice & Roth, 1996; Kulik, Kulik, & Cohen). However, interest in PSI continues, and a number of recent articles have looked to PSI, including a case study of its use for increasing college retention in eight courses that found an overwhelming positive response from faculty and students (Foss, Foss, Paynton, & Hahn, 2014). Also, Eyrie (2007) reviewed current research and found that PSI is now being applied to online learning. PSI highlights a number of key principles of personalized instruction, namely personalized pacing, a focus on mastery learning (or competence), formative assessments to help students recognize their own level of competence rather than to contribute to a final grade, and a focus on social interaction and support. Of note, however, is PSI's limited support for student control of instructional format or goals.

Montessori method

One of the most visible models to incorporate significant elements of personalized instruction is the Montessori method (Montessori, 1964). Over 100 years old, the first Montessori school was developed for impoverished preschoolers in Italy and was estimated to now have over 5,000 schools in the United

States, including 300 public schools, some of which are high schools (Lillard & Else-Quest, 2006).

The Montessori method has the teacher act as a guide rather than director, encourages curiosity and intrinsic motivation in students, has students of mixed age who work individually or collaboratively in groups, and gives students choice over what they will work on—although the activities are well structured and less flexible, and an orderly classroom is stressed to provide an effective learning environment (Lillard, 2005).

Lillard and Else-Quest (2006) conducted a study comparing groups of randomly assigned five-year olds and 12-year olds who had completed kindergarten and elementary school, respectively, in Montessori and traditional schools and found that the Montessori students performed higher, not only in academic areas, but also in social skills. Not all studies have shown positive outcomes, and Lillard (2013) posits that this may be due to the fact that Montessori is not trademarked and not all schools adhere strictly to the method like the schools she and her colleague examined.

The Montessori method implements numerous aspects of personalized instruction, including a learner-centered focus with intrinsic motivation and the teacher acting as a guide, self-pacing, some student choice in instruction, a focus on mastery, and learning through social interaction. It should be noted that, while students have broad choice in their learning activities or “work”, the instruction itself is quite structured and ordered around specific approaches.

Personalized task selection model

A more recent model seeks to mitigate the criticisms of system-directed approaches to personalization, in which computer systems select learning tasks for individual students based on data. It does this by incorporating student choice and thus retaining the benefits of learner-driven approaches to personalization while also avoiding the potential for cognitive overload that can come from presenting too many task choices to the student (Corbalan, Kester, & van Merriënboer, 2006). Whole-task learning, which promotes learning through authentic (and therefore complex) tasks while promoting transfer and integrating knowledge, skills, and attitudes, can be overwhelming, particularly to novice students (van Merriënboer, Kirschner, & Kester, 2003). The personalized task selection model (Corbalan, et al., 2006) was informed by the four-component instructional design model (4C/ID model) (van Merriënboer, 1997), but has a narrower focus on personalization and task selection than the later ten steps to complex learning from which it was adapted (van Merriënboer & Kirschner, 2012).

The model (Corbalan, et al., 2006) has three components: characteristics, personalization, and learning-task database. The *characteristics* are comprised of task characteristics and student characteristics, which are documented in a portfolio. Task characteristics include the task’s complexity or difficulty, embedded support for students, and data on other task features, such as performance context or task input and output format. The student characteristics, contained in a learner portfolio, are information about the student’s expertise through performance on tasks and mental effort required on completed tasks. The *personalization* mechanism supports processes for system-controlled instruction through task-selection rules and learner-controlled instruction through students selecting tasks from a pre-selected subset (the size of which is based on learner expertise). The *learning-task database* contains the learning-tasks themselves from which the subset is selected for the student to choose from, based on such aspects as complexity or the level of embedded support.

A study by the authors utilizing this model with 55 first-year Health Science students found that adaptive task selection with program control (an intelligent tutoring system makes instructional decisions based on domain goals, current student learning, and student input) was more efficient and resulted in greater student perceived task involvement (greater effort directed at learning), while adaptive learning coupled with shared task selection (student selects task from system derived list) produced greater task involvement (calculated by learning outcomes and self-reported mental load) (Corbalan, Kester, & van Merriënboer, 2008). Another study found greater training performance, transfer test performance, and student perceived task involvement when students (94 first-year students in Health Sciences) were able to select from pre-selected tasks with different surface features than previous tasks (Corbalan, Kester, & van Merriënboer, 2009). While Corbalan and her colleagues’ model

(2006) does an excellent job of addressing the issue of cognitive overload that can come with students directing their learning, it serves as a midpoint between system-directed instruction and learner-directed instruction.

Recently, Taminiau et al. (2014) offered a similar take on adaptive instruction called on-demand education with a stronger focus on learner choice in learning pathways through a cycle of task performance, self-assessment, and task selection—with advice generated by the system. Both personalized task selection and on-demand education focus on computer adaptive instruction rather than incorporating guidelines for teacher-supported task selection or learner-directed setting of learning-goals but nevertheless have shared goals with personalized instruction in supporting a degree of student control in task selection, and provide maps of considerations for how this process might occur. While adaptive approaches to task selection are important to explore, they are limited by the student data and inputs they draw from and the artificial intelligence model and rules programmed to manage the complexities of individual student considerations that must be analyzed in order to select the best instructional tasks for learners. Furthermore, by removing the social interaction that takes place during negotiation of task selection between students and teachers, valuable learning opportunities are lost.

These three models highlight existing designs for personalizing instruction while also reporting related research. We next look at values and then universal principles for personalizing instruction informed by these models as well as underlying theory.

II. Values

It becomes apparent, when defining personalized instruction and describing its underlying theories, that a number of specific values provide a better understanding of what it should entail and how it should be implemented. Personalized instruction is at its most basic level focused on being learner-centered. While the concept of learner-centered, like personalization, can be used broadly, we use personalization as an aspect of learner-centeredness that supports a significant degree of learner autonomy and direction of the learning process. A personalized approach should develop student self-regulation, promote intrinsic motivation, and engage the learner, in addition to promoting knowledge-based learning outcomes.

A personalized approach values learning, meaning the focus should be on learning outcomes and mastery of knowledge and skills, not on what might be the most efficient means of instruction. Rather, it should focus on what will be most effective, particularly when considering self-regulatory skills. Furthermore, while the importance of the teacher should not be understated, their role should shift to being a facilitator of learning and mentor rather than content provider. A personalized approach should focus on the individual learner and best meeting her needs, incorporating learner choice and goal setting rather than developing a system that merely adapts existing components to individuals based on their characteristics. This is not meant to diminish the effectiveness and positive outcomes that data analysis and adaptive computer systems can play in supporting a personalized process. Instead, this value highlights the importance of social interaction throughout the learning process, including personalizing goal setting, the task environment, assessment, and reflection for self-regulated learning, which would be a core element in an ideal implementation of personalized instruction.

III. Universal Principles

A number of universal principles can be drawn from relevant models and theories for guiding the design of personalized instruction. These focus on personalized instructional goals, personalized task environment, personalized scaffolding of instruction, personalized assessment of performance, and personalized reflection on the learning process and the learning outcome.

1. Personalized Instructional Goals[*]

As previously discussed, self-determination theory argues that individual control over learning goals supports intrinsic motivation and an increased likelihood that the goals will be met (Deci, Ryan, & Williams, 1996). The three personalized models reviewed all fell short of true self-determination, although all also contained elements of learner-determination of the learning process. Complete personalization of instructional goals is a challenging and difficult principle to meet, as some required educational standards typically exist, and rightfully so. Furthermore, learners are often not the best equipped to make accurate decisions as to what goals are most important to pursue. However, self-determination does not mean goal selection is done by the student in a vacuum with no support. A process of personalization should be applied to developing a learner's short- and long-term learning goals and should support the periodic and systematic reexamination of these goals. The development of a personalized learning plan should be structured around required standards as well as optional ones and should have some direction based on the learner's current competence and informed by the learner's parents if appropriate (or agreed to by the learner in the case of legal adults).

Where adapted learning falls short in addressing individual learning goals is the lack of social interaction around the identification and planning for these goals. It is very common for students, particularly those with limited self-regulation skills such as many students within today's one-size-fits-all system of education, to lack a clear vision of what they want to learn, what they need to learn, and why. Good teachers are able to facilitate the exploration process and bring valuable experience to the conversation, identifying strengths and interests the student may be unaware of. This process can be no less than life altering and is a key component of the mentoring that can arise around human relationship. So, while adaptive instruction systems can store and access learner goals, an ideal implementation of personalization will incorporate and facilitate mentoring.

Personalizing instruction, therefore, begins with eliciting personal goals, both short-term and long-term, and documenting a learning plan and record of attainment. Depending on the process in place for monitoring and adjusting these goals, instruction can be designed by merely accessing these data, or if it has not yet been elicited and captured, the process needs to be initiated in order to align instruction with the individual's specific goals, motivation, and current learning.

Personalized long-term goals

The setting of goals has been shown to be highly effective for developing self-regulated learning (Schunk, 1990; Schunk, 1991; Zimmerman, 1990) and should be encouraged throughout a learner's education. This is key to developing an effective personal learning plan (PLP), as learners must understand potential learning outcomes and the reasoning behind them in order both to be motivated to attain them and to internalize the relationships among skills, knowledge, and culture that comprise the whole-task they select (van Merriënboer, et al., 2003). Furthermore, personalization of goals does not mean that the learner must meet specified standard competencies that domain experts have identified. If the learner desires to be an environmental scientist, the setting of long-term goals will identify what domain-specific competencies must be met as well as what general competencies all learners must meet. Long-term goals will also help to identify potential collaborators in peers who share similar or complementary long-term goals.

Personalized short-term goals

Just as the process of identifying personal long-term goals is essential to establishing a PLP, so is the identification and tracking of short-term goals established to plan how the learner will progress towards meeting long-term goals. This is a key requirement for personalizing the task environment. Short-term goals identify what specific competencies must currently be targeted. This can also be used to motivate the learner. While intrinsic motivation is the foremost goal of developing personal long-term goals, establishing short-term goals can provide a degree of extrinsic motivation to complete required standard competencies that the learner may be less motivated to pursue.

While the process of creating and updating the PLP will provide discussion over why these required competencies are necessary for meeting long-term goals, learners may naturally desire to focus more narrowly on what they are most motivated to learn. Broad learner choice and control is necessary, and integrating competencies that are less engaging to the learner within motivating whole-task projects is ideal. Therefore, restricting access to desired goals until a certain level of required competence is met in less motivating competencies can be a way to extrinsically motivate students to pursue such competencies. This is similar to how video games require periods of less engaging gameplay to unlock more desirable gameplay experiences, a process commonly referred to as "grinding" that can nevertheless be very effectively utilized with highly engaging games. For example, a learner with identified long-term goals associated with creative writing might perform at a lower level in mathematics and be less motivated to select required math standards. Restricting further work on goals directly related to creative writing until the learner has met minimal required mathematical competencies could be effective if the whole-task writing projects that integrate these competencies cannot be satisfactorily completed without that competence in mathematics.

Personalized learning record and plan

As previously described, long-term goal setting will inform the co-creation of the short-term goals and a PLP by student and teacher (and possibly parent or other guardian). Options for the learning pathways available for meeting the short-term goals should be provided. The process of identifying and revisiting long-term goals and adjusting the PLP to align near-term projects and the goals they address will help move the PLP from broader to more specific as more short-term goals are identified and met. A record of a learner's progression along this PLP will be essential to aligning the task environment to the learner's individual learning goals and mastery of specific domains while ensuring broad competencies and education of the whole person.

*2. Personalized Task Environment**

Personalizing the task environment manages the process of personalizing the task selection, personalizing any collaboration involved in completing the task, and personalizing the self-regulation process.

Personalized task selection

As described in the Personalized Task Selection Model (Corbalan, et al., 2006), learner choice in selection of the instructional task should be personalized to align with the learner's interests, short-term goals (which are aligned with long-term goals as specified in the PLP), and prior learning (progression along the PLP and its learning pathways). Corbalan and colleagues (2006) note the dangers of causing cognitive overload, particularly in—but not limited to—novice learners, by presenting too many possible tasks to select. In their proposed adaptive system for personalization, they recommend using an instructional agent to select subsets of potential tasks for the student to choose from. Ideally, we should capitalize on the expertise and experience of an instructor who is deeply familiar with the student and her characteristics as well as relevant high-quality instructional tasks. A database of existing tasks to select from will be helpful to this process, but collaboration between the instructor and the student and potentially her peers can also result in truly personalized tasks and just-in-time instructional task design to meet specific learning needs, personal goals, and interests. Furthermore, in order to avoid cognitive overload or the selection of inappropriate tasks, tasks can be adjusted or chosen based on their difficulty level and fit with the student's current level of competence or expertise. Corbalan et al. (2006) designed an adaptive system based on data on the amount of mental effort required to complete earlier, related tasks but which could likewise be recorded in the student's PLP to guide the process of social negotiation for task selection.

Personalized collaboration

The degree of collaboration involved in completion of tasks should also be personalized. Social interaction is a core component of personalized learning as reflected in its social constructivist approach to instruction. However, this does not mean that students will always learn in groups. The teacher will play a key role in negotiating with the student which tasks will best be done individually and which would benefit from collaboration. Learning from and with peers should be a common occurrence and, as reflected in research on the Montessori method (Lillard & Else-Quest, 2006), can result in improved social skills, an important outcome for whole-person education. Student collaboration can match students with similar or complementary goals or skills, helping students fill roles in tasks aligned with their current learning needs, as well as take into account interests and long-term goals. Additionally, preference on which teammates to collaborate with can be taken into account to help avoid destructive group interactions that negatively impact the learning of all as well as ensuring that students do not always base work groups on friendships rather than task goals.

Personalized self-regulation[*]

As described by Corbalan and colleagues (2006), students have different levels of self-regulation skills, and therefore the nature and amount of support or scaffolding should be personalized based on the student's self-regulation skills and developmental needs. This is of particular importance for students who have been educated in a traditional instructional environment, as the lack of focus on student control likely will result in limited self-regulation skills. Scaffolding of self-regulation will need to be stronger and the structure of task completion and progress on PLPs more directive for novice self-regulators and then faded with time as students develop stronger ability to own their learning process and make more informed and effective decisions.

3. Personalized Scaffolding of Instruction[**]

Much like personalization of the nature and amount of scaffolding for self-regulation is needed, the quantity and quality of instructional scaffolding should also be personalized.

Personalized quantity and quality of scaffolding

Keller's (1968) PSI model makes recommendations for personalizing the quantity of scaffolding for individual students. Students are able to work on their own and advance at their own pace through instruction but receive individual tutoring from peers whenever necessary. By utilizing peers who have successfully completed the course, support for students working through instruction on their own is available whenever needed, and formative evaluation is frequent, in the form of immediate scoring and feedback. By offloading the responsibility for all scaffolding and assessment from the teacher to peer tutors, instruction is improved and the teacher is freed to focus more on facilitating the broader learning process.

Corbalan et al. (2006) embed support for learners in their adaptive computer system. However, this raises the limitations of utilizing a strictly computer-based system for such support. The Montessori (1964) method uses demonstration by teacher and peers that can be faded or skipped altogether based on the student's current learning. Furthermore, just as students have preferences for types of instruction, they also have preferences for types of scaffolding, with some preferring computer-based scaffolds and others face-to-face demonstrations, or even examination of previously completed peer products aligned with their current task. Ultimately, a combination of embedded learning scaffolds and the availability of opportunities for scaffolding from teachers and peers should be available for personalizing the quantity and quality of instructional scaffolding based on the student's zone of proximal development (Vygotsky, 1978).

4. Personalized Assessment of Performance and Learning*

Personalization of the assessment of student performance on selected instructional tasks and attainments should also be incorporated. This can be realized through personalizing the selection of the assessor of the performance and personalizing the student's product or activity to represent her competence in the targeted performance.

Personalized assessor

In the current teacher-centered system, teachers must be content experts and are therefore separated by domain expertise. Students typically work on part-task problems that simplify tasks and deconstruct them into separate domains. In a whole-task system, a more integrated understanding of tasks is needed to properly assess these more authentic and complex tasks. Therefore, who is assessing a task performance should also be personalized for efficient and effective assessment of student learning. A focus on authentic tasks can expand student work beyond the constraints of the classroom and into the community. Therefore, external experts, including parents, business employees, and other stakeholders in the community, whether they be a physical or virtual (online) community, could be utilized to assess student task performance when needed. Furthermore, some learning could be assessed by computer systems and other learning by peer tutors and collaborators. Students assessing the learning of their peers can serve to further strengthen their own learning. Keller (1968) included the opportunity for students to negotiate and discuss the assessment provided by their peers in order to improve accuracy and further develop learning.

Personalized representation of competence

The opportunity for learners to have choice not only in learning goals, but also in the representation of their competence, can further develop intrinsic motivation. In creating a personal portfolio of attainments, students will compile a collection of demonstrated competence aligned with their PLP. Competence could be demonstrated in a variety of formats. Corbalan et al. (2006) note that repeated representation of competence in different formats can support more detailed and accurate assessment and support transfer of learning to different contexts. A significant aspect of task selection will be identifying potential products that students will produce by completing instructional tasks, and these should be personalized to align with student goals and interests. Depending on the goals, tasks and resulting products could be traditional written work, such as a persuasive letter to the editor or to the student's state or federal representative, or a research report, video capture of a public speech or performance, a digital product such as a student-developed video game or other multimedia, or even a physical product such as an artwork, a robot, an architectural model, or a product prototype.

5. Personalized Reflection*

Personalization of student reflection should be done on both the learning process and the learning outcomes.

On the learning process

Related to personalizing the level of self-regulation provided, it is important for students to meta-cognitively reflect on their learning process as part of their overall learning and to better develop and recognize their level of self-regulation. When and how this reflection takes place should also be personalized. Some students will most effectively be able to reflect with built-in frequent reflection points throughout the project, while others could best be served by reflecting at the conclusion of the project. This can be informed by their current level of self-regulation and past learning experiences and can be supported and scaffolded in a variety of ways: as part of portfolio work, as quick questions provided and stored by the computer system, or as a piece of their product, such as a reflective essay or a portion of a speech.

On the learning outcomes

Finally, personalized reflection on the learning outcomes of tasks or projects is needed to close the cycle of learning and self-regulation. Learning products or performances resulting from chosen tasks provide the opportunity to connect the learning process to the learning outcomes reached and targeted goals remaining. It is expected that students will not always adequately realize their targeted learning outcomes. Formative feedback is an important part of the learning process, and some projects that were targeted to meet certain learning outcomes may not have resulted in satisfactorily meeting those goals. By reflecting on how their resulting product or performance met and did not meet expected outcomes, students will be better prepared to identify future instructional tasks as well as potentially examine how to approach additional work on products and the accompanying learning process in order to better meet desired outcomes. These data, including learning outcomes and student effort—labeled task involvement by Corbalan et al. (2008)—is important for better personalizing future instruction.

IV. Situational Principles

A number of situational principles exist that only apply in some situations and that impact the prescribed methods for designing personalized instruction. These include incorporating personalized instruction within a time-based system, designing personalized instruction without the support of technology, utilizing personalized instruction with students who have been operating within traditional instructional systems, and personalizing instruction in an entirely online environment.

Personalized Instruction in Time-Based Systems

Personalized instruction is clearly best suited for implementation within a system designed to support customization and student progress based on learning, as opposed to a system based on standardization and time-based student progress. However, PSI (Keller, 1968) demonstrates that it is possible to implement personalized approaches within such systems.* Keller's experiences and guidelines provide insight into how to support personalization within systems designed with different fundamental goals than the learner-centered paradigm (sorting-focused as opposed to learning-focused and teacher-centered as opposed to learner-centered). Keller (1968) utilizes PSI within a class environment, so students are still enrolled in a traditional course; however, they are given control of their instructional pacing by progressing according to their ability and knowledge, whether that results in faster or slower progression.

Keller (1968) did describe the case of a student who moved significantly slower than others and ultimately enrolled in the course twice in order to complete the desired learning. Time is a primary concern with this sort of approach as the semester calendars determine when time has run out, which is contrary to the stated focus on mastery. An alternative approach with PSI in the cases reported by Foss et al. (2014) was for students to select what their final grade would be based on how much of the course they intended to master. Students reported satisfaction with the course even when choosing to aspire only to a C or B in the course. PSI utilizes peer tutoring, frequent formative feedback, and self-directed learning to give learners control over learning in a fashion they choose within the given time frame, and positive results have largely been reported. However, a student's choice to not master a significant portion of the course is not reflective of PSI's ultimate goals, and Keller (1968) reported a significantly reduced number of students scoring lower grades with his approach to implementation.

Ultimately, the difficulty of implementing personalized approaches within a traditional system may have led to the decline in popularity of PSI. Some hypothesize the non-traditional teacher role may have led instructors to abandon the approach out of concern for how it might reflect on them, given traditional professional expectations for lecture in higher education (Buskist, Cush, & DeGrandpre, 1991).

Approaches to implementing personalized instruction within time-based systems must take special care to consider unique strategies to support self-paced and mastery learning within time constraints. Considerations could include integrating learning tasks across courses to provide additional time for learning and more authentic, whole-task learning approaches. Giving students incompletes until they master all required learning objectives is another alternative. Lowering goals from mastery to competence, or awarding grades based on where the student's learning places her on the continuum between novice and expert is another consideration. All have potential drawbacks but could still prove beneficial to instructors desiring personalized learning but limited by the system in which they find themselves.

Personalized Instruction without Supporting Technology

The support of computer technology can significantly ease the implementation of personalized instruction. As described in our articles detailing the functions of PIES (Reigeluth et al., 2008; Reigeluth et al., in press; Reigeluth, Watson, & Watson, 2012; W.R. Watson, Watson, & Reigeluth, 2012; W.R. Watson, Watson, & Reigeluth, 2015), technology is a powerful tool in a system where learning is personalized, because each student's goals, current progress, and record of attainments must be tracked. Clearly, advocates for adaptive instructional approaches to personalized instruction focus on computer technology and intelligent instructional agents to not only facilitate but also drive the process of personalization.

However, technology is not a prerequisite for personalization of instruction.[*] Many Montessori classrooms utilize personalized instruction with limited computer resources. Furthermore, in the case detailed later in this chapter, we describe an alternative high school with highly limited resources that tracked student learning entirely on paper. Certainly, an organized and structured approach must be taken and a paper-based system implemented to plan for, track, store, and report on student learning in a personalized approach. Students should have easy access to their personalized learning plans (in the case we studied, student plans were placed where easily visible to students and staff), and these plans should be updated frequently, even daily. Evidence of student attainments and their alignment with standards should be stored as portfolios, and sample instructional tasks and scaffolds should be stored in files to support instructional task selection. The lack of computer-based instruction puts more of the responsibility on students and teachers, but is nevertheless feasible.

Perhaps the most challenging aspects of a paper-based system are the reporting requirements, which require more effort for students and staff to access, and create an additional layer of effort for parents to keep track of their child's progress. However, the development of intrinsic motivation to succeed can be powerful, and, as detailed later in our case, students made sure that they knew what they were working on and how they were progressing towards graduation.

Personalized Instruction for Traditional Students

Special attention must also be given to helping students transition from a traditional instructional environment to a personalized one. As detailed in her multiple case study of three families transitioning their children from traditional elementary classrooms to Montessori elementary classrooms, Stroud (2015) reported that all three families identified difficulty with their children adjusting to self-directed learning in regards to weekly planning and time management of work periods with long periods of work time. Two families noted that it took six weeks for their child to adjust to the personalized nature of the new environment (Stroud, 2015).[*] This is to be expected, and special attention should be paid to developing self-regulated learning skills in transitioning students, with significant scaffolding early in their personalized learning process as they adjust to expectations of more ownership of their learning.

It could potentially take years for students to develop the intrinsic motivation and self-regulation skills to perform as expected within a personalized environment. Teachers should work with families to establish a relationship and develop communication that can further establish expectations and understanding of the learning process. Stroud (2015) stressed the need for strong communication between educators and families and for families to fully understand the culture and philosophy of the school in order to support transition, although all three families reported a positive spike in intrinsic motivation to learn once the children adjusted to the culture.

Personalized Instruction for Online Learning

Finally, there could be situations where personalized instruction takes place entirely online. Although collaboration and social communication can be more challenging in online environments, an online-only environment does not require that personalization of instruction be system-driven. A strong communication process is needed to ensure frequent and necessary communication among teachers, students, parents, and collaborators, whether they are peer tutors, peer students in project teams, or external experts supporting assessment and scaffolding.

It can be easier for students to get lost in online environments, so a personalized environment requires more scaffolding and established structure where students are expected to login and report their learning activities and progress. Online environments are also free of some of the restraints that come with a physical building, so they also potentially can open up access to collaborators from around the globe or peer learners from different cultures and backgrounds who can bring valuable perspectives and experiences to the learning community. The establishment of a learning community is also of significant import in online personalized instruction to ensure the social aspects of learning are incorporated and strengthened.

V. Case Description

This section reports on a sample case study that we conducted of an alternative high school that implemented personalized instruction. An alternative high school within the Indianapolis Metropolitan School District of Decatur Township presents an interesting and beneficial example of one school's implementation of personalized instruction (S.L. Watson, 2011; S.L. Watson & Watson, 2011). The school district was one of 11 public school districts in Indianapolis and serves approximately 5,600 students. According to the National Center for Education Statistics (2008), the district was predominantly white, including less than 9% minority population. Exceeding the Indiana state average, 51% of the district's students received free or reduced-price lunch.

Originally, the Decatur Enrichment Center (DEC) alternative school was established for students in the school district who would choose to learn in a more project-based, flexible learning environment. However, the focus had shifted, and students who had been expelled from the high school or were clearly failing at school were the only students enrolled. These students typically did not receive enough family support, had problems with pregnancy or drugs, were getting in trouble with the law, or had extreme behavioral problems in school. They were students who had been struggling because of the *disadvantaged processes* in their local communities, families, and schools due to economic, family, and social pressures (Natriello, McDill & Pallas, 1990; Synder & Sutherland-Smith, 2002).

At the time of S.L. Watson's (2011) study, DEC had approximately 70 students and five staff members, including two full-time staff (the principal and one teacher) and three part-time staff members: two instructional aides and a counselor. It was located a mile from the district high school, and the alternative students were not permitted to visit the high school or the district library, or they would be arrested.

DEC was a one-classroom schoolhouse, with two small teacher offices on each side of the entryway. Computer stations and desks for group-based project work were scattered around the room, with a small kitchen located at the far end. The classroom walls were decorated with a variety of different artwork and graffiti that the students had painted.

The classroom usually had around 20 students, as they would come in at the time of day they wanted to but at a time prearranged with the teachers. All staff assumed the role of teachers, helping students with their daily schoolwork. The class environment was always very active, with humor and discussions about life and politics. On a typical day, you would see several students sitting at computers and tables, alone or in groups, supporting each other through various forms of peer-tutoring. Teachers worked with an individual student or small group of students. Often, students would go to the kitchen to fix food for themselves, as well as going to the credit checklist to see their individual schoolwork progress.

The students' level of learning would usually be considerably lower than in the traditional school when the students started in the DEC. However, during the next few years, the students would rapidly progress in the personalized environment. By their senior year, most took the Graduation Qualifying Exam (GQE) without problems, with DEC graduating about 15 students every year. Furthermore, graduating students reported a well developed sense of intrinsic motivation and post-graduation aspirations for higher education.

The DEC displayed many unique characteristics while operating with a personalized instructional environment. First, the curriculum and instructional process at the DEC were very flexible. The school curriculum had a list of learning objectives and instructional choices available, and the students would take the lead in picking a learning objective and their instructional task for that particular topic. The teacher would then work with each student to ensure that learning outcomes would align with state standards. The instructional curriculum provided four primary instructional choices for the students:

1. learning packets, which were booklets or worksheets students could go through;
2. technology projects, such as creating PowerPoint presentations, brochures, multimedia websites, or games;
3. seminars that were similar to traditional lectures, and, finally;
4. computer-based instructional tutorials such as the PLATO learning system.

Students were respected as co-collaborators of the teachers, engaging in an active and reflective process of setting learning goals and tasks. They also held each other accountable for completing a certain number of credits every few weeks, which helped them to set and meet the mini deadlines that they established for themselves on their own. Students came to the school based on their own schedule, so some came in the morning and some at night. Every day students would enter the school and immediately check their progress on their PLP, which was posted in the room. They would identify what they were working on that day and begin their work. Student records and instructional tasks were kept in the staff's filing cabinet.

The learning process at the DEC focused on both learning the content and enhancing motivation and self-regulatory skills by placing responsibility and ownership on the students. Teachers reported that when students first arrived at the DEC, teachers were viewed with suspicion and dislike, but once students realized that they directed their learning, behavior problems quickly vanished and a respectful and healthy community was formed.

For additional cases of personalized instruction, several sources in the literature are available. A number of other sample schools and school districts implementing personalized instruction are described in Reigeluth and Karnopp (2013), and they also provide a list of what they identify as "new paradigm" schools which utilize personalized instruction. Aslan, Reigeluth, and Thomas (2014) conducted a case study of the Minnesota New Country School which also implements a highly personalized instructional process.

VI. Conclusion

A personalized approach to instruction shares and can incorporate a variety of instructional designs, theory, and tools, including such methods as problem-based learning, project-based learning, computer-based instruction, adaptive instruction, and competency-based education. Furthermore, as highlighted at the beginning of this chapter, personalization is not precisely defined and is used broadly without a widely agreed-upon common definition. Nevertheless, it has core values and principles that this chapter has described. Also, the goal of personalized instruction has been presented for over half a century and remains a vibrant and frequently proposed vision, with recent federal reform funding pushing for personalized approaches. Further research is needed to continue to refine and support the principles and methods put forward here.

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Notes

* *Editors' note: For more about this, see Chapter 9.*

* *Editors' note: Most of the other theories in this volume also address goal setting, especially Chapters 6 (Principle 3), 8 (Principle 1), 9 (Principle 2), and 10 (Principle 1).*

* *Editors' note: A task focus is characteristic of all the theories in this volume, but Chapters 3, 6, 7, 8, 12, 13, and 15 devote considerable attention to offering guidelines about the design and use of tasks.*

* *Editors' note: For more about self-regulated learning, see Chapter 9.*

** *Editors' note: Guidelines for scaffolding are offered by most theories in this volume, especially Chapters 1 (Principle 2), 2 (Principle 2), 3 (Principle 1), 6 (Principle 6), 8 (Principle 3), and 13 (Principle 3).*

* *Editors' note: Assessment is addressed by most theories in this volume, but fairly detailed guidance is offered by Chapters 1 (Principle 1), 2 (Principles 4–6), 7 (Principles 3–4), 9 (Principle 3), 10 (Principle 2), and 15 (Principles 1–2).*

* *Editors' note: Reflection is an important part of the learner-centered paradigm and as such is dealt with in most chapters, but especially in Chapters 3 (Principle 5), 7 (Principle 2), 10 (Principle 6), and 12 (Principles 1–2).*

* *Editors' note: Using personalization within the constraints of time-based student progress, as a step toward the learner-centered paradigm, is related to the focus of theories in Unit 3 of this volume.*

* *Editors' note: Using personalization within the constraints of low technology, as a step toward the learner-centered paradigm, is also related to the focus of theories in Unit 3 of this volume.*

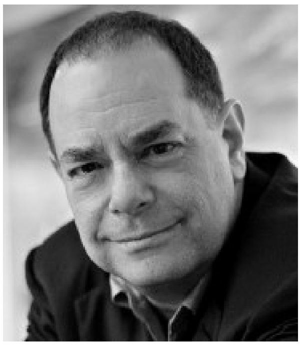
* *Editors' note: Of course, these problems would not exist if students had begun in a learner-centered school, like a Montessori school.*

5

A NEW PARADIGM OF CURRICULUM

Marc Prensky

GLOBAL FUTURE EDUCATION FOUNDATION AND INSTITUTE



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EDITORS' FOREWORD

As a curriculum theory, this has some different kinds of components from an instructional theory.

Preconditions (when to use the theory)

- *For all kinds of contexts in which purposeful learning is desired, both formal and informal.*

Values (opinions about what is important)

- *The curriculum should not be the same for all students; students should have much more choice over what to learn.*
- *The curriculum should be skills based (organized around skill sets) not knowledge-based (organized around subject matter areas).*
- *The curriculum should be much broader, containing many more major topics.*
- *True education is about people becoming good, capable, flexible people who can maximize their talents and reach their goals.*
- *For a post-industrial society, the pillars of the curriculum should be effective thinking, acting, relating, and accomplishing, which should be taught directly, instead of by proxy.*
- *Equating education with the learning of math, English, science, and social studies is deceitful because it no longer prepares students for tomorrow's world, contrary to our promises.*

Universal Principles

Top-level skills

- *The four main subjects of a curriculum to prepare all people for a useful and successful life are effective thinking, acting, relating, and accomplishing. They are what students get assessed in.*

Sub-skills for effective thinking

- *Effective thinking includes: understanding communication, quantitative and pattern thinking, scientific thinking, critical thinking, historical perspective, problem-solving, curiosity and questioning, creative thinking, design thinking, integrative thinking, systems thinking, financial thinking, inquiry and argument, judgment, self-knowledge, and more. These need to be taught systematically, in a way that is comprehensive and likely to get them acquired.*
- *The subject domain for thinking effectively doesn't matter, as long as it is of interest to the student.*
- *There are some things that we want all or kids to think about, such as ethics and forms of government, but there are fewer of these than most people think.*

Sub-skills for effective action

- *Effective action includes: habits of highly effective people, body and health optimization, agility, adaptability, leadership and followership, decision making under uncertainty, experimentation, research, prudent risk-taking, reality testing, patience, positive mindset, resilience and "grit," entrepreneurship, innovation, improvisation, breaking down barriers, project management, and more. These need to be taught systematically, in a way that is comprehensive and likely to get them acquired.*
- *The subject domain for acting effectively doesn't matter, as long as it is of interest to the*

student.

Sub-skills for effective relationships

- *Effective relationships include: Communication and collaboration (one-to-one, in teams, in families, in communities, at work, online, in virtual worlds), listening, networking, relationship-building, empathy, courage, compassion, tolerance, ethics, politics, citizenship, conflict resolution, and more. These need to be taught systematically, in a way that is comprehensive and likely to get them acquired.*

Sub-skills for effective accomplishment

- *Effective accomplishment consists of doing projects in the real world—small, or local projects and group and individual accomplishments in the early years, and larger, eventually worldwide, projects and accomplishments in later years. This needs to be taught systematically, in a way that is comprehensive and likely to yield powerful results for both the individual and the community/world.*
- *The focus for effective accomplishment doesn't matter, as long as it is of importance to the student.*

Different Situations

- *An individual curriculum should be offered for each student, but it should still have all four top-level, core skills.*

Implementation Issues

- *Technology should be the foundation for implementation of this curriculum.*
- *The teacher's role must change from distributing content to guiding and motivating student learning, offering respect and empathy, and fostering self-directed learning.*
- *A different kind of teacher training will be needed that focuses on the new role and at least one of the four core skill areas.*
- *The new paradigm of curriculum will benefit from different approaches rather than the single one we have in our Industrial-Age curriculum.*

– C.M.R., B.J.B., & R.D.M.

A NEW PARADIGM OF CURRICULUM

I. Introduction

The idea of what we teach—i.e., what subjects comprise (or do not comprise) our curriculum—does not get nearly enough attention.* I believe it is an underlying cause of our current education malaise at least as much, and probably more, than our issues with "how" we teach.

We *do* have endless "curricular" debates about standards, details, scope and sequence, and other things. But, at the overall level, we all stick to a curriculum composed of what I call the "MESS" (i.e., math, English language arts, science, and social studies) or the "MESS+" (the same including arts, phys. ed., foreign languages, and other electives).

Such a knowledge-based curriculum that is the same for all is already outmoded; more and more subscribe to the idea of a skills-based curriculum. And a curriculum that truly includes all the key skills that today's students need to know would be very different than anything proposed today—which is typically nothing more than embedding or grafting a particularly few new skills, such as creativity, innovation, or entrepreneurship, onto the old. A better curriculum would be much broader, and contain many more major topics, in many different areas, than we teach today. And it would be organized not by subject matter, but by skill sets.

The choice of the subject matters that comprise the MESS goes back to decisions made in the 19th century (The Committee of 10, 1893). The MESS-based curriculum is now more or less standard all around the world—almost no school, or school system, offers anything other than some version of the MESS(+). It's what parents expect. It's what we license teachers on, test on, grade on, and admit kids to college on. It needs serious rethinking for our current age.

Curriculum, particularly at the highest level, is so important because it is our "bet" on what will be important for our kids in the future. For a long time we "bet" on Greek and Latin, until we finally accepted that they would not be very useful for most students. But we still, over 100 years after the "Committee of 10"—ten college presidents, assembled by the National Education Association—did its job in 1892: make a big bet on the MESS.

But the strangest thing about the world's current MESS-based curriculum is that it is not based on people's real underlying educational needs at all. It is based, rather, on a set of "proxies."

Most people would agree that to succeed in the world, a person—any person—needs to be able to **think effectively, act effectively, relate effectively, and accomplish effectively**. But we do not teach those things directly to our students, nor do those things compose our curriculum.

Instead, we have for ages used mathematics, language, science, and history (or social studies) as "proxies" or "vehicles" for teaching and acquiring many of the truly needed skills.

Algebra, for example, is not something we teach our kids because they will use it—most students certainly won't after their schooling. We teach algebra as a proxy or vehicle for teaching abstract and symbolic thinking. Geometry is a proxy for teaching logic. The historical chronology, geography, and other details are proxies for the underlying lessons of human conflict, cooperation, and change. Native and foreign languages are proxies for communication skills. Literature is a proxy for understanding human behavior and teaching students to express themselves well. Science (especially the "history of science" we now mostly teach) is a proxy for underlying skills of inquiry and skepticism.

While all of these subjects do have, for some, intrinsic interest and merit, that interest varies widely from person to person. Almost no student needs all the things we now teach her or him. What all students do need are the *underlying skills* that the subjects we teach are proxies for: the ability to think effectively, act effectively, relate to others effectively, and accomplish useful things effectively—in whatever particular area is of interest to them.

Today, we teach these most basic underlying skills extremely indirectly. In many cases we never even communicate to our students what the real underlying skills actually are. Some teachers may say to students, "My real job is to teach you to think." And some students may figure out on their own that "social studies" is not just the name of a subject, but is really about people and society. (I never did, until college.) But that's not the norm.

Worse, we *don't even have* proxies for many important skills—we just don't include them at all. Effective acting, relating, and accomplishing are rarely, if ever taught (or ever mentioned) in K-12 education.

Even our best independent schools—often with long lists of "character skills" they try to build—are severely limited in the scope of the underlying skills they teach: they still focus heavily on "academics," i.e., the old "core proxies" of MESS.

But that's not nearly enough for tomorrow's adults.

Proxy education and limited scope may have been sufficient (and even good) in previous times. Many of the needed underlying skills not taught in school were taught at home, or in the church, or though apprenticeship. The top schools taught "character skills" to the elite. And the actual (as opposed to the underlying) skills and knowledge obtained from the proxies was what many students needed back then, something they could not, in those times, obtain easily, or at all, in other ways.

So that combination may have worked in the 18th, 19th and 20th centuries—a time when education was much less universal, and the world was a different place. Clearly we had, in those times, “educated” people.

But the approach has never worked for all. And it is certainly not the education that will work, and prepare our kids, for today and tomorrow.

So is indirect (i.e., proxy-based) education the best thing—or even a good thing—to do? Or is there a more direct way to go about education?

Imagine if—because we clearly want to teach kids to be alert and focused, and because someone realized that truck driving requires being alert and focused—we decided that every student should spend years learning to drive trucks—starting with vans in elementary school and working their way up to tractor-trailers in high school. And imagine that we required all kids, in order to graduate (so as to demonstrate their focused attention), to handle an 18-wheeler? Ridiculous, of course. But it’s not so far different from what we do now with MESS.

After much observation and speaking with kids around the world, I believe strongly that the biggest reason kids are dissatisfied with their education today—and are increasingly failing in school and dropping out in large numbers around the world—is less our outdated teaching methods (although they certainly contribute) and far more the fact that what we are asking our kids to do and learn is, for most of them, not teaching them skills they know they will need for life and success. Most of what we teach will *never* be of use to them directly, and is in the curriculum only as an outdated proxy for helping acquire the skills they really need to have. And everyone knows it.

So it’s less *how* we teach that’s the real problem,* and more *what* we teach. This is *incredibly* obvious to most kids, but most adults either can’t see it, or choose not to.

Whatever curricular innovation exists in the world—and some does—is limited not only in scope, but also in usage. Significant curriculum beyond the MESS (and the arts) is used in only a relatively few schools around the globe—almost all of them privately funded. Typically, the curricular innovations are created and funded by special-interest groups with a single, or narrow purpose in mind. Laudable (though not very widely used) curricula have been produced for skills like emotional intelligence, negotiation, entrepreneurship, and the Seven Habits of Highly Effective People.

Attempts at larger-scale, comprehensive curricular change are often met with strong opposition from parents and often from educators as well. Reasons for the opposition include the belief, as we noted, that mastering the “subjects” of MESS is what education is about, and therefore what all kids need, plus an attitude of “Don’t experiment with my kid” from parents. Yet in this time of change, we can responsibly do nothing *but* experiment in our schools.

Any large-scale large curricular reforms that do pass and get implemented, like the U.S.’s Common Core initiative, do not offer alternatives to the existing core subjects, but merely “tighten up the standards” for that old curriculum. This is not even remotely enough.

II. Values

Math, Language Arts, Science, and Social Studies Are NOT What “Education” Is About

Because we’ve been teaching the four “core” subjects of MESS so universally, for so long, many have come to accept those four things as what “education” is truly about. It’s why people actually believe and accept that one narrowly focused test, such as PISA, can compare—and rank—“the education” in countries across the world.

But I submit that is false.

PISA can certainly rank 15-year olds on their scores on the PISA test. But I submit that it doesn't measure "education." Education is far less about "learning subjects" or even acquiring specific skills like mathematical thinking, and far more about people *becoming*: becoming good, capable, flexible people who can maximize their talents and reach their goals. We call that, in English, "becoming educated."

Further, I submit that "education" is, at the highest level, about a particular *kind* of "becoming." Education is—or should be—about each person becoming able to **think effectively, to act effectively, to relate effectively to others, and to accomplish useful things effectively**, to the best of their capabilities, regardless of the field they choose to enter. Moreover, I believe that to become an educated person, none of those categories can be omitted, even though three out of the four are generally omitted from school today.

Under the main categories of Effective Thinking, Effective Action, Effective Relationships, and Effective Accomplishment, there are a great many skills and sub-skills to be acquired as part of an education (see further down for the list). But nothing is "above" these four main skills in terms of our educational requirements. Other skills that ought to be acquired—ethics, culture, citizenship, preparation for employment—all are part of, and flow from, acquiring the top-level skills of Effective Thinking, Effective Action, Effective Relationships, and Effective Accomplishment.

Those four skills, I believe, are where we should be focusing our kids' education and attention; individualizing by passion; and using modern pedagogies and technologies that students understand, relate to, and enjoy.

The assumption that education is only—or even mainly—about the MESS, and that these are the main things our kids should study in school, is a false and deceitful one. Worse, this old assumption is now leading the world, and the education of our youth, in extremely harmful directions. It is time for us to lose the "proxies" and tell our students directly what they really need and what we really want from them.

We can—and I believe we must—do this.

The reason I say equating "education" with the learning of MESS is "deceitful" is because it no longer prepares students for tomorrow's world, as we promise kids, explicitly or implicitly, that education will.

Kids no longer fall for that pitch. They know that the world they will live in—i.e., the world we are educating them for today—is a new and very different one from the one *we* knew (and originally designed our current paradigm of education for).

- Their new world has far more variability, uncertainty, complexity, and ambiguity ("VUCA"—Google it) than ours ever did.
- Their world's pace of change is not just faster, but is greatly accelerating—humans have never before experienced such rapidly accelerating change.
- Their brains, extended and enhanced by our new technology, are becoming more capable, providing them with new capacities humans never had before (such as the ability, for example, to collect and analyze trillions of data points.)

And those huge changes are not even the most significant differences in our kids' world.

The most important difference of all, I believe, is that they have a new world network—the Internet. As the Internet quickly becomes universal, all of them, and all the world's people, are becoming connected, to all human information—**and to each other**—by an always-on, real-time web of synchronous and asynchronous connectivity. Best viewed as mankind's first large-scale public experiment at living in and using this new connected world, Facebook already has over a billion participants. And Facebook and its contemporaries represent only a *small first step* in harnessing and applying the network's true power.

Because of the Internet we already we have, said *Time* Magazine in May 2013, a worldwide generation of young people more similar to one another than to their parents and elders in their own countries and cultures.

This new reality for today's youth frightens a great many parents and other adults. But it has important implications for the future of global education—the first of which is for us to get every kid in the world online.

As the world changes in so many ways, so do its educational "basics" and requirements. Nowhere is it "ordained"—important as the MESS subjects have been for us in the past—that those subjects are the "right" pillars on which to base our entire education for all time, and particularly for the future.

In fact, those subjects were not codified as the basic "canon" for education in the U.S. until 1892, when the Committee of 10 recommended that those four subjects comprise the bulk of every high school curriculum. Through a combination of tradition, copying, and influence, those four subjects have now become our "world curriculum" of today.

Although other subjects, including art, music, physical education, hygiene, shop, home economics, and more recently information technology—each with strong proponents—have been added at various times to the curriculum, almost all world educators today would agree that the four "core" MESS subjects are the "key" ones. They are the parts of the curriculum that don't get eliminated, or relegated to after-school programs, when money is short.

But mastering the MESS curriculum we teach today, while of course still important for some students, does not come anywhere close to preparing *all* our young people sufficiently for their new, changing world.

Not only are those four subjects, as we have seen, just proxies for needed underlying skills, but, worse, a great many of the skills all our kids *do* need for the future are currently missing from our curriculum, especially in the important areas of acting, relating, and accomplishing.

Essentially, we now focus the bulk of our kids' valuable attention, during their most "influence-able" years, on wrong things. And this difficult and dangerous situation can't, and won't, be fixed by just adding on a few "21st-century skills," as many currently propose (for reasons I will discuss below). What's needed is a wholly new and differently focused curriculum, one that directs our kids' attention to the skills they really need, and not to areas that all of them need "only some of"; that directs their attention not just to fields such as STEM, but to the skills that underlie success in *all* fields.

III. Universal Principles

An Alternative

It is important to bear in mind that having MESS as the fundamental, top-level components of the curriculum is *not* the only way to organize education—there are many other ways. And it is becoming clear that, despite our educational history and traditions, some of those ways are far better for the students of today and tomorrow.

I am not the first to think this, of course. There are schools all over the world teaching curricula of many different sorts. But the issue, as I see it, is that almost all of those schools still consider MESS to be "the core" of education (or of what our kids need to succeed). So they make whatever changes they do *in addition to* teaching MESS, rather than *instead of*.

I propose something very different.

What if, instead of organizing our education at the top level by the four subjects of MESS—and measuring and evaluating our kids only on them (e.g., "How good are you in math?" "What's your verbal SAT score?" "What is your country's PISA ranking in science?"), we chose a different framework for our education?

Suppose we were to organize education—comprehensively from kindergarten to secondary—around four very different “top-level” subjects? What if we organized education around the key things that are *actually important to the success of every person in the world*?

I believe, that if we did this, those four subjects would be the following:

- Effective Thinking
- Effective Action
- Effective Relationships
- Effective Accomplishment.

Those are the top-level skills that people—any people—need to be good at to have a useful and successful life, no matter what their location, work, or interests.

“What do you mean by ‘effective’?” you may well ask. The adjective is there, for me, not as a definition (effective takes a huge variety of different forms), but rather as a distinguisher from “ineffective.” Most of us have learned to recognize the distinction between effective and ineffective—although often it’s difficult. As part of their education, our young people need as much practice as we can give them in doing so.

So—with the qualifier of “effective”—thinking, acting, relating, and accomplishing are the four main subjects of this new curriculum. All students “take” them as their four main subjects for 13 years. They are what students get assessed and graded in.* And unlike the subjects of today, the names of those top-level subjects—Thinking, Acting, Relating, and Accomplishing—make it very clear to the students what their education is about, what they should become better at, and on what criteria they will be evaluated.

The Sub-Categories

Three of the four main subjects of the curriculum are further broken down into sub-categories. These include those shown in Table 5.1. They are not definitive, and others may be added.

The fourth main subject, “Effective Accomplishment” consists of doing projects in the real world—small, or local projects and group and individual accomplishments in the early years, and larger, eventually worldwide, projects and accomplishments in later years. The categories of projects will depend on the interests and passions of the particular students, the needs of the community and world, and the skills teachers feel it is in the best interest of individual students to acquire or improve.

TABLE 5.1 Subcategories of Effective Thinking, Action, and Relationships

Effective Thinking	*Effective Action*	*Effective Relationships*
Understanding Communication	Habits of Highly	Communication &
Quantitative & Pattern Thinking	Effective People	Collaboration
Scientific Thinking	Body & Health optimization	– One-to-one
Critical Thinking	Agility	– In teams
Historical Perspective	Adaptability	– In families
Problem-Solving	Leadership & Followership	– In communities
– Individual	Decision Making	– At work
– Collaborative	Under Uncertainty	– Online
Curiosity & Questioning	Experimentation	– In virtual worlds
Creative Thinking	Research	Listening
Design Thinking	Prudent Risk-Taking	Networking
Integrative Thinking	Reality Testing/Feedback	Relationship-Building
Systems Thinking	Patience	Empathy
Financial Thinking	Positive mindset	Courage
Inquiry & Argument	Resilience & "Grit"	Compassion
Judgment	Entrepreneurship	Tolerance
Transfer	Innovation	Ethics
Aesthetics	Improvisation	Politics
Habits of Mind	Ingenuity	Citizenship
Positive Mindset	Strategy & Tactics	Conflict Resolution
– Passions	Project Management	Negotiation
– Strengths & weaknesses	Programming Machines	Coaching
Stress Control	Making Effective Videos	Being Coached
Focus	Innovating with Current &	Peer-to-Peer Teaching
Contemplation & Meditation	Future Technologies	Mentoring

It can be easily seen that most of the above sub-topics are not today covered, either systematically or at all, in almost any school. It should also be noted that even *all* of the so-called "21st-century skills" proposed comprise only a small fraction of the skills kids need to learn. The same is true of other proposed frameworks, such as the so-called "4Cs" (Communication, Collaboration, Creativity, and Critical Thinking).

Let me examine each of the four proposed new subjects—Effective Thinking, Effective Action, Effective Relationships and Effective Accomplishment— in turn.

Effective thinking

Here are some of the components that would be in the "effective thinking" portion of the curriculum, as shown in Table 5.1:

- Understanding Communication
- Quantitative and Pattern Thinking
- Scientific Thinking
- Critical Thinking
- Historical Perspective
- Problem-Solving
  - Individual
  - Collaborative
- Curiosity and Questioning
- Creative Thinking
- Design Thinking
- Integrative Thinking
- Systems Thinking
- Financial Thinking
- Inquiry and Argument

- Judgment
- Transfer
- Aesthetics
- Habits of Mind
- Positive Mindset
- Self-knowledge of One's:
  - Passions
  - Strengths and Weaknesses
- Stress Control
- Focus
- Contemplation and Meditation.

Almost anyone would, I believe, agree that all of these are important. Yet today, other than the top three or four, these are not things all kids are taught in our K-12 curriculum. Not that teachers, and schools, don't teach some of them—some do. But not *systematically*, in a way that is comprehensive and likely to get them acquired. The only components we do teach systematically to all are reading and mathematical thinking. More recently, scientific thinking, critical thinking, and problem solving may also be included in this group.

But all of the other "thinking" skills, including the extremely important skills of design thinking, systems thinking, judgment, aesthetics, habits of mind, and self-knowledge of one's own passions and strengths (and, of course, others), are *not* taught systematically as part of our curriculum. Even those areas that are taught are often approached more in terms of "content" than of "thinking."

A result of this approach is that today many of our college teachers complain frequently that, "I have to teach my students to think." But college is not the time to be starting this—it would be beneficial much earlier. Our kids should be spending a much larger portion of their K-12 time learning, systematically, to think effectively. So "Thinking Effectively" should be a top-level subject for every student.

But thinking, you might ask, about *what*? Many academics argue that thinking has to be "domain-grounded," and, while there are differences of opinion on the subject, they may very well be right.

But *which* domain doesn't matter, as long as kids learn to do their thinking well. All of the fundamentals of good thinking can be learned by considering situations and problems in whatever area is of interest to each individual student.

There are some things, of course, that we would like *all* of our kids to think about—ethics, and forms of government, for example. But there are, I believe, many fewer of these than most think. A key principle in education should be "General skills for all, individual examples for each student."

For example, I recently heard of a math course that begins by analyzing mathematically the question "Am I popular?" While this is important to many young people, other students might have their own questions to analyze mathematically. And all of those same questions can also be analyzed in many other ways as well. So we do not need a textbook full of "officially appropriate" or "relevant" problems, because *any* problem of appropriate scope and level can be used to teach the components of effective thinking. We will never run out of these.

The positive result of doing this is that we would focus our students' attention far less on the subject matter, and far more on the way they approached thinking about it. After taking "Effective Thinking" for 13 years, students would come out able to think effectively about *almost any* problem or issue in multiple ways—wearing, as Edward DeBono puts it, multiple "hats" or "thinking caps." Our young people would also be able to recognize which types of thinking were *ineffective* in particular situations, something that today's kids are not, for the most part, focused on or good at.

So we certainly can—and I believe we must—teach the crucial subject area of "Effective Thinking" more specifically, more systematically, and better than we do today in our curriculum.

But another big part of our educational problem today is that most curricula are *only* about "thinking."

Other huge domains that are crucial for life and success—particularly acting, relating, and accomplishing—are almost entirely missing. But not in this new curriculum.

Effective action

Everyone is familiar with people who know lots of things, but can't do much. One good reason for this is that we hardly ever teach—or don't teach—effective action in school. But we certainly could.

Thanks to Stephen Covey (1989), for example, The "Seven Habits of Highly Effective People" have been known and recognized for over a quarter of a century. What justification can there possibly be for our being aware of these incredibly important habits, yet not teaching them, systematically, to our kids? (The habits are: Begin with the end in mind, Do first things first, Be proactive, Seek first to understand, then to be understood, Think win-win, Synergize, and Sharpen the saw.) Having learned them from his books, I use them every day, and try to practice all of them regularly. Our kids could too—but they generally don't learn, or practice, these habits in class. Ironically, the Covey Institute has developed a curriculum to teach the habits to students, so we even have good ideas about how to do it. This curriculum is used by some schools, but not by most.

Components of effective action that we could and should be teaching our kids include positive mindset, resilience, "grit," entrepreneurship, innovation, improvisation, breaking down barriers, project management, and more (see Table 5.1). There are experts—and often already developed curricular units—in almost all of these areas. But they are not part of our standard curriculum. Why not?

Here's just one simple example: We often have our kids read, in kindergarten (in the U.S., at least) the story of *The Little Engine That Could.* It's a useful introduction to positive thinking. But then we don't systematically follow up and build on this by teaching the incredible power of a positive mindset (as shown, for example, in the work of Carol Dweck, 2006, 2012), for the subsequent 12 school years.

Or we say to our kids we want them to be resilient, but we don't *teach* them resilience over our entire curriculum, even though it's a skill acquired largely though practice over time.

There exist, around the world, curricula for teaching entrepreneurship and creativity, but few of our K-12 schools use them. Few schools, if any, include project management anywhere in what they teach, even though it's a well-established and highly useful discipline, valuable in any walk of life.

Again, we *could* do this. Doing so would be incredibly helpful to our kids—imagine what they could accomplish if we did.

Effective relationships

Many consider building and maintaining effective relationships to be the most important skill a person can possess. Relationships, of course, do often come up in school—in classrooms, in projects and in literature.

Yet how much of our curriculum is devoted to systematically analyzing those relationships, with the goal of making students better at building and maintaining their own effective relationships?

The answer is little, if any, despite the fact that the study of relationships is deep and well known. Again, many curricular units on "emotional intelligence" and "social skills" already exist, but are not widely-used.

Most teachers *do* try to help kids deal with one-on-one relationships and issues as they occur in the classroom (although not, generally, as part of the curriculum). But they could also be helping their students, particularly if it were in the curriculum, become far more effective at building and maintaining relationships in teams, families, communities, workplaces, and, of course, online.

We could also systematically be helping our kids become more effective at skills that help build effective relationships, such as empathy, ethics, politics, citizenship, negotiation, and conflict resolution.* Yet again, for almost all of these, there already exist curricula created by various groups.

What if we made building and maintaining effective relationships a key pillar of the world's curriculum?

Effective accomplishment

Of all the things missing from today's curriculum, not teaching our kids, systematically, about *accomplishment in the real world* is perhaps our greatest failing. I say that because, if we did, it could improve so many important things. Today, we essentially waste almost all the enormous potential "accomplishing power" of our youth, by not requiring them to use it.

Imagine, for example, if "first grade" in any of the world's poor villages lacking a water cistern was about building one. And "second grade" was about building a water purification system. And "third grade" about building a Wi-Fi system. And so on. The same principle, of course, could apply to any place, rich or poor—just substitute whatever they are missing and need, e.g., facilities for seniors, better connectivity, etc.

We stopped our kids from working in the real world in former times[**] because the kids were often physically exploited. But times are now different. Much of the work to be done in the world today no longer requires physical work, but rather intellectual work (e.g., designing, creating, and coding on computers).

All kids, even our youngest ones, love to work on real, important projects. Most can figure out how to manage themselves, both as individuals and groups, particularly as they get older. Students of all ages, joined together on our increasingly powerful networks, could be accomplishing enormous numbers of desperately needed things in the world—not just in their local areas, but in nations and businesses around the globe.

All of these projects would give our kids powerful and valuable educational experience. We should not only be encouraging this, but using our curriculum to help kids do it systematically, throughout their K-12 years. If we did this, our kids could leave school not just with a transcript of their grades, but with a résumé of what they have accomplished in the world (Chen & Black, 2010).

IV. Different Situations

It is important to understand that because each student is different in terms of their needs and interests, what we need, in the way of subject matter, is an individual curriculum for each student.[*] Impossible in the past, this is becoming more and more of a possibility through technology. But differences in individual interests or situations *do not affect* the basic human need for effective thinking, effective action, effective relationships, and effective accomplishment. That is the true value of organizing a curriculum in terms of these basic human skill areas. They are all necessary, in some combination, by all people, for success.

V. Implementation Issues

A saying, usually attributed to St. Augustine, is: "In essentials unity, in non-essentials, liberty, and in all things charity." Once we unify around what the basic human skill groups are, and that that is what we want to teach our kids, there is an infinite number of ways we can organize and teach those skills: directly, through problems, through real-world accomplishments, and many, many more.[**] That is the type of liberty and diversity we want in our schools.

Here are a couple of wider issues.

The Role of Technology

What I am proposing here is a curriculum for the future. Yet that curriculum hardly mentions technology.

Why is that?

The answer was provided to me, a few years ago, by a high school student, who said: "You guys [i.e., adults] think of technology as tools. We think of it as a foundation—it underlies everything we do."

Technology's role in the new curriculum is as a foundation—a support for everything we do. The entire curriculum I propose here should be thought of as bathed in, and supported by technology, which, these days, is rapidly and continually improving.

Technology also allows that support to be differentiating. This is a similar foundational role, of course, to that provided by reading and writing (also technologies) for the last several hundred years. Our reading and writing "foundation" is now morphing into a much broader technological foundation for education.

While the four overarching "core" skills of the new curriculum—Effective Thinking, Effective Action, Effective Relationships, and Effective Accomplishment—remain the same for all students, technology enables each student, every day, to do individualized work on each of those four key skills,* as well as to do many old things faster and better.

Importantly, however, even though it is a curriculum for the future, the new curriculum does not focus *primarily* on technology. Its goal, rather, is to use technology—in as powerful and up-to-date a fashion as possible—to help improve our students' becoming better at Effective Thinking, Effective Action, Effective Relationships, and Effective Accomplishment.

The Role of Teachers

And what of teachers? What is their role in this new curriculum? Will it change from what it is today?

Teachers—good teachers—continue to play a huge and important part in education, and in this new curriculum. Adults will always have an important role in educating our kids—we need good teachers desperately. But the teacher's job, and role, will never again be the same as it has been in the past, or is today.

We no longer need our teachers to be the distributors of content about MESS. Already, technology can do a reasonable job of distributing all of our content—in more and more interactive, participative and creative ways**—to those students who require it. The Khan Academy and MOOCs of today are already doing this, and they should be seen as, and evaluated as, only our very first baby steps. Technology's capabilities will continue to improve rapidly. Soon technology will be doing a *great* job on the content side.

But technology can't, and shouldn't, do everything in education.

For one thing, a great many—perhaps all—of the new skills and sub-skills included in the new curriculum require *nuance*—nuance that, for now, only a human can provide. Educators must work with technology to assure that the technology does what it can do best—e.g., provide lots of differentiated and individualized examples—and that humans do what they do best—e.g., help students understand and interpret those examples in all their human complexity.

We also need good teachers for the extremely important things that technology *can't* do at all. These include motivating our students deeply, respecting our students, empathizing with them, and encouraging their individual passions. Motivation, respect, empathy, and passion do not—and will not (at least for the foreseeable future)—come from machines. Those are the *human* traits needed for a successful education. They are the things we require our human teachers to provide.

And, additionally, good teachers are required for teaching our students to teach themselves,* deliberately and well, for the rest of their lives, as they will have to do.

The training and preparation (and licensing) of teachers for a curriculum organized around Effective Thinking, Effective Action, Effective Relationships, and Effective Accomplishment will, of course, have to be different from that of today. Most teachers will no longer be specialists in math, language arts, science, or social studies, but rather they will become specialists in the four new top-level areas of: Thinking, Action, Relationships, and Accomplishment. You might want to reflect a moment, as a reader, on which of these four new domains *you* might be interested in specializing in and/or teaching. What would draw you there?

Will it Work?

"Interesting, but will it work?" is something that will be asked by many (by funders especially, but also by educators and parents). Will it work, importantly, not just in the small sense of raising achievement scores (we would need new tests for this), but in the larger sense of making the world, over time, a better place, with better-educated people.

The only honest answer is "we don't know." But since our current education is now failing, we need alternatives—something we don't currently have enough of.

There are, however, many reasons for optimism, reasons to think that this new curriculum, or something like it, will work, in some useful sense, for a great many more kids than does today's MESS curriculum.

For one thing it is a lot more direct: it lets students know exactly what is important and we want from them. And it is also becoming apparent to many that kids can deal with concepts far earlier in life than many of us thought—and like to do so.

It is also becoming clearer that people learn and accomplish far more when they are applying concepts to their own areas of interest, and not to general problems manufactured for all.

And finally, we know from centuries of apprenticeships that people learn well through accomplishment.

But, asking whether a curriculum based on "what people really need to succeed," and on "individual passion-based examples for each student," and on "real-world accomplishment rather than just learning" in fact works, is not like asking whether some new test preparation software works. The goal of having all people become educated, and of having a world where all—or at least more—people can think, act, relate, and accomplish effectively, is a complex one. Comparing two systems as different as our current curriculum and this new one will not be easy.

In a sense, it is perhaps more like people in the 18th century asking, "Will a system based on people governing themselves—i.e., democracy—work?" The answer is not something we can or will measure precisely, determine quickly or easily, or judge by small, controlled experiments. Society is far too complex for that. At some point someone will have to take a leap of faith, as the fledgling United States did, and run a "grand experiment."

Will it Work for All?

This is proposed as a "curriculum for all." So a key question is whether this new curriculum will work —and work better—*not just* for the top 10% of our kids (almost anything will work for them) but also for the remaining 90%, as well as for kids who are not today receiving any formal education at all. Because the strongest arguments for this curriculum are (1) that it is both more useful; and (2) that it is passion-based, there are strong indications that it could.

In the end, any curriculum is only as good as its implementation, and this is never uniform. Teachers will have to be trained and become good at implementing this new approach. Education, like democracy, takes many forms, and has implementations that are very different. So, in all likelihood, will this curriculum.

It is imperative that we do think about and try new approaches to our curriculum—approaches that are different and more suited to our world and kids of today and tomorrow than the single one we now have.

My argument is not that this is the ultimate alternative but, rather, that we need alternatives. This new curriculum* is offered in the spirit of this need for experimentation and change.

VI. Closing Remarks

What we are really changing, of course, is our underlying philosophy about education. The underlying philosophy of the new curriculum is that focusing education on Effective Thinking, Effective Action, Effective Relationships, and Effective Accomplishment, acquiring those skills through students' individual passions, and applying them to life through real-world accomplishments will be a better approach than focusing everyone on MESS.

One thing we can say with certainty is that this will not harm our kids. It will clearly benefit many—and I believe all.

The Goal of Education

Underlying our need to change the curriculum is a new—or revised—understanding, not just of our changed context, but of what education is *for* in our society—what its goal is.

If asked "What is the goal of education?" many would answer it is "learning." "Learning" is what we try to measure in our assessments. We often refer to our students as "learners." Almost all the books found in the "education section" of bookstores today—online and off—are about some type or method of "learning."

But learning is *not* the real goal of education—certainly not any more. Today "learning" is only a *means* to the real goal of education, which is "*becoming*": becoming a good, capable, and flexible person, who will help make the world a better place.

"Becoming" is—or should be—the real goal of education in the world, the goal we pass on to our children. And until everyone realizes this, accepts it, and acts on it, much of the huge amount of time and money the world now spends on education will remain, essentially, wasted.

It is my great hope that by moving to something like the new curriculum described here, and by focusing our young people, therefore, on the "true" basics of Effective Thinking, Effective Action, Effective Relationships, and Effective Accomplishment, acquired through individual passions and applied to helping the world—rather than focusing kids on what we teach kids today—the world will take giant steps toward the goal of effectively educating all its people and, therefore, toward making the world a better place for all of us, and our posterity, to live.

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Notes

* *Editors' note: The field of instructional design addresses "what to teach" through needs analysis and content or task analysis. While this is extensively used in corporate and government training, it is seldom, if ever, used in K-12 and higher education. Perhaps the reason is that the latter forms of education are public goods, rather*

than private goods, and consequently should appropriately be based to a large extent on the values of the community and its individuals. This chapter helps make that link more visible.

* *Editors' note: This may be a bit overstated, given the ideas presented in the other chapters of this volume and its previous volumes, but the point that paradigm change in curriculum is very important and largely overlooked is a valid one.*

* *Editors' note: Think of "graded" as criterion-referenced rather than norm-referenced student records, as described in Chapter 1.*

* *Editors' note: See Chapters 21 and 22 in Volume II of Instructional-Design Theories and Models.*

** *Editors' note: Specifically, during the Industrial Age.*

* *Editors' note: For more on this, see Chapter 4.*

** *Editors' note: The other chapters in this volume provide guidance about how all of these instructional methods can be combined in a coherent educational or training system.*

* *Editors' Note: This is a major theme of Chapter 1 and our focus on how to teach.*

** *Editors' note: For more on this, see Chapter 11, Designing Technology for the Learner-Centered Paradigm of Education.*

* *Editors' note: This is the notion of self-regulated learning, the focus of Chapter 9.*

* *Editors' note: It should be clear that this is not just a new curriculum, but a new paradigm of curriculum—one that has many of the same elements but a totally different structure from our current paradigm of curriculum.*

UNIT 2

More Detailed Designs for the Learner-Centered Paradigm

Unit Foreword

In Unit 2 we present five instructional designs that elaborate on the fundamental principles of learner-centered instruction in a variety of educational settings across K-12 and higher education. Each of these designs incorporates one or more of the five universal learner-centered design principles described in Chapter 1, but none of them incorporates all. We've also included a chapter at the end of Unit 2 that describes the design of a Personalized Integrated Educational System (PIES) that would provide the technology backbone to support a truly learner-centered instructional system that implements all five universal learner-centered design principles. Though PIES has not yet been built as an integrated whole, as you read this chapter you should recognize several components that do already exist in disparate systems and some components that may yet need to be created.

Unit 2 begins with **Chapter 6**, *Designing Maker-Based Instruction*, by McKay and Glazewski. The authors describe maker-based instruction, an approach which facilitates students building meaningful artifacts to achieve learning goals and demonstrate understanding of content. The authors explain how maker projects can not only help students learn production and design-oriented skills, but also create opportunities for students to produce an artifact both meaningful and personally valuable; the meaning and value come from the making process itself. This approach implements such learner-centered principles as attainment-based instruction, task-centered instruction, personalized instruction, and changed roles. The extent to which each principle is implemented depends on the specific design decisions, instructional context, and other important factors present in the educational setting.

In **Chapter 7**, *Designing Collaborative Production of Digital Media*, Kalaitzidis, Litts, and Halverson describe a "New Literacies" perspective on instructional design and explain its implementation in an instructional environment that engages learners in collaborative, creative, interest-driven, and production-oriented digital media projects. This active learning approach implements such learner-centered principles as attainment-based instruction, task-centered instruction, and personalized instruction. In this design, also, the extent to which each principle is implemented depends on the specific design decisions, instructional context, and other important factors present in the educational setting.

In **Chapter 8**, *Designing Games for Instruction*, Myers and Reigeluth describe a games-based approach to instruction that promotes learning in rich, immersive, simulated, problem-oriented environments designed to challenge learners in multiple ways. The authors state that this approach implements "learning by doing" in a social environment and leads to deeper learner engagement, which elicits greater learner effort and ultimately results in improved student learning. This approach generally implements such learner-centered principles as attainment-based instruction, task-centered instruction, personalized instruction, and changed roles. The extent to which each principle is implemented depends on the specific game design decisions, and other important factors associated with the encompassing instructional system (students, instructor, school, home environment, etc.).

In **Chapter 9**, *Designing Instruction for Self-Regulated Learning*, Huh and Reigeluth describe why supporting self-regulation in learners is of even greater importance now, in the Information Age, than ever before, and how instruction can be designed to improve learner self-regulation. As learners take on a more active role in all forms of learner-centered instruction (such as those described in this volume), the ability to self-regulate learning is critical for the development of effective lifelong learning skills.

The design explained in this chapter is intended to help learners assume more ownership for, take control of more aspects of, and find ways to customize (personalize) their own learning experience to better fit their own needs and goals. The details of a specific implementation will determine how significantly such learner-centered principles as attainment-based instruction, task-centered instruction, personalized instruction, and changed roles are supported.

The final chapter in Unit 2 that describes an existing instructional design is **Chapter 10**, *Designing Instructional Coaching*, by Knight, Hock, and Knight. The authors describe an instructional design that changes the traditional teacher-learner relationship to one modeled after a classic coaching approach. The specific design context of this chapter is teacher mentoring and professional development (with classroom teachers taking on the role of learners), but the principles apply to many other instructional settings. As explained by the authors, in the instructional coaching design, goal setting, questioning, and data gathering (typical of one-to-one coaching) are integrated with explanation, modeling, and feedback to help teachers teach more effectively and improve student learning. This approach implements such learner-centered principles as attainment-based instruction, task-centered instruction, personalized instruction, and changed roles. The extent to which each principle is implemented depends on the specific design decisions, instructional context, and other important factors present in the educational setting.

In the last chapter in Unit 2, **Chapter 11**, *Designing Technology for the Learner-Centered Paradigm of Education*, Reigeluth does not present an existing instructional design, but rather describes design features of a proposed system, PIES, that would provide the technological supports for truly learner-centered instruction as we've described it in Chapter One. The author explains four major functions required to support students (recordkeeping for student learning, planning for student learning, instruction for student learning, and assessment for/of student learning) and three secondary functions (communication and collaboration, PIES administration, and improvement of PIES). If developed fully, this approach would support the implementation of all five learner-centered principles: attainment-based instruction, task-centered instruction, personalized instruction, changed roles, and changed curriculum.

As in Unit 1, at the outset of each chapter, we provide a summary of the key elements of each instructional design, highlighting important contextual factors and listing instructional values, universal design principles, situational design principles (when included by authors), and implementation considerations. In several chapters, the authors have also provided helpful summary tables to aid your understanding and provide a useful resource for later reference.

As you read these chapters, you might find that you are familiar with various aspects or elements of these designs, having experienced them as a student or instructor in the past. You might also think about ways that you could adapt one or more of these designs to fit your own specific educational setting. We encourage you to think creatively as you reflect on your own experiences and consider the possibilities for further personal and professional application of each design.

– C.M.R., B.J.B., & R.D.M.

6

DESIGNING MAKER-BASED INSTRUCTION

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EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *Content that can be experienced through the production of tangible products.*

Learners

- *All students.*

Learning environments

- *Application-oriented, learner-centered environment that supports the production of meaningful physical artifacts that students value.*

Instructional development constraints

- *Significant planning and development may be required to provide the location, resources, and instructional supports needed by students as they create physical artifacts.*

Values (opinions about what is important)

About ends (learning goals)

- *Generating physical objects that are personally meaningful and valuable is highly valued.*
- *Conceptual understanding and connections between the theoretical and physical properties of materials are highly valued.*

About means (instructional methods)

- *Learning through doing (active learning) is highly valued.*
- *Learning situated within a collaborative community is highly valued.*

About priorities (criteria for successful instruction)

- *Effectiveness and appeal are more important than efficiency.*

About power (to make decisions about the previous three)

- *Self-directed learning is highly valued.*

Universal Principles

1. Identify a starting point

- *Identify a starting point based on a learner's inspiration, interests, and interactions, for making to be productive and inventive.*

2. Provide tools, materials, and resources

- *In order to make products, appropriate tools, materials, and resources are required. (See the Situational Principles section for variations.)*

3. Formulate design goals

- *Design goals should be co-constructed between a learner and instructor.*
- *Design goals should be guided by human-centered design questions, such as "Why am I making this?" and "Who will experience it?"*

4. Structure the design task

- *The design task should expand the learner's ability in purposeful directions through iterative artifact development and refinement or re-development.*
- *Provide appropriate design guidance. (See the Situational Principles section for variations.)*

5. Foster cycles of prototyping, failure, and refinement

- *Use prototyping to test an initial hypothesis in a real-world situation.*
- *As flaws in the design solution become apparent in use, the analysis and understanding of failure should guide further product development (refinement).*
- *Continue the cycle of prototyping, failure, and refinement until an acceptable solution emerges.*

6. Assist learners in generating meaningful inquiry questions

- *Use meaningful inquiry questions to support learners' interest and progress toward learning goals.*
- *Instructors should provide direct assistance to most learners to develop meaningful inquiry questions. Instructors should use a scaffolding process of asking a series of inquiry questions (of increasing complexity) to help learners develop inquiry skills.*

7. Facilitate value beyond the lab

- *Facilitate maker activities that are directly connected to content and have an authentic purpose for the making.*
- *Explicitly connect student making efforts to broader value beyond school.*

Situational Principles

Designing the maker space

- *The provisioning of a space with resources and the type of artifacts which may reasonably be produced depend on the design of the maker space. Common designs and their affordances include:*
    - *Dedicated space allows for more substantial fabrication tools, enabling more complex processes and artifacts.*
    - *Pop-up space allows for a smaller maker space footprint, often more ideal for an occasional maker project in an otherwise non-maker (traditional) curriculum.*
    - *Mobile cart space is useful when one or more fabrication tools are used in various locations rather than in a fixed space, and is particularly useful in spreading the maker*

space technology (and process) to multiple classrooms and embedding the process directly into "regular" classrooms.

Forefronting content or purpose

- *The ideal set of tools and resources is not only determined by budgetary constraints, but is also guided by the purpose of the maker space activity. Significant variations often occur in setting with varying orientations.*
  - *STEM orientation, such as robotics or engineering projects, may require extensive technical fabrication tools.*
  - *Design and craft orientation projects often require relatively simple hand tools, which may allow for effective integration of maker projects into regular curriculum and may better support the development of maker-oriented culture in a school setting.*

Providing learner guidance

- *Guidance for tools and materials varies according to the tools, materials, and methods of application to maker projects.*
- *Guidance varies for application of learning from the maker project to the overall discipline or curriculum.*
  - *Provide opportunities for reflection, timely coaching, and direct assistance when required to support learners completing projects.*

Case Description

- *The Interactive Book Project*

– C.M.R., B.J.B., & R.D.M.

DESIGNING MAKER-BASED INSTRUCTION

I. Introduction

We begin with an historical overview of digital fabrication technologies developed at MIT that grew to include incorporating analog technologies, design, and art processes intersecting with the digital. This progression has led to considerable dialog within the maker community to include a wide array of making projects that in the past might have been considered prime for home economics and shop classes, such as sewing, wood working, and welding. This nature of making includes transdisciplinary processes combining digital and analog methods, stems in part from Piaget and Dewey, and reflects a convergence of digital fabrication technologies, visual art practice, and inquiry, all of which will be explored in the chapter. Additionally, we detail specific principles that guide making in formal contexts, which include the following: a common starting point, tools and resources, design goals, and learner guidance. We also detail situational principles that guide use and integration of making practices: (1) inquiry; (2) value beyond the lab; and (3) prototyping, failure, and refinement.

What Is Making?

The current cultural and educational phenomenon known as "making" has its roots in MIT's Fab Lab (shorthand for digital (fab)rication (lab)oratory) as conceived by Neil Gershenfeld. MIT's lab was originally constructed as a technology space centered on learner-driven processes using the rapid prototyping tools of engineering and design, such as 3D printers and laser cutters (Gershenfeld, 2005). Making, as defined for this chapter, references a practice that is located at the intersections of art, design, engineering, and traditional craft, resulting in a physical object. The *maker movement*, as it is termed, references the broader community that has formed out of these practices and reflects a set of shared goals and values enabling the individual to generate objects through open source knowledge and technologies.

Groups of like-minded individuals focused on innovation, collaboration, and shared resources have formed and turned a practice initially found only in higher education institutions into a broader community of maker practice. These group-oriented efforts that are moving the center of maker culture outward can be found in collaborative studios called maker spaces or hacker spaces.

In this broader context, researchers and educators have begun to explore the capacity for maker technologies to enhance children's learning.[*] One example of how a craft and technology interface is being incorporated into the learning environment can be seen in the development of circuits that are sewn into textile work, from t-shirts and backpacks to any number of other textile crafts (Buechley, Eisenberg, Catchen, & Crockett, 2008), resulting in electronic textiles, or e-textiles. The circuits are relatively easy to integrate into the textiles, and are programmable to create an interactive e-textile project.

Because e-textile circuits are constructed with uninsulated conductive thread, in order to avoid creating a short circuit, and thereby a non-functional circuit, significantly more attention than in traditionally constructed circuit projects needs to be paid in the circuit-building process. This extra attention to detail suggests there may be beneficial aspects of e-textile projects that lead to increased learning of some engineering principles related to circuitry (Peppler & Glosson, 2013). There is also an indication that projects such as e-textiles may provide a more successful entry point for girls in engineering-oriented projects (Buchholz, Shively, Peppler, & Wohlwend, 2014).

Maker-oriented projects, however, function not only to develop engineering-oriented literacies, but also to create opportunities for children to make something that has both meaning and personal value by the very fact of the making process. This is further emphasized in how individuals highlight their personal projects in websites such as DIY.org, and Instructables.com. This echoes Papert and Harel's (1991) ideas where "learning as 'building knowledge structures' . . . happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity" (p. 1).

Making and learning: Foundations

While considered by some as new and groundbreaking, these maker-oriented processes resonate with learning theories a century old. Dewey and Vygotsky spoke to the possibilities of improved learning through systems of authentic, experiential, and holistic problem- and project-based learning as far back as the 1920s. Within the context of maker culture, learning can be considered as an experiential and aesthetic process (Dewey, 1934/2005), and as a socially situated process (Vygotsky, 1978) where the learner comes to knowledge within zones of proximal development. Additionally, learning can be frequently engaged via problem-based and project-based processes through collaborative digital technology as activity systems seen in theories of situated cognition (Greeno, 2006).

II. Values

Integration of maker practices reflects a set of values that informs how the instructional environment is arranged:

- Learning can be fostered through doing in a meaningful context.
- Learning through making is situated within a community.
- Learning through making should be largely active and self-directed.

Each of these is discussed in more detail below.

Learning through Doing

Many makers find value in a making-to-learn orientation rather than a learning-to-make as the former places emphasis on the process rather than the object. We argue that as individuals make and create, they are engaging their environment in ways that may help them connect both theoretical and physical properties of materials and their uses. For example, when building a sensor circuit that detects temperature, the learner is applying knowledge of circuitry as well as the conductive properties of materials. Children live in a digital world full of programmed objects they interact with, and maker projects may allow children to begin to understand just how the computational element of the world they experience actually works. As Ackermann writes, "knowledge is not information to be delivered at one end, and encoded, memorized, retrieved, and applied at the other end. Instead, knowledge is experience that is acquired through interaction with the world, people and things" (2001, p. 3). However, we note that this orientation does not go far in explaining how learning might happen, which is why learning should take place within a community context.

Dewey set foundational structures for thinking about teaching and instruction with meaningful context in mind. He argued for the need to enable continuity of experience, foster meaningful interaction, and present a progressive organization of material (Dewey, 1938). For Dewey, this "more organized form" is in the educator's role to make decisions about curriculum and material, holding in mind both the need and prior experience of the learner in an interactive and connected environment. In a maker context, such activities might have potential to devolve into less productive, or even non-productive, activity; therefore we consider the importance and role of instructional structures, which we discuss later in this chapter.

Situated within a Community

We acknowledge that sociocultural theories of learning consider how the social environment affects the individual where the learning takes place, and contend that learning takes place within physical, social, and cultural environments that are at play and shape how learning develops (Jarvis, 2009). One's learning is in context to that environment, and developing a connection to the contextual nature of learning may allow for authentic learning processes to unfold. Ackermann (2004) makes the point that knowledge then is not "a commodity to be transmitted" (p. 2), but an experience to be actively built through interactions with materials, peers, and experts. Projects that require learners to craft models, texts, or other representations of knowledge can be transformed with the addition of computing elements where their knowledge and skill is distributed across the community. While not a primary focus of this paper, we reference the sociocultural frame in order to forefront the value of authentic and interest-driven knowledge building that can be fostered in a community. This is evidenced in the organization of maker spaces: shared expertise in which both individual and collaborative endeavors are propelled forward by the collective work and participation of everyone.

Active and Self-Directed

The origins of many of our ideas regarding learner self-direction can be traced back to John Dewey, who argued that relevant and deep learning should take place in an environment that entrusts control to the learner (Dewey, 1938). Dewey was clear to point out that self-control is not fostered by absence of teacher or other control, but, rather, by giving the learner freedom to pursue that which is intrinsically worthwhile in a guided environment. His ideas are in direct contrast to what he terms "traditional" education, defined as students confined to seated rows in a primarily didactic environment. He stated:

> There cannot be complete quietude in a laboratory or workshop . . . There should be brief intervals of time for quiet reflection provided for even the young. But they are periods of genuine reflection only when they follow after times of more overt action and are used to organize what has been gained in periods of activity in which hands and other parts of the body beside the brain are used (Dewey, 1938, p. 62–63).

However, it is important to note that maker activities might have potential to devolve into less productive, or even non-productive, activity and therefore we consider the importance and role of instructional design.

III. Enacting Design Practices: A Set of Universal Principles

In order to understand the principles that might guide and reflect the instructional considerations in a maker lab, we begin with some critical questions. How might making intersect with formal learning environments and standardized curricula?[*] What are the affordances of learning environments rooted in practices found within maker culture? What are the drawbacks? We suggest that successful integration, at minimum, needs the following:

1. A starting point
2. Tools, materials, and resources
3. Design goals
4. Structure for design task
5. Prototyping, failure, and refinement
6. Learner inquiry that begins with meaningful questions
7. Value beyond school.

1. Identify a Starting Point

Productive and inventive making begins with a starting point based on an individual's inspiration, interests, and interactions that eventually will result in objects developed in the context of a community.[*] For example, children may choose to engage in working on robotics projects, and the proliferation of official robotics challenges may serve to fuel such activities. In the context of rich online communities such as DIY.org, children may find inspiration through each other, and the sharing community it engenders is one in which all manner of making is encouraged.

One difficulty of formalizing an interest-driven community and converting it to instructional settings is that characteristics of maker spaces in informal learning contexts are not easily replicable in classrooms.[**] Maker spaces, which are often set up as fab labs and hacker spaces, are slowly becoming more prominent in the broader context of the informal learning environment; moreover, the informal community within these spaces exists to enable individuals to pursue self-defined goals. Thus, membership is both evolving and permeable. By contrast, a formal setting, such as a classroom, does not typically involve evolving or permeable membership, though self-defined goals and learner choice do not necessarily have to be forfeited in order to achieve learning outcomes. In fact, Dewey (1938) argued that learning purposes are located in such self-directed practices:

> There is, I think, no point in the philosophy of progressive education which is sounder than its emphasis upon the importance of the participation of the learner in the formation of the purposes which direct his [sic] activities in the learning process, just as there is no defect in traditional education greater than its failure to secure the active cooperation of the pupil in construction of the purposes involved in his studying (p. 67).

In other words, active learner cooperation can be characterized as a foundational and requisite element of any meaningful instructional setting. Thus, we suggest that any number of instructional contexts might hold the potential to enable learners to learn through making, but one critical element is a starting point that prioritizes learner interests and self-direction[*] that are realized in the practices of design and making. Tools and resources are integral to this endeavor.

2. Provide Tools, Materials, and Resources

While some making labs are defined spaces, others can be multi-use areas or even mobile carts.** Rapid technological advances have reduced both the scale and the price of the production tools of maker spaces, such as laser cutters, 3D printers, and vinyl cutters. Additionally, while traditional engineering-oriented learning spaces have incorporated circuit-building projects through the use of complicated process-based activities that require specialized tools such as soldering stations, significant technological advances have been made in materials science that allow for circuit-building activities using simple low-tech materials such as pencils and paper already found in any classroom.

However, some noted difficulties with the process of physically incorporating making in educational settings are the costs of the tools to outfit a lab, and the need to have a dedicated space for the lab. Some barriers of having a dedicated maker space in a fixed location are the need to move the students into the space to work and the concurrent structured pedagogies that may create classroom formats similar in structure to the traditional classroom science lab. These are noted as barriers because they tend to induce learning structures and environments that are counterintuitive to the capacities and affordances of maker technologies to create learning conditions driven by the interests of the learners.*** These are constraints that might be avoided by introducing the technologies directly into the classroom space so that they might be integrated directly into the curricular activities of the class, and allowing for those activities to be co-constructed with the learner based on her interests.

3. Formulate Design Goals

We consider design goals a critical element of the context. Design goals might be primarily learner-driven, though they are typically co-constructed with an instructor in some way. We define design as a unifying process across many disciplines and ideas. Design is a way in which an ecology or constellation of elements may be interwoven to convey information that fluctuates between the micro and the macro, to create a system of signs to mark out the individual and the whole (Nelson & Stolterman, 2012). Design works then to create a network of elements that are interwoven to convey information and useful affordances through the realized object, artifact, or experience. For Ackermann (2007), this is how "designing (*projettare* in Italian) can be seen as the flipside of reflective abstraction: an iterative process of mindful concretization, or materialization of ideas (*concrétisation réfléchie* in French)" (p. 2). As in the designing and crafting of artifacts with maker technology, "to design is to give form, or expression, to inner feelings and ideas, thus projecting them outwards, making them tangible" (Ackerman, 2007, p. 230).

Thinking in these terms allows for a way to consider how ideas and information are parsed out to convey meaning through systems that both clarify and, through juxtapositions, create a mental instability that helps us to reconsider what we know. This is conceived as human-centered design rather than as technology-centered design (Krippendorff & Butter, 2007). It is the difference between asking, "Why am I making this and who will experience it?" (human-centered) and "What can I make?" (technology-centered). Materials, resources, and tools are assembled out of the individual's goals, ideas, and collaborations, resulting in the overarching structure that comprises the designed object.

4. Structure the Design Task

Because a maker space is such a complex learning environment, we consider the most productive ways to structure the design task. How do the maker activities allow for the structuring to assist the learner beyond his or her current capacities?* This is where Jonassen's (2010) framework for design problem solving informs a deeper understanding of the iterative processes that serve to support and allow the individual learner to grow through guidance of experts and other more knowledgeable peers. Jonassen (2010) notes that design problems are among the most complex and ill-structured, but that most designers engage a cycle that begins with a problem space and moves toward interests, ideas, and artifacts (see Figure 6.1). While the cycle should be interpreted as iterative and learners can move both to previous elements of the cycle at any point, we have deliberately depicted the artifact as a cycle of object that enters the world and can then be refined (multiple times if the learner is motived to do so). Using these processes, learners can be assisted to both form the "appropriate" cognitive mental models from a task and engage in a task that may reshape the learner's ideas and understanding. Guidance can assume many forms, which we discuss in the Situational Principles section.

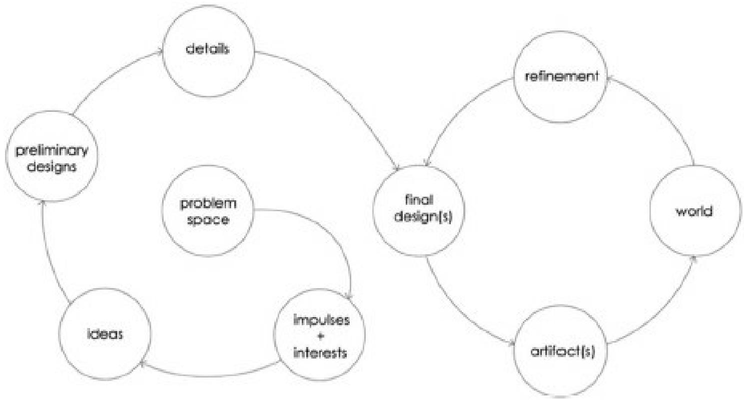


FIGURE 6.1 Design Cycle

5. Foster Cycles of Prototyping, Failure, and Refinement

In understanding prototyping, failure, and refinement, it is helpful to consider design processes as they are motivated via inquiry processes. In coming to an initial solution to a problem identified through the inquiry process, a prototype is first constructed in order to test a hypothesis in a real-world situation. To use an example from the section on learner inquiry, when a learner asks "Can I help people with arthritis through design of a better stove knob?" a prototype of a stove knob needs to be fabricated and tested for the ways in which it is useful in relation to people with arthritis.

Real-world prototyping is used to discover a designed object's true affordances in use. When the prototype's design doesn't function to solve the structured problem, this may be characterized as failure. While there is a tendency to consider failure as negative, we argue that failure functions in a positive way to help guide further refinements of prototypes toward a final model. If the learner forms a hypothesis (i.e., "this specific shape of a stove knob is easier for someone with arthritis to use") and if the hypothesis doesn't hold true in a real-world application through testing of the prototype, then there is new knowledge for the learner to use in the next iteration of the prototype.

This next iteration in the design process is what we are referring to as refinement. Refinements occur by way of continued inquiry processes used to understand the outcomes of using prototypes in the physical world. When the prototype is not functioning as a successful solution to the structured problem, the failures are noted and applied to the next iteration of the prototype.

These aspects of prototyping, failure, and refinement can be well supported by the tools and processes found within maker spaces. Additionally, the full array of disciplinary practices within which rapid prototyping tools can be used is indication of the potential positive affordances of the tools within an educational setting. This is in fact now being played out extensively through the work of building fab labs in schools that have expressed interest and desire to incorporate the tools and connected curriculum (Blikstein, 2013).

6. Assist Learners in Generating Meaningful Inquiry Questions

We define inquiry in this context broadly. In short, we mean any form of activity that is driven by interests in the pursuit of meaningful questions through engagement with tools, texts, materials, peers, guides, and other resources* (Abrams, Southerland, & Silva, 2008; Anderson, 2002; Savery, 2015). A meaningful question can be generated and located from anywhere within the situation: learner interest

("Can I help people with arthritis through design of a better stove knob?") or materials curiosity and testing ("How can I discover and explain what happens when these two plastics of different densities are combined?") or combined representation ("What if I represent my ideas through a textbook that incorporates screen animations when you turn the page?"). In these examples, each inquiry question forefronts both the design goals and the purpose of the design.

However, we note that it is not likely a learner will develop a meaningful and complex inquiry problem without guidance toward a meaningful question, which we discuss below under situational principles. Thus, the teacher should guide interests and help students articulate a question that will likely lead to meaningful learning. For example, we can imagine a situation in which a student says, "I want to mix these two different plastics together," a motivation that may not necessarily be articulated out loud. It is up to the teacher to decide how to provide guidance and in what forms.[**] The initial impulse (mixing two different plastics) can be accomplished without much forethought; the plastics can be mixed and the outcome can be observed, but this does not suggest or indicate any form of deep learning or meaningful engagement. However, if the teacher engages a process that will enable both maker activity combined with disciplinary engagement, she might ask and probe:

- "Describe the materials to me."
- "What do we know about these materials? What are the terms we use to describe physical properties of materials and objects in our world?"
- "What about the two plastics makes them different?"
- "How do you define 'combine' and what makes you think the plastics can be combined?"
- "How can we combine them? What processes do you know about? Should we learn about new processes?"
- "What do you think might happen?"
- "How will you make and record your observations?"
- "OK, let's form a question, plan our test, and record our observations. Then let's plan a test in which we replace one of the plastics for a different material, and make some broader inferences."

Arriving at an inquiry question through these forms of probing and guidance accomplishes at least three goals: (1) enabling the teacher to enlist the student in the idea investment, (2) helping the teacher evaluate knowledge and understanding, and (3) fostering productive inquiry and disciplinary engagement. From this point, the learner can move forward with a plan. However, the learners should also be provided with knowledge of value beyond the lab. In other words, how is this object connected to a broader audience, conversation, or disciplinary activity?

7. Facilitate Value Beyond the Lab

In their landmark study of the relationship between authentic intellectual work and standardized tests, Newmann, Bryk, and Nagaoka (2001) conducted detailed observations from three grade levels over the course of three years from more than 400 Chicago classrooms. They asked a big question: What happens when you compare outcomes from classrooms of higher authentic intellectual work to those of lower intellectual work on standardized tests?[*] They found that three dimensions were required in the classroom to observe the greatest benefit and outcome: construction, inquiry, and value beyond school. In the context of making, construction and inquiry have already been covered elsewhere in this chapter; value beyond school is meant to lend deeper purpose to the work of making and likely fosters what Dewey (1938) referred to as the felt need. By Newmann et al.'s definition, student activities and artifacts are connected to a larger audience or disciplinary activity. More specifically, instructors should facilitate maker activities that are directly connected to content and have an authentic purpose for the making.

In the example above with the plastics testing, the learner can be led to understand that she is doing much more than smashing two different forms of plastics together. More specifically, she is engaging in a fundamental experiment with roots in physics, chemistry, and materials engineering. Materials engineers try to create new materials, and they use processes of processing, testing, and experimenting to understand properties and behaviors of materials under different conditions. They record their observations, explain their results, and make inferences regarding potential applications. Advances in materials testing have given us everything from objects in our pockets, such as microchips to power our phones, and in our bodies, such as new polymers to repair bones. Thus, when students are engaged in materials experimentation, observation, and inference, whether with plastics or any other materials, they are also engaging in typical engineering practices. Such practices, when made visible to them, may connect students and their making efforts to broader value beyond school.

IV. Situational Principles

There are at least three situational principles that can guide use and integration of making practices in an instructional making environment, and it is up to the teacher to guide learners in what and how to consider these elements: (1) designing the maker space, (2) forefronting content or purpose, and (3) providing learner guidance.

1. Designing the Maker Space

While we consider the provisioning of a maker space with appropriate tools and resources to be a universal principle, we understand the design of any maker space to be variable as they are each situated in different contexts. Various factors influence design decisions.*

Dedicated space

When space and funding are available, it may serve to create a dedicated maker space. Such a space could be designed with the fabrication tools in fixed locations around the perimeter; adequate work surfaces placed centrally; cabinets for power tools, chemical storage, and personal safety equipment to be easily accessed; and a central fume and dust extraction system installed to ensure a healthy working environment.

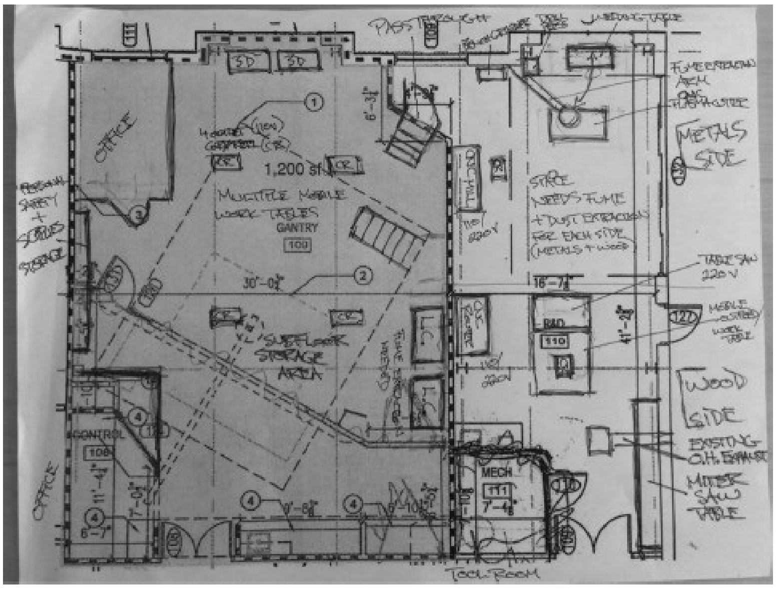


FIGURE 6.2 Dedicated Space Plans

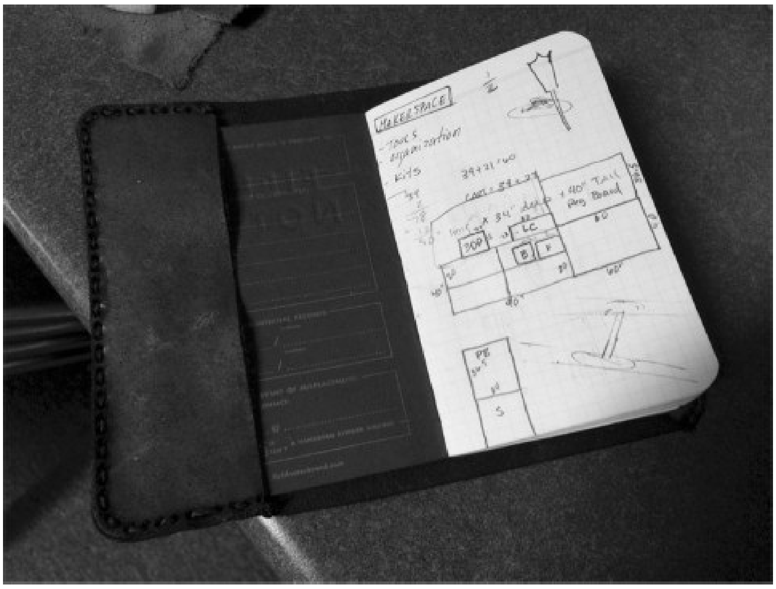


FIGURE 6.3 Dedicated Space Sketch

Pop-up space

When resources are particularly limited, and only a small selection of equipment is available, such as having only a sewing machine, 3D printer, and a basic selection of hand tools, a maker space may be designed to function as a pop-up space. This may also be a particularly useful design option when the integration of maker tools and processes into curriculum and instruction is intermittent, or if instructors are only just beginning to explore the capacities and affordances of maker spaces. A pop-up space could involve a simple procedure of setting up a 3D printing station on a desk, and pulling out hand tools for use as needed for various projects.

Mobile cart

Yet another option in designing for space is to create a mobile system. This is particularly useful when there is an opportunity to procure several of the primary digital fabrication tools, such as laser cutter, 3D printer, and vinyl cutter, but there is not available room for constructing a dedicated maker space. A mobile system also allows for the spread of the technology across multiple classrooms, and inserts the tools and processes for engaging them directly into the classroom environment.

FIGURE 6.4 3D Printer on Desk for Pop-up Space

FIGURE 6.5 Mobile Maker Cart with 3D Printer and Laser Cutter

We argue that this latter aspect is a critical feature of maker spaces in schools and may create the conditions to more fully integrate maker technologies and processes into curricular and instructional practices.[*] This may be an advantage of a mobile system over that of a dedicated shop-like space where students only engage maker practices in a more piecemeal fashion. A mobile cart is the design option used in the following case description given below, and highlights some of the affordances of this design choice (McKay & Peppler, 2013).

2. Forefronting Content or Purpose

While we have discussed some potential issues around designing space, a significant consideration in what resources to procure relates to what is being forefronted pedagogically. We consider there is value in having a full spread of tools from analog hand tools such as ratchet sets and hot glue guns, to computer numerically controlled (CNC) digital fabrication tools such as laser cutters and CNC mills. However, there will always be a need to carefully weigh the pedagogical mission of any particular maker space against the budgetary constraints in determining what the best spread of tools and resources may be. This is true of any instructional environment.[*]

STEM orientation

If the pedagogy in an instructional environment is to forefront STEM content then robotics and engineering oriented projects may be favored. In such a case laser cutters, 3D printers, and soldering stations become necessary for the efficient fabrication of engineered physical structures. An advantage of such pedagogical choices can be found in taking advantage of the rapid prototyping capacity of such machines. This can also allow for students to engage in the iterative design processes that come in concert with the design failures inherent in testing engineering designs.

Design and craft orientation

When forefronting pedagogy rooted in design processes is a focus, the procurement of tools promoted as the flagships of maker spaces (laser cutters and 3D printers) is useful but perhaps not as necessary. This may be particularly so when projects take the form of high and low-tech integration. Examples of such projects can be found in the aforementioned e-textiles as well as paper circuits. In both of these examples, circuits are integrated into analog materials that are crafted and shaped by hand. This approach may allow for learners to acquire new knowledge in computational thinking obliquely to the project rather than through science-based methods and reasoning processes.

Furthermore, when this approach is taken, teachers can learn maker-oriented processes in a way that allows them to more smoothly transition into working with the oftentimes more difficult to master digital fabrication machines. Integrating maker processes into the classroom represents more of a cultural shift in the learning environment than it does a simple use of tools and materials to support learning. Making design decisions to create a maker space that are oriented toward a more moderated integration can also create conditions for teachers to develop a more in-depth knowledge of the affordances and capacities of the tools and resources. As educators progress in that knowledge they may procure tools and resources with a broader integration and purpose in mind rather than relying on the tools and resources to inform the content.

3. Providing Learner Guidance

There are at least two dimensions under which an expert or instructor should provide guidance. The first is with use of materials and tools. The second relates to specific forms of learning guidance that foster connections between the activities of making and disciplinary content.

Guidance for tools and materials is critical to ensuring both fidelity of artifact design and safety in the environment. Some labs might require external certification while others might consider this process more informally. There may be moments in which materials testing is part of the goal, in which case the instructor might want let learners experiment with materials to achieve different outcomes. For example, the instructor might want learners to build speaker cones for a sound project through a variety of materials in order to achieve different shapes and forms. One goal in this case might be to help learners see how cones shape sound, and enable direct connections to the physical properties of sound. In a case like this, materials discovery is part of the process; however, the learner will still need knowledge about tools that might be use to cut and shape cones, such as use of a number 10 blade, specific cutting techniques, and other shaping tools. Direct guidance regarding tools will likely result in a more refined design and a safer context.

Instructors also want to consider productive engagement with disciplinary content. In some cases, instructors may want to foster **reflection** within the design cycle and help students to think about their own design thinking. This is generally prompted either individually or within the group setting: “Why did you make this choice?” “Tell me about your use of materials here.” “Where will this idea go next?” Or guidance may involve specific **coaching** through complex or difficult problems, such as how to build a motor that meets certain requirements. In some cases, a student may be genuinely “stuck,” which requires **direct assistance**; at other times, the learner may be satisfied with a superficial or flawed or cluttered design, at which point the teacher will **prompt** more refinement and deeper understanding.[*]

Decisions about when to enact these forms of guidance are based on learner facility and situation within the design cycle. Novice learners may require instruction with tools or safety certification prior to even entering the maker lab. Learners may not need additional guidance after they have acquired knowledge of tools, though new materials might need additional support and consideration to understand their primary use and affordances. Furthermore, each project or new endeavor may require just-in-time learner assistance to ensure disciplinary engagement.

V. Case Description: The Interactive Book Project

One such investigation into these ideas comes in the form of an intervention co-developed by one of the authors with teachers and administrators at a community-based K-8 charter school in a small Midwestern city: the Interactive Book Project. The project is supported by a mobile cart that hosts a nearly full complement of the tools and equipment that can be found in a fuller scale fab lab, but is contained in a small portable unit that can be utilized directly in the classroom spaces. While the cart functions to provide the tools and learning environment of a fab lab to the students, another major consideration is how the cart functions toward integrating a culture around making with the pre-existing school culture of the faculty and staff. This latter aspect is intended to serve as a platform from which teachers may then be able to integrate maker projects contextual to their curriculum and instructional practices directly into their classrooms.

As the teachers learn how to navigate the world of programming and physical computing, finding the intersections of maker practices and classroom teaching becomes an easier endeavor. But these digital tools carry with them some level of abstraction from an embodied experience, which is a significant aspect to our learning processes. With this in mind we have developed a simple low-tech project that combines the physical crafting of a small folded book with digital storytelling developed in the entry-level programming environment of Scratch (see Figures 6.6 and 6.7). The book has a simple circuit drawn into it, which in turn is connected to an object interface board known as a Makey Makey that allows the book to operate the Scratch program.

The Scratch programming language, developed by Mitchell Resnick and his team at MIT, allows children easier access to learning the principles of programming. Released in 2006, it is utilized extensively in both traditional school environments and informal learning spaces such as the Computer Clubhouse where it was first tested. Programming in Scratch is a process of connecting Graphical User Interface (GUI) drag-and-drop blocks into a work window. There are eight different types of blocks—Motion, Control, Looks, Sensing, Sound, Operators, Pen, and Variables—that work in concert through their various commands (see Figure 6.8).

As a GUI programming environment, the focus is taken away from needing to be syntactically correct in the programming process. This utilization of a GUI is intended to encourage a more playful process of developing programming literacy, by allowing for the programmer to move quickly through iterations of their building of the program.

With Scratch, young people can program their own interactive stories, animations, games, music, and art—then share their creations with one another online. In the process, young people learn important mathematical and computational ideas, while also learning to think creatively, reason systematically, and work collaboratively. Scratch is designed to make the activity of programming more tinkerable, more meaningful, and more social—and thus appeal to broader, more diverse audiences than traditional programming languages. Scratch builds on youth interests in popular culture, social media, and expressive communication.

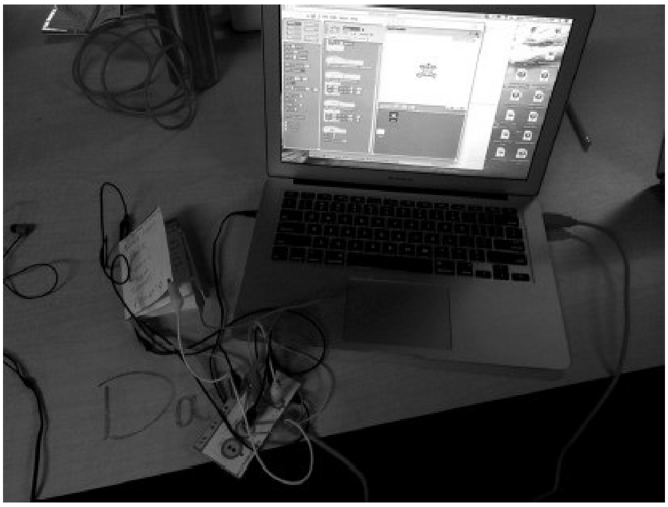
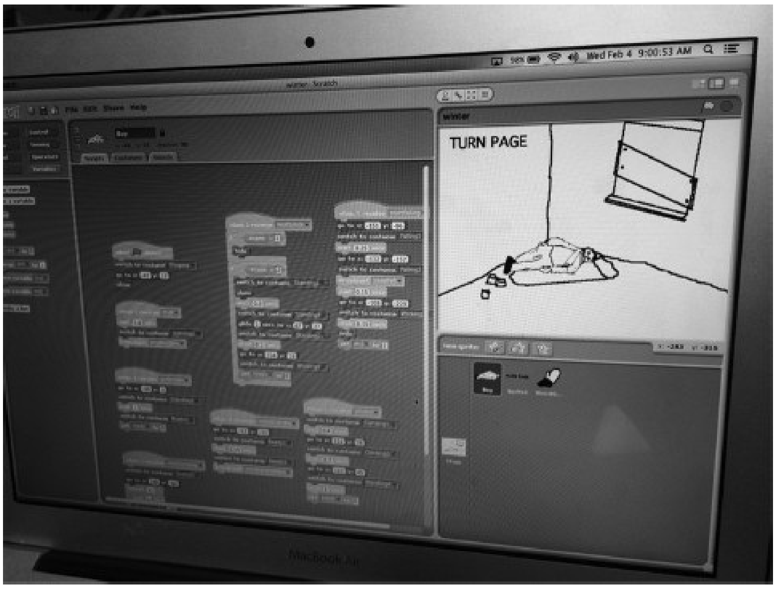


FIGURE 6.6 Interactive Book with Circuits that Connect to the Makey Makey Interface Board

[FIGURE 6.7](#) Circuitry on the Page Triggers Programmed Events on the Computer Screen



[FIGURE 6.8](#) Scratch Programming Interface

Makey Makey is an object interface board developed parallel to, and intended to work in concert with, Scratch. Makey Makey consists of a printed circuit board (PCB) that has all of the inputs that it takes to operate a computer keyboard, and a USB port that allows for the Makey Makey board to be connected to a computer. This feature allows for several keyboard command operations to be conducted through the Makey Makey board directly, but more importantly the board allows for the connection of any conductive object to run keyboard operations by connecting the objects directly to the Makey Makey board.

Makey Makey boards are commonly demonstrated by connecting bananas to the board, and then using them as “piano keys” to play a virtual piano on the computer. This interactive book project uses all of the same basic parameters of hooking up the board to external objects, but utilizes a circuit that is drawn across the extent of the book in graphite. While the graphite is fussy at times, and will rub away, leaving behind an inadequate substrate for the circuit to function properly, it is simple to develop the circuits, and also provides opportunity for the bookmakers to debug their book.

Significantly, however, the book is a tangible object that is itself constructed, and done so in concert with programming in Scratch. Thus it may provide a means for the maker to not only deepen their story in the book through external events in Scratch, but also develop multiple literacies across media. The media in this way are no longer abstracted from one another, nor is a story developed solely within a singular environment, either as only a book or on the screen. Additionally the bookmaker has an opportunity to create their own visual and auditory environments in design programs such as Illustrator, Inkscape, Audacity, or Garage Band, among many others.

The interactive book project also reflects the universal and situational principles discussed above. First of all, students engage in meaningful inquiry through choice and selection regarding purpose, message, and representation. The inquiry question does not embody a project, such as “What book can I make and what animation forms can I integrate?” but rather, “How do I represent my ideas?” Second, the project reflects value beyond school. Not only is there an audience for the book, but there is opportunity to foster a deeper connection to the historical ways in which humans have used and modified text and imagery from our earliest days until now. Finally, the project incorporates prototyping, failure, and refinement. More specifically, students must put all the pieces together before the book “works,” so to speak, which involves complex circuit building, programming, graphic design, and story making. Furthermore, as all the animations are mutable (and possibly the paper text, depending on the design), there are no limits to the number of times a learner can refine or redefine the graphics in the project.

VI. Closing Remarks: Building Up

In considering the implementation of these maker technologies into the classroom, it is necessary to look at instructors’ capacities to work with the technologies in the learning environment in a manner that works in context with the curricular activities they design for their students. While many of the assumptions around the difficulties of teachers in integrating technology into the classroom hold up, key factors toward the successful implementation of that technology has also been attributed to teachers’ technology proficiency, social awareness, and an ability to match their pedagogical beliefs with technology to effect successful innovations in the classroom (Zhao et al., 2002). While it is not the purpose of this paper to detail these specifics, it is important to note that, as with any new initiative, instructors are also likely to need support and guidance, particularly as they need to account for the various situational nuances within their own contexts.

As maker technologies become more available in schools and communities, the potential exists to realize new and different forms of engagement that may lead to deeper learning. However, as we have argued, there are numerous considerations that inform how we might foster productive engagement and learning. Dewey (1938) informed how we might consider the ways in which learning happens through doing in ways are best gained through trial and error in the context of rich social interaction.

However, as we have also noted, it is not enough to have a rich context without instructional structures that inform organization of the context. Dewey (1938) informed how these structures might look, and his ideas are just as relevant today as they were a century ago: the educator’s responsibility is to make decisions about curriculum and material, holding in mind both the interest and prior experience of the learner within the interactive and connected environment. Thus, the learner is given numerous degrees of freedom, but in a bounded environment that capitalizes on interests while also fostering the environment of shared expertise and values that support maker culture.

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Notes

* *Editors' note: In Chapter 5, Prensky identified "effective accomplishing" as one of the four pillars of a new paradigm of curriculum. Maker technologies seem focused on this as a kind of learning outcome, in addition to being a method for such other outcomes as Prensky's "effective thinking" and "effective relating."*

* *Editors' note: This "looking for intersections" among old systemic structures and new practices is a common starting perspective when shifting from primarily teacher-centered to more learner-centered approaches to instruction.*

* *Editors' note: To the extent that this is truly individualized, this principle aligns with several universal principles for learner-centered instruction described in Chapter 1 and with Principles 1 and 2 in Chapter 4.*

** *Editors' note: A key aspect of paradigm change is transforming the classroom into a learning environment in which maker spaces and other forms of task-centered instruction are a central feature.*

* *Editors' note: For more on this, see Chapter 9, Designing Instruction for Self-Regulated Learning.*

** *Editors' note: The use of mobile carts may enable maker-based instruction in a variety of informal learning environments. Chapter 14, Design Considerations for Mobile Learning, provides useful design principles when mobile technologies are used to support learners bridging formal and informal learning environments.*

*** *Editors' note: These potential barriers highlight the need for strategic alignment of the various components of the entire instructional system to fully implement learner-centered instruction. This need is discussed in detail in Chapter 1.*

* *Editors' note: Approaches to assist each learner beyond his or her current capability is an important aspect of learner-centered instruction and is described by the Scaffolding sub-principle (2.2) of the Task-Centered Instruction principle in Chapter 1.*

* *Editors' note: This need for individually meaningful questions (and associated instructional elements) supports an important aspect of learner-centered instruction further described by the Task Environment sub-principle (2.1) of the Task-centered Instruction principle in Chapter 1.*

** *Editors' note: This aspect is an example of the need for changing the role of the teacher in learner-centered instruction and is described by the Teacher Roles sub-principle (4.1) of the Changed Roles principle in Chapter 1.*

* *Editors' note: This question highlights an inherent challenge when attempting to support the Information-Age instructional paradigm in predominantly Industrial-Age systems. Measuring the effect of new paradigm methods with old paradigm assessment tools and methods is systemically inconsistent, and supports the need for a comprehensive approach to learner-centered instruction as explained in Chapter1, including learner-centered, attainment-based assessment.*

* *Editors' note: For a comprehensive discussion of the nature of situational design factors, see Chapter 1, What is Instructional-Design Theory, and How is It Changing? in Volume I of this series.*

* *Editors' note: See Chapter 14, Design Considerations for Mobile Learning, for more instructional design principles associated with mobile learning environments.*

* *Editors' note: The need to align pedagogy with other systemic elements, such as budget constraints, is similar to the need to align specific instructional methods and activities to overall instructional strategies or approaches. The need for systemic alignment is also discussed in the situational principles section of Chapter 13, Designing Instruction for Flipped Classrooms, and Chapter 15, Designing Just-in Time Instruction.*

* *Editors' note: These varying aspects of learner guidance align well with the Scaffolding sub-principle (2.2) of the Task-centered Instruction principle in Chapter 1.*

7

DESIGNING COLLABORATIVE PRODUCTION OF DIGITAL MEDIA

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Erica Rosenfeld Halverson is an associate professor of digital media and literacy in the Department of Curriculum & Instruction at the University of Wisconsin-Madison. Erica's research focuses on how people learn in and through the arts across a range of disciplines including theatre, film, radio, and the visual arts. Currently, Erica is examining the role of the maker movement in transforming how museums and libraries think about working with learners, particularly those who have been disenfranchised from mainstream learning opportunities. Erica has published her work in a range of outlets including the *Harvard Education Review*, *Journal of the Learning Sciences*, and *Teachers College Record*. Erica is the co-editor of the two-volume *Makeology* series, to be published by Routledge in 2016.

EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *The content entails application and transfer, not just memorization. Learners' content understanding can be represented through digital media.*

Learners

- *All students.*

Learning environments

- *Collaborative, creative, interest-driven, learner-centered and production-oriented.*

Instructional development constraints

- *Requires a digital media production environment (hardware, software, and network) and instructor development skills.*

Values [*] *(opinions about what is important)*

About ends (learning goals)

- *Enculturation, becoming, and being, not just knowing.*
- *Literacy is viewed as primarily a sociocultural phenomenon rather than a psychological one.*
- *Self-expression, creativity, collaboration skills, acceptance of diversity and subjectivity, and development of technical, critical, and social skills.*
- *Empowerment to create one's own future.*

About means (instructional methods)

- *Interest-driven learning, learning by doing (constructionism, production orientation), community, contextual authenticity (situative-sociocultural perspective), and critique/reflection.*
- *An emphasis on learning systems rather than individual learners, content, or instruction.*

About priorities (criteria for successful instruction)

- *Effectiveness and appeal, more than efficiency.*

About power (to make decisions about the previous three)

- *Self-directed learning.*

Universal and Situational Principles

1. A production-oriented approach to learning

- *Develop learner–artifact relationships. Learners should create something personally meaningful and innovative. Instructors should provide adequate tools and time for this relationship to develop and deepen.*
- *Support learners' identities as designers. Learners should learn to think and talk about their artifacts like designers, using a grammar of design.*
- *Remake class into a workshop, with learners engaged in a collaborative production process.*
- ***Situational considerations include:***
  - *Assessing artifact quality: The instructional design should provide measures of artifact assessment relative to the genre, historical time, and target audience of production.*
  - *Distribute technological expertise across learners: Choose tools based upon the choice of project rather than constraining project choice to the tools available or already known by the instructor.*
  - *Align time constraints: Consider how much time learners need to create artifacts that satisfy their own creative expectations rather than setting strict constraints, as these may hinder learners' relationships with the object of their production.*

2. The importance of critique and reflection

- *Practice critique and reflection: Critique and reflection should be routine activities of learning and design. Offer regularly scheduled critique and reflection sessions. Also encourage spontaneous critique and reflection at opportune situations.*
- *Keep design journals: Require that students keep and submit logs of their design and learning activity.*
- *Use theoretical resources (readings, explanatory materials, experts, etc.) to develop meta-representational competence—the ability to use representational tools, reflect on which tools should be used, and to understand how the interaction between tool and meaning work toward a purpose.*
- ***Situational considerations include:***
  - *Frequency of critique: Instructors must keep a pulse on learning throughout projects in order to balancing critique and reflection with production. At times it may be necessary to offload critique to online forums as project deadlines near.*
  - *Managing failure: Learners may not always meet the expectations or deadlines set by instructors. In these instances of "failure," instructors have two situational alternatives to keep learners engaged and motivated: offer them more time to finish the project or allow them to explain how their projects meet or do not meet goals.*

3. The presence of an authentic audience for work

- *Consider audience from the outset: Audience should play a generative role throughout the creative process. Instruction should ask learners to identify potential audiences from the outset of their work.*
- *Find audiences: Appropriate audiences might include invited peers, friends, family, school communities, online viewers, and much more. Help learners find appropriate audiences and engage with those groups as the artifact takes shape.*
- *Use audience in assessment: It is crucial to examine how student artifacts perform "in the wild." Presenting work to authentic audiences and receiving their feedback is one of the few ways to make student work more legitimate.*
- ***Situational considerations include:***
  - *Appropriate audiences: Instructors should determine at the outset whether the audience*

- *should be closed (class-only) or open (public) audience. The choice of audience helps guide the constraints of a project.*
  - *Correlating audience to assessment: Consider the assessment environment. As class size increases, a more standardized assessment may be needed. Standardized measures can be provided to certain kinds of audiences to aid in assessment.*

4. Reframing teaching as mentorship

- *Distribute learning: Spread the onus of learning across the entire class community, including the teacher (mentor) as learner.*
- *Distribute teaching: Acknowledge and leverage the variations of learner interests as pedagogical opportunities. The class community should function as a distributed system; all members—instructors, mentors, and learners—should learn from each other and the tools they choose to use. In this model, more senior class members model the process of learning.*
- *Distribute assessment: Expand who assesses to include peers, audience, and mentor, and expand what is assessed to include learning process, products, and the instructional design.*
- ***Situational considerations include:***
  - *Dialogic, flexible design: Instruction and the design of it should not be rigid, top-down activities. As learners grow, create, and demand new resources, the design of instruction must adapt to meet their needs. Instructors should elicit ideas for these refinements from learners themselves.*
  - *Distribution in education: Instructors must reconcile the notion of distribution with their own institutional expectations. Note that even from a distributed perspective, teachers should retain a central role as planners and guides of activity.*

Implementation Issues

- ***Finding and accessing expertise**. The demand and need for production-oriented expertise may exceed the capability of an instructor to supply. External expert resources may be needed to fill the role of "more experienced other," or additional expertise may be developed within the learning community itself.*
- ***Access to resources.** Even with digital production-oriented project environments, necessary resources may be expensive to acquire and cumbersome to install and manage.*
- ***Issues of "time".** Learner-centered production is a lengthy process, so the breadth and depth of assigned projects must be carefully managed.*

– C.M.R., B.J.B., & R.D.M.

DESIGNING COLLABORATIVE PRODUCTION OF DIGITAL MEDIA

I. Introduction

A New Literacies Perspective on Instructional Design

In 2006, a group of learning theorists predicted an upcoming "decade of synergy" during which scholars would synthesize diverse learning research to transform the design of education (Bransford et al., 2006). This synergy is well underway, especially in the field of literacy learning: the New Literacy Studies (Gee, 2011; Lankshear & Knobel, 2007), recent scholarship concerning informal, digital cultures (Ito et al., 2010; Jenkins, Purushotma, Clinton, Weigel, & Robison, 2006), and "situative" developments in learning theory (Harel & Papert, 1991; Wenger, 1998) all describe becoming literate as involving production, community, and authenticity. From these perspectives, literacy means doing, becoming, and being, not just knowing. In this chapter, we take up Bransford et al.'s call for synthesis to describe a convergent "New Literacies" perspective (Lankshear & Knobel, 2011) on instructional design. In the following sections, we operationalize this perspective to assemble a New Literacies pedagogical framework intended to engage learners in collaborative, creative, interest-driven, and production-oriented digital media projects that enable them to become active participants within and beyond the classroom.

Two key ideas define the New Literacies perspective. First, literacy is reinterpreted as primarily a *sociocultural* phenomenon rather than as a psychological one. While sociocultural interpretations of literacy vary, all share a paradigmatic shift in reconceptualizing literacy from decoding and encoding text to a set of productive, consumptive, and negotiative meaning-making practices mediated by social, cultural, and material contexts; literacies are inherently multimodal, technology-dependent, always ideological, and wrapped-up in social identities (Gee, 2003a, 2011; Lankshear & Knobel, 2006, 2011; Street 2003). A sociocultural perspective does not deny that reading and writing text represent one type of literacy practice, but it does argue that there exist multiple, equally valid others (Cazden et al., 1996), pushing educators beyond traditional understandings of literacy by encouraging them to consider what counts as literacy, how and why it is practiced, and for whom.

These questions give rise to the second key idea: A New Literacies perspective focuses on the ontological shift that occurs as *digital technologies* reshape how and what people learn as they participate in literacy practices (Lankshear & Knobel, 2007). Central to this position is the understanding that digital media technologies afford new ways to make meaning and, therefore, empower people. Anyone with a computer and Internet access may participate in communities as both a consumer and producer of meaning and share these creations with an audience to effect change (Jenkins et al., 2006; Lankshear & Knobel, 2011). Scholars Doug Thomas and John Seely Brown (2011) characterize this transformation as a cultural reawakening, going so far as to apply the label "the new culture of learning."*

Other scholars offer similar characterizations of this new form of making and doing literacy. While labeled differently—"participatory culture," "affinity spaces," "passion communities," "interest-driven networks"—all present a situative, sociocultural interpretation of how people increasingly use digital technology to 1) form informal communities around a shared interest or domain; 2) learn to legitimately participate in its practices; and 3) produce and share artifacts meaningful to that community and beyond (Halverson, 2012). *What* people learn by participating in these communities remains an unsettled question; nonetheless, the common characterization does indicate that these communities thrive upon innovation in tools, meanings, and ways-of-knowing, and favor distributive, emergent, and egalitarian methods for achieving goals (e.g. Jenkins et al., 2006). In the following discussion, we operationalize this characterization of New Literacies to construct a learner-centered instructional design framework intended to address the changing social, cultural, and technological realities of literacy and learning in the 21st century; we call this framework a New Literacies Pedagogy (NLP).

Theoretical Foundations of NLP

Issues of equity, critical awareness, and relevance

Three changing realities linked to literacy and learning make NLP immediately pertinent, if not necessary for the redesign of education. Drawing upon Jenkins et al.'s (2006) seminal work in this area, these three are best described as problems of equity, critical awareness, and relevance.

The equity problem. Since the mid-1990s scholars have been arguing that if youth are to realize successful 21st century futures, they must find opportunities to legitimately participate in New Literacies practices (Cazden et al., 1996; Drotner, 2008). This is no less true today. Youth themselves have become quite aware of this reality; their participation in informal digital learning communities continues to grow (Ito et al., 2010; Peppler, 2013). Yet, even if we assume that many youth have the opportunity to participate in digital communities, it is certain that not *all* do (Jenkins et al., 2006). How can educators ensure that all youth have these opportunities?

The critical awareness problem. Even for those youth who do participate in online communities, it is not clear that they develop the critical competencies necessary to navigate today's convergent media landscape or that they are able to articulate what they have learned (Kafai & Peppler, 2011). This can be construed as a lack of *access*, not to technology, but to understanding, what Jenkins et al. (2006) refer to as "the participation gap". How might educators frame participation in digital literacy practices in ways that inspire critical dispositions?

The relevance problem. It is clear that 21st-century learners turn to informal, digital communities because such communities are relevant in ways that formal schooling, currently designed, is not. That is, not only do digital communities offer youth opportunities to learn new literacies, but they also allow for interest-driven learning and self expression, encourage collaboration, instill acceptance of diversity and subjectivity, and develop technical, critical, and social skills valued in contemporary home and work environments (Peppler, 2013). Most importantly, they empower people to be active participants in creating their own futures (Cazden et al., 1996; Cope & Kalantzis, 2000). Simply, learners now demand more customization, voice, and practicality from learning arrangements, and can find it almost exclusively outside of formal, designed education. How might educators adapt their learning environments to meet these demands?

NLP addresses these challenges by proposing a design methodology that dovetails features of informal, digital learning culture with the affordances of formal learning spaces. Sociocultural literacy interventions often address equity issues through critical approaches to reading and writing texts. NLP takes up this agenda and operationalizes it through the lens of digital culture. To that end we offer a systematic design composed of four thematic categories: 1) a production-oriented approach to learning, 2) the importance of critique and reflection, 3) the presence of an authentic audience for work, and 4) reframing teaching as mentorship.

Connecting situative-sociocultural and constructionist theories

NLP synthesizes two related theoretical traditions – constructionist and situative-sociocultural theories of learning. While each theory begins with differing epistemological positions and units of analysis, both lead to similar instructional design choices (Barab & Duffy, 2000; Hannafin, Hannafin, Land, & Oliver, 1997). The combination of these learning theories provides purchase to conceptualize and design for the symbiotic relationship between learners and environments.

Constructionist theorists assert that learning happens when we create artifacts in the real world. Only through making something work can we truly understand and demonstrate our understanding of complex processes. Seymour Papert's (1980, 1996) curiosity to uncover *the art of learning* drove his conception of the theory of constructionism. At the heart of this theory is construction, both of knowledge and of artifacts. In essence, constructionism argues for the existence of a unique, interdependent relationship between personally meaningful external artifacts and knowledge-in-the-head; both interpret and reinterpret each other (Kafai & Resnick, 1996). Created artifacts—or "objects-to-think-with," as Papert describes them—sit at the "intersection of cultural presence, embedded knowledge, and the possibility for personal identification" (Papert, 1980, p. 11). Learning happens when one "makes" rather than "gets" both knowledge and artifacts (Kafai & Resnick, 1996).

Fundamental to constructionism is the idea that learning does not occur in a void (Papert, 1980; Kafai, 2006); *contexts* play a crucial role. Situative-sociocultural theories expand upon this insight by focusing analysis upon the distribution of cognition across complex systems (Gee, 2010; Greeno, Collins & Resnick, 1996; Pea, 1997). This collection of theories generally characterizes learning as an interdependent process of legitimate participation in the practices of a community, which often involves the creation of meaningful artifacts (Lave & Wenger, 1991; Wenger, 2010). Learning, situative-sociocultural scholars argue, is a social process of enculturation and becoming (Brown, Collins, & Duguid, 1989; Wenger, 1998).

We believe situative-sociocultural and constructionist theories of learning complement each other

(Cobb, 1994). Whereas constructionism underscores the relationship between the learner and their artifact, the situative-sociocultural perspective focuses upon the contexts that mediate learners' knowledge construction. Balancing these two theoretical emphases proves indispensable to our NLP, through which we seek to design for how individuals learn to participate in established practices of communities where such participation entails the negotiation, redesign, and sharing of appropriated and recontextualized representations of meaning (Thomas & Brown, 2011).

Learner-centered design: Authenticity and the New Ethos[*]

A New Literacies Pedagogy requires both a paradigmatic and an ontological shift toward learner-centered design. In broad terms, it is a transition from "teaching about the world" to "engagement within the world" (Brown & Adler, 2008; Scardamalia & Bereiter, 1994, 2006). This entails a recalibration of design focus away from individuals, content, and skills toward communities, cultures, and practices (Wenger, 1998). Two value-laden implications become immediately apparent.

First, NLP encourages educators to strive for *authenticity* of learning activities (Brown, Collins & Duguid, 1989): When learning, being and doing are inseparable from context, it makes the most sense to design learning activities that interact with real-world cultures, communities, and practices. By "authenticity" we might mean any one of the following:

- tasks that are personally meaningful;
- tasks that honor disciplinary and/or professional practices;
- tasks that can be assessed within the context of the production and learning process;
- tasks that connect to practices in the real world either through legitimate communities of practices or in simulated scenarios (Hay & Barab, 2001; Shaffer & Resnick, 1999).

Scholars and designers who value "thick authenticity" (Shaffer & Resnick, 1999) argue for the inclusion of all of these forms in the creation of production-oriented learning tasks. Clearly there are trade-offs associated with each of these approaches, and design methods are likely to vary based upon conditions such as the expertise of learners, access to out-of-school communities, and the nature of practices to be learned.

Second, the sociocultural foundations of NLP compel educators to account for and to incorporate the ideology that pervades the new culture of learning. To that end, scholars define this ideology as the *New Ethos*: a worldview that is more inclusive, more participatory, more sensitive to multiplicity and diversity, and more egalitarian (Lankshear & Knobel, 2011; Chávez, & Soep, 2005). Above all else, the New Ethos *embraces change* (Thomas & Brown, 2011). While such a view may paint too positive a picture of digital culture as a whole, we find agreement in the way it problematizes traditional, stable, and hierarchical educational arrangements. We aim to take seriously the ethos of democratic engagement through new literacies practices, and we have seen that this ethos inspires a more learner-centered design.

TABLE 7.1 Values of NLP Design

Values	*Description*
Authenticity	A quality of learning activity marked by legitimate participation, simulated practice, or personal meaning.
The New Ethos	An ideology inherent to participatory culture that tends toward "bootstrapping," distribution, egalitarianism, diversity, and multiplicity.
Learner-Center Design	An instructional design perspective that emphasizes learning systems rather than individual learners, content, or instruction.

Indeed, these values inform our interpretation of the "learner-centered" construct. We believe that learner-centered designs should privilege neither the environment, nor the curriculum, nor the student. Instead, a learner-centered design focuses upon a complex system of authentic and legitimate learning activity (for a similar perspective, see Moss, 2008; Rogoff, 2008; Rogoff et al., 2007). Thus in this chapter, we offer an instructional framework that places learners on an equal footing with their environment. Such designs should empower learners by asking them to transform their environment, both within the classroom and beyond (Pea, 1997; Scardamalia & Bereiter, 2006). In order to do so, learners must also develop the competency to adapt to and move amongst the contexts and standards within which their activities reside. Table 7.1 summarizes the value system embedded within NLP design.

III and IV. Universal and Situational Principles of NLP

From a situative perspective, instructional strategies inevitably vary based upon context. Yet, we also believe that NLP intimates themes that cut across all conditions. To that end, we explicate four broad categories of principles with some attention to situational caveats.[*]

1. A Production-Oriented Approach to Learning

NLP empowers learners to be producers and designers of meaningful digital media. To do this, we have focused on designing a learning environment that supports the relationship between the learner, the external artifact they create, and the community within which they do so. We call this a production-oriented approach to learning and propose three universal ideas to realize it: 1) facilitate learners' productive relationship with artifacts, 2) develop learners' identities as designers, and 3) encourage collaboration among learners within a media-rich environment through a workshop-style instructional environment.

Develop learner–artifact relationships

Foremost, if learners are to produce digital media, then the instructional design must facilitate the development of learner–artifact relationships. This entails two instructional strategies. First, instructors guide learners to create something both *personally meaningful* and *innovative*. Instructional goals should allow learners the freedom and choice to create an external artifact of personal interest and value (Harel & Papert, 1990), while simultaneously pushing them to use and repurpose existing cultural resources (Lankshear & Knobel, 2011). Personal interest can originate with the content (e.g., I want to tell the story of my first year at high school), the format (e.g., I would like to create a video remix), or both. The aim is twofold: give learners agency and ownership over their artifact and connect it with broader contexts. In this way, learners create contextualized artifacts that speak both to self and to community.

The second relationship-building strategy is more practical: instructors should provide adequate *tools* and *time* for learners to deepen their relationship with the object they are making. Many of these tools may be low tech, what Papert (1980) calls "objects-to-think-with," that concretize learners' abstract project ideas. In a game design project for example, instructors can create or source scaffolded index cards to support cycles of paper prototyping. This allows learners to construct and refine ideas with minimal investments of technical effort. In terms of time, instructors must prepare for the naturally iterative "debugging" (Papert, 1980) process that happens when learners make things. Debugging can take different forms; it becomes most apparent as students transition from paper-prototyping to digital production. During this phase, instructors must aid learners through their debugging frustrations by persistently encouraging them to test, refine, and share their ideas.

Support identities as designers

In a production-oriented approach, educators must also develop learners' identities as designers. By "design identities," we mean that learners appropriate the conceptual tools and discourses necessary to build a relationship with both their artifact and communities of designers; this entails two basic strategies. First, encourage learners to think and talk about their artifact like designers by modeling discourse around a *grammar of design* (Cazden et al., 1996). A design grammar refers to the tools and means of communication that are authentic to a given genre, providing learners with the concepts and terminology necessary to articulate their individual design goals and ideas. Making a radio documentary, for example, requires knowledge about audio capture and editing tools, narrative reporting, music and other sound effects, and how people who make radio use these tools to effectively communicate ideas using only sound. Second, situate learners within a community of designers who are motivated by participation in authentic practices. Learners need to see that they are not working in a vacuum and need opportunities to share victories and challenges with others working on similar problems. Not only is it vital to leave room for personal drive and interest to mature, but also to engage learners in design practices that connect to out-of-class communities (Barab & Duffy, 2000; Hay & Barab, 2001). When the design goal is both internally *and* externally valuable, learners tend to adopt the language and practice of design, supporting their identities as designers.

Remake class into a workshop

Last, a production-oriented approach to learning converts "class" into a workshop-style format where learners engage in a collaborative production process through which they may pursue their own individual projects, yet work together toward the same "umbrella goal" (Harel & Papert, 1991).[*] In this space, even if learners do not appear to be working together directly, they are engaging in "collaboration through the air", a process of indirectly "picking up" and "trying out" others' ideas, and "dropping" the ones that do not work (Harel & Papert, 1991). Likewise, encouraging informal and spontaneous conversation among learners is just as important as ensuring the community has the proper tools. Make technology and example projects available (e.g., in eyesight) in the space; ideally, instructors should select a collection of technologies based upon 1) their use by real-world communities and 2) their ability to support multimodal, "convergent" representations (Kafai, Peppler, & Chapman, 2011). Table 7.2 summarizes the principles involved in a production-oriented approach to learning.

Situational considerations

When taking a production-oriented approach to learning, a few key situational considerations emerge: assessing artifact quality, distributing technological expertise across learners, and aligning time constraints to specific creative production processes. First, since assessment is a necessary component of formal learning environments, measures of quality must be designed. These measures are situated in the context of *the genre* for production (i.e., what makes a "good" documentary is different from what makes a "good" mash-up), *historical time* of production (sitcoms in 2013 look substantively different from sitcoms in 1962), and *for whom* the product is intended (an audience of peers will receive a piece differently from an audience of outsiders) (Halverson et al., 2012). These aspects must be considered as instructors develop product assessment measures. Particularly, we suggest that instructors either craft a measure of quality *a priori* that is grounded in "what counts" as good within a specific genre[*] or take a collaborative assessment approach by measuring quality according to the class's self-defined goals.[**]

TABLE 7.2 Universal Principles of a Production-Oriented Approach to Learning

Universal Principles	*Description*
Develop learner–artifact relationships	Instruction should encourage learners to create personally meaningful artifacts and provides the appropriate tools and time for production to occur.
Support identities as designers	Instruction should embed learners within a community of designers, providing opportunities to learn and adopt authentic discourse through situated practice.
Remake class into a workshop	"Class" should become a productive environment where learners proximally or distally collaborate to design digital media.

Second, our approach to production requires a distributed, just-in-time orientation[***] toward technologies (Gee, 2003a; Halverson, 2012). As a result, the choice of technological tools (both software and hardware) depends upon the type of project, rather than the other way around. Students learn to use tools as needed, and instructors should plan for students to acquire technological expertise as *part of the production process*, rather than as a separate set of skills. This means that individual project choice may lead a learner to tools that instructors had not anticipated. An important situational understanding is that not all students will learn the same tools at the same time or with equivalent mastery. Instead, expect for technological expertise to be distributed across the community. In preparation for such distributed variations of technology use, instructors should reserve local technological resources, encourage students to share their technological expertise with others, and support and serve students in a just-in-time manner rather than making all decisions about which technologies to teach and use *a priori*.

TABLE 7.3 Situational Considerations of a Production-Oriented Approach to Learning

Universal Principles	*Description*
Develop learner–artifact relationships	Instruction should encourage learners to create personally meaningful artifacts and provides the appropriate tools and time for production to occur.
Support identities as designers	Instruction should embed learners within a community of designers, providing opportunities to learn and adopt authentic discourse through situated practice.
Remake class into a workshop	"Class" should become a productive environment where learners proximally or distally collaborate to design digital media.

While new technologies have made productive work both more accessible and efficient, any time "saved" by utilizing these technologies typically gets redistributed to creative pursuits. For example, video production software expedites aspects of the editing process—learners no longer need to develop, physically cut, and replace film. Yet, as learners spend less time engaged in the "dirty work" of editing, they are afforded opportunities to creatively play with various editing possibilities. In both instances, creative projects require large investments of time. Instructional designers must consider the time allotted for these projects based upon the expectations for production, the quantity and/or duration of media to be produced, and the level of communal expertise. For example, projects expecting high levels of production, more in-depth media products, or a high level of communal expertise will require more time to reap the benefits of learning that a production-oriented approach offers. Instructors may want to "scope" project choice in advance and create clear time and depth parameters for students in order to make finishing projects manageable within the course of class time and some out-of-class work.[*] Table 7.3 summarizes the situational considerations involved in a production-oriented approach to learning.

2. The Importance of Critique and Reflection

Production-oriented activities are a powerful method for learning; yet, on their own they have the potential to provoke narrow, "producer-like" outcomes (Gee, 2003b). NLP aims to engender a *critical awareness* by encouraging meta-cognition in ways that may not emerge naturally through the production process. A critical vantage enables students to move amongst different communities, refine designs, and ultimately improve and innovate practice (Kress, 2000; Kafai & Peppler, 2011). To reach this goal, we use activities of critique and reflection as a "balance" to interest-driven productive activities. In this section, we provide three strategies to realize such activities in a meaningful way.

Practice critique and reflection[*]

First, critique and reflection must be a routine practice of the learning community. By *critique* we do not mean criticism; rather we refer to arts-based pedagogies seen in visual arts classrooms (Hetland, Winner, Veenema, & Sheridan, 2013) and out-of-school arts organizations (Soep, 2006), as well as in emergent discourse commonly found in online digital production communities (Ito et al., 2010). Critique is a method for moving work forward through group dialogue and reflection. A meaningful critique sees learners incorporate conceptual resources as they converse with their peers about their own products, and those products' relation to other students' work and to outside audiences.

As students create artifacts, instruction provides both scheduled and informal opportunities to engage in critique. This means that instructors both assign specific time for critique and allow students to set aside productive activities to engage in constructive dialogue at will. Scheduled critique should be included at a variety of scales including informal peer discussion, within-group critique sessions (see, for example Soep, 2006, for a description of how small groups engage in critique during the production process), and whole class discussions where groups present their piece in process and the group responds to the work by describing their personal responses to the work. Critique sessions from outside experts are also useful, when available in the form of guest artists, former student participants, and colleagues. The combination of these dialogic activities strengthens the class community and affords students a regular opportunity to take on, experiment with, and refine design discourse.

Keep design journals

Second, instructors should assign *design journals*. While journaling is not a routine practice of digital communities, it has a history of use in literacy and design pedagogy (e.g. Puntambekar & Kolodner, 2005). Design journals prompt learners to routinely reflect upon the *products* and *processes* of their learning. Product-oriented entries develop the relationship between the learner and the object of their production so that learners can refine their representations and relate these refinements to critique and context. Ideally, product-oriented entries speak to two scales. First, learners address the progressive refinement of their product itself, analyzing the development of the relationship between content, form, technology, and function over multiple iterations. We expand upon this idea in the next point where we discuss *meta-representational competence*. Second, product-oriented entries ask learners to explore how their works draw upon, interact with, and transform available cultural resources.

Process-oriented entries prompt learners to transition from a preoccupation with the objects of their production toward conceptualizing their increasingly legitimate participation as representative of meaningful learning (Collins, 2006). They assist learners in making the development of their thinking "visible" and "intentional" (Collins, Brown & Newman, 1989; Puntambekar & Kolodner, 2005; Scardamalia & Bereiter, 2006). Good process entries are introspective in nature, demonstrating a learner's progressively reflexive, situated awareness of their activity over time. Instructors should not be discouraged by initial "superficiality." Learners may not have previously encountered such reflexive exercises; thus, instructors can expect these entries to drastically transform over the duration of a course. Part of this transformation entails a growing willingness on the part of learners to disclose *failures* as opportunities for redesign and learning. Because honest reflection upon testing, failure, and refinement are atypical of schooling, modeling by more experienced class members during scheduled discussion sessions is essential for engendering this willingness. By the end of a course, these journal entries become valuable data for longitudinal assessment, representing a partial trajectory of an individual's learning.

Aim for meta-representational competence

Third, use *theoretical resources* to develop *meta-representational competence* (MRC). By "theoretical resources" we mean course readings and instructor-created support materials, as well as guest lectures from experts when possible. Specifically, these resources should cover design and learning theories in order to provide students the analytic frame to support their production, journal reflections, and critique activities. Instructors should include theory in at least two ways: First, arrange regular class discussions about a text or material itself; this means that students are expected to read outside of class and are prepared to discuss it. Second, theory should form the conceptual foundation for scheduled critique sessions.

We have found that theoretical resources assist in the development of students' MRC. MRC is the ability to use representational tools, to reflect on which tools should be used, and to understand how the interaction between tool and meaning work toward a purpose (diSessa & Sherin, 2000; Halverson, 2013). For example, a student should both be able to edit a video using software and be able to articulate their use of editing choices (quick cuts, introduction of new music, slow motion, etc.) in order to convey specific meanings in relation to context and audience. In this instance, theoretical materials concerning film production would provide the conceptual frame. Students demonstrate MRC as they articulate how their vision aligns with the affordances of the technology in use and guides their technological choices towards tools that support the representation of their intended meaning. MRC assists in engendering the critical awareness necessary to navigate digital "convergent culture" (Jenkins, 2006; Kafai & Peppler, 2011) and is a useful measure for learning in art (Halverson, 2013), math (Enyedy, 2005) and science (diSessa & Sherin, 2000). Table 7.4 summarizes the key principles involved in critique and reflection.

Situational considerations

In our experience, learners tend to favor production-oriented activities over those of critique and reflection. We believe this indicates not a flaw in NLP, but rather raw excitement to create. That excitement needs always to be nurtured. While robust critique and reflection are necessary learning catalysts, they are also time-consuming activities; we acknowledge that on some days learners simply need time to work together, especially as project deadlines near. We do not recommend eschewing critique altogether during these phases; instead, we suggest that once trust has been established among the community, it may be possible to offload some critique into an asynchronous, online space. However, be aware that face-to-face interactions often prompt spontaneous conversation in ways difficult to emulate in online interactions. We leave it to individual educators to decide the frequency of in-class and online critique and reflection based upon approaching deadlines, project scope and learner acumen.

TABLE 7.4 Principles of Critique and Reflection

Universal Principles	*Description*
Practice critique and reflection	Critique and reflection should be routine activities of learning and design. Offer regularly scheduled critique and reflection sessions. Also encourage spontaneous critique and reflection at opportune situations.
Keep design journals	Require that students keep and submit logs of their design and learning activity. These logs should typically take the form of written journals. However, they can take a variety of forms, including blogs, audio journals, video diaries, or a combination of these modalities.
Develop meta-representational competence	Use course readings and discussions to develop *meta-representational competence*. MRC is the ability to use representational tools, to reflect on which tools should be used, and to understand how the interaction between tool and meaning work toward a purpose (diSessa & Sherin, 2000; Halverson, 2013).

TABLE 7.5 Situational Considerations of Critique and Reflection

Situational Considerations	*Description*
Frequency of critique	Instructors must keep a pulse on learning throughout projects in order to balancing critique and reflection with production. At times it may be necessary to offload critique to online forums as project deadlines near.
Managing failure	Learners may not always meet the expectations or deadlines set by instructors. In these instances of "failure," instructors have two situational alternatives to keep learners engaged and motivated: offer them more time to finish the project or allow them to explain how their projects meet or do not meet goals.

How instructors manage "failure" also becomes a situational task. Given that students are taking risks, producing unfamiliar artifacts, *and* working toward a situated understanding of their activity, it is possible that they "fail." We put "fail" in quotation marks because typically, failure is constructed as not learning or not meeting learning objectives. We construct failure as a legitimate part of the learning process that instructors can capitalize on in their work with students. In NLP, instructors always need to help learners work through failure. Yet, it remains a situational consideration because, when failure arises, instructors have two circumstantial options. In our experience, it is not uncommon for students to express a latent revelation only a few days before a project deadline and request more time to rectify their work.

We want to emphasize that if learners openly acknowledge their previous "failure" and ask for time for improvement, this is necessarily a "success." In this circumstance, 1) instructors can allow students to articulate why their piece does not meet the goals of the genre (as well as the ways it does) and to reflect on what they would do differently; this is MRC in action and is a logical choice when time constraints disallow extending project deadlines;[*] and 2) if the situation allows for a deadline extension (e.g., it is the middle rather than end of a term or semester), instructors can give learners more time to complete the project in a way that fits the genre and therefore the goals. If extensions are an option, all students in the course must understand that learning processes are developmental and that more time does not indicate special consideration, but rather the chance for this project to complete another iteration. Table 7.5 summarizes the situational considerations involved in critique and reflection.

3. The Presence of an Authentic Audience for Work

As we've emphasized, NLP enrolls learners as legitimate community members who engage in authentic New Literacies practices. From a situative-sociocultural position, legitimate membership requires increasingly central and proficient participation (Lave & Wenger, 1991). In New Literacies, centrality and proficiency are typically demonstrated by sharing digital artifacts not only with close peers, but also with broader audiences. Accordingly, NLP asks learners to consider audience throughout the creative process and share their work with colleagues and the public at large (Halverson, 2012; Lankshear & Knobel, 2011).

Consider audience from the outset

It is important to recognize that audience plays a generative role throughout production, critique, and reflection activities, not just at the end of a process when an artifact is ready to be shared (Magnifico, 2010). Consequently, designers must identify target audiences from the outset and engage with these groups throughout the process. Critique and reflection can be used to guide learners to consider audience at multiple scales, including their classmates, out-of-class peers, the university or school community, and potential online viewerships. In this way, audience comes to partially motivate the work; production decisions are made as a result of who the audience is (and will be) and what this audience understands about the content and genre of the work.

Find audiences

Since audience plays such an influential role throughout production, finding the appropriate audience is imperative to supporting learners' design processes. Beyond sharing with peers in critique and reflection, instructors can also create public sharing opportunities within the context of the course. These may include "poster session final exams" with invited experts or "gallery days" with invited peers, friends and/or family. In these cases, learners can be required to bring peers to an assessment project as part of their participation in the course.

Furthermore, because NLP aims, in part, for a participatory model of authenticity (Hay & Barab, 2001), instructors should find legitimate ways for students to engage with broader publics as a core part of the course experience. Some of these opportunities could include: 1) in-school/on-campus opportunities (e.g., campus-wide symposia or presentation opportunities); 2) out-of-school/off-campus opportunities (e.g., Maker Faires or digital video competitions); 3) public opportunities (e.g., a YouTube channel or social media outlets); 4) collaborations with other organizations locally (e.g., public libraries) and nationally (e.g., YOUMedia). We believe that it is the instructor's responsibility to seek out opportunities to interact with legitimate audiences as a normal part of learning activity.

Use audience in assessment

TABLE 7.6 The Principles of Engaging Audience in NLP

Universal Principles	*Description*
Consider audience from the outset	Audience plays a generative role throughout the creative process. Instruction should ask learners to identify potential audiences from the outset of their work.
Find audiences	Appropriate audiences might include invited peers, friends, family, school communities, online viewers, media competitions, Maker Fairs, or even public outlets such as YouTube. Help learners find appropriate audiences and engage with these groups as the artifact takes shape.
Audience and assessment	Audiences should play a role in assessment. It is crucial to examine how student artifacts perform "in the wild." While placing student work "in harm's way" and using the results for assessment may disrupt the "safety of the classroom," presenting work to authentic audiences is one of the few ways to make student work more legitimate.

Considering audience throughout the production process includes distributing assessment to the audience. Instructors should include audience members as co-participants in the assessment process by examining how student productions perform "in the wild." Instructors can provide audiences with rubrics to help guide their evaluation, if there exist specific outcomes that need to be addressed with the work. For example, if students are expected to create a narrative for audiences, instructors can ask audiences to respond to the narrative they experienced. Audience feedback can also be solicited without *a priori* structure as a way to determine what they take from the experience. If students create short films, an open film festival can be followed by a question-answer session with the audience as a way to hear audience reactions. Or films can be posted on a public or semi-public site and audiences can respond asynchronously through comment features on the site. The degree of expertise of the audience will, in large part, determine the degree to which audiences may need the feedback process scaffolded for them. Table 7.6 describes the role of audience in NLP.

Situational considerations

Selecting an appropriate audience and the role audience plays in assessment are both dependent on the circumstantial purposes of the task. As we have made clear, designing for audience is always a situational undertaking since audience should align with the goals and constraints of the task. Because representational decisions and critique depend on whom the group determines will ultimately receive the work, instructors should decide at the outset whether the audience is closed (class-only) or open (public) audience. Additionally, the choice of audience helps guide the constraints of a project; for example, if a class will participate in a public digital video competition, learners need ample time to achieve competitive product quality. In our experience, introducing or changing the audience partway through a project has disrupted the design process. Therefore, instructors should consider audience throughout and take seriously the notion that work will be viewed by outsiders.

TABLE 7.7 Situational Considerations in the Use of Audience for NLP

Situational Considerations	Description
Appropriate audiences	Instructors should determine at the outset whether the audience should be closed (class-only) or open (public) audience. The choice of audience helps guide the constraints of a project.
Correlating audience to assessment	Consider the assessment environment. As class size increases, a more standardized assessment may be needed. Standardized measures can be provided to certain kinds of audiences to aid in assessment.

Moreover, instructors should consider the assessment environment in which they work. Again, the relationship between traditional classroom assessment and external audience assessment will be determined by the situational purposes of the task. For large classes with many sections, a more standardized assessment may be needed. For smaller courses, a more externally-driven assessment design may be appropriate. A more standardized assessment could take the form of a rubric that audience members will use to offer feedback on students' final projects, while a more externally-driven assessment could be constructed in the context of a sharing opportunity such as a film festival or a planned audience event. Table 7.7 summarizes the situational considerations involved in the use of audience for NLP.

4. Reframing Teaching as Mentorship

In NLP, we reframe teaching as *mentorship* in order to address how the roles and responsibilities of the "teacher" and "student" must transform in ways that reflect distributed learning relationships in digital culture. To define this notion, we draw upon Kafai, Peppler, and Chapman's (2009) perspective of mentorship that expands upon "top-down" teacher models to include "more equitable, constructionist and learner roles" (p. 90).[*] This vantage significantly blurs the boundary between teacher and learner. Specifically, we see mentorship as extending theories of distributed cognition and intelligence (Salomon, 1997) to practices of teaching, learning, and assessment. While the notion of "distribution" necessarily interferes with our typically siloed understanding of teaching, learning, and assessment, we still find it helpful to frame the universal principles using those three familiar categories.

Distribute learning

NLP distributes learning by joining all community members as partners in production, sharing, and critique activities. In this way, we reframe teachers as mentors, for they not only provide explicit scaffolding and goals for students when appropriate, but also *collaborate with* and *learn from* students throughout the production of digital artifacts. This type of mentorship requires both a practical and attitudinal shift. At face value, mentors partake in the same learning practices—they create digital media, share what they have made, and contribute to critique sessions—but do so in a way that makes explicit the learning process. For example, a mentor could articulate a solution to a pervasive design problem, explain the strategy used to realize it, and hear alternative solutions from students who may have solved the same problem in a different way.

Because mentors are, quite literally, part of the learning community, they must also express an open attitude toward learning. This open attitude carries two crucial implications. First, mentors may well have to learn new technologies and techniques alongside students. In fact, it is common for learners to request novel technologies for class use; a mentor explores these possibilities, learns how to use new technologies with learners, and changes the instructional design accordingly. Second, mentors cannot expect all learners to learn the same things, at the same time, and from the "top-down." Learners must be allowed to produce customized projects, master new technologies, and develop new discourses and ways-of-knowing. In this way, it becomes entirely reasonable that learners might surpass the official teacher in certain areas of expertise. A mentor leverages distributed learner interests as learning opportunities by eliciting instructional dialogue from these budding experts. Such a distributed, open attitude aligns with digital culture and strengthens the community: mentors model appropriate ways to work, interact, *and learn*; what's more, when mentors learn from their mentees, learners themselves begin to view their activity as legitimately contributing to the community.

Distribute teaching

In NLP, one cannot distribute learning without also distributing teaching. In broad terms, this means that mentorship stretches across the learning environment. The idea contains both obvious and subtle strategies. Most plainly, instructors should enroll more advanced learners to mentor peers on targeted tasks (Brown et al., 1993). Peer mentors, because they are engaged in similar production activities, are often able to situate design problems and solutions within the appropriate conceptual frame (Collins et al., 1989). Moreover, peer mentors demonstrate the *process of learning* to solve design problems; they, like teacher-mentors, become models for "learning how to learn" (Brown et al. 1993; Brown & Campione, 1996). More subtly, the distribution of teaching stretches across tools as well as people (Pea, 1997). There are times when no one in the room knows the answer to a question. Learners are encouraged to use technological resources including open source materials such as YouTube and Khan Academy, as well as more specific communities such as Google groups and listservs that focus on solving problems of practice.

We acknowledge the difficulty of designing these types of informal peer mentoring relationships, especially when students are allowed to follow individual interest (rather than being assigned to work in teams). Instead, we argue that if instructors have executed other NLP strategies, distributed teaching tends to occur naturally. When instructors notice it, they must encourage it by either asking learners to help others or by requesting that they share their learning process with the class.

Distribute assessment

Our construct of mentorship impacts methods of assessment. A distributed view of assessment pushes educators to reconsider both who does the assessing and the assessed object. When learners are collaborators, instructors should afford learners the opportunity to provide feedback on the contributions of their peers. This type of peer assessment can take a variety of forms; we find that learners provide the most useful responses when their evaluations are confidentially created and stored. We suggest that instructors generate formal documents that students complete and submit electronically outside of class. Further, when instructors factor peer evaluation into the assessment of participation, learners begin to view peer mentoring as part of legitimate learning activity rather than as an unfair aid to those who have "fallen behind."

Likewise, distributed mentorship also widens the focus of assessment: when mentors are also learners, the instructional design itself must be open to evaluation. It is incumbent upon instructors to ask learners if the instructional design has met their needs, and, if not, what might be done to improve it. Taken together these two ideas intimate that instructional designs cannot be static frameworks, but rather "reflective practicums" (Brown & Adler, 2008). Table 7.8 describes the principles involved in reframing teaching as mentorship.

Situational considerations

It is clear that a distributed notion of mentorship complicates the instructional design process. Whereas "instructional design" often implies professionally *planned* learning activity, the distributed perspective of NLP—a perspective common in digital culture—disrupts the idea that instruction *and the design of it* can be rigid, top-down activities.[*] As learners create, reflect, critique and share, the instructional design process necessarily transforms. Indeed, opening the designs to change, learning from student activity, and empowering learners to shape the instructional framework become integral to nurturing a learner-centered digital design community where peer mentorship is the norm rather than an exception (Brown & Adler, 2008). Indeed, we proudly admit that some of the instructional ideas in this chapter came about through discussions with our students. It is crucial for instructors to elicit learners' suggestions for refinements to the instructional design and incorporate them situationally.

TABLE 7.8 Principles for Reframing Teaching as Mentorship

Universal Principles	*Description*
Distribute learning	Spread the onus of learning across the entire class community. In this model, more senior class members model the process of learning.
Distribute teaching	Acknowledge and leverage the variations of learner interests as pedagogical opportunities. The class community should function as a distributed system; all members—instructors, mentors, and learners—should learn from each other and the tools they choose to use.
Distribute assessment	Expand the objects of assessment to include peer review, audience reactions, mentor notes, and learners' feedback about the instructional design.

The idea that people naturally learn from each other in a more distributed fashion is not a revolutionary concept; nonetheless, it has been largely ignored in the design of formal classroom settings (Thomas & Brown, 2011).** There seems to be a mismatch between the framework of distributed instruction, learning, and assessment and ideals of what formal education ought to look like. It is important to acknowledge that the instructor still serves a function in this model, that s/he is likely the most expert in course content and pedagogical strategies. These contributions become more apparent when the instructor orchestrates the classroom environment and interactions among members. Giving just-in-time lectures on specific topics, structuring critique sessions, and designing rubrics for feedback are some of the ways that learners can feel confident that the instructor is still steering the ship.***

The same might be said of more experienced, though less tech-savvy mentors: older students who may not be technical experts can still very well co-participate with learners in "cognitive apprenticeships" (Collins et al., 1989); that is, while some learners may have technical expertise, it is likely the case that they still require help understanding how to engage in critical inquiry and reflection. The job of the more experienced, though less tech-savvy class community members is to arrange opportunities for interaction that privilege what every individual brings to the table in the construction of digital artifacts. Table 7.9 summarizes the situational considerations in reframing teaching as mentorship.

TABLE 7.9 Situational Considerations Involved in Reframing Teaching as Mentorship

Situational Considerations	*Description*
Dialogic, flexible design	The idea that instruction and the design of it can not be rigid, top-down activities. As learners grow, create, and demand new resources, the design of instruction must adapt to meet their needs. Instructors should elicit ideas for these refinements from learners themselves.
Distribution in education	Instructors must reconcile the notion of distribution with their own institutional expectations. Note that even from a distributed perspective, teachers retain a central role as planners and guides of activity.

V. Common Implementation Issues

Many current examples of NLP in action come from out-of-school learning settings (e.g., Chávez & Soep, 2005; Kafai et al., 2009; Clark & Sheridan, 2010). In our design process, we drew upon insights from how participants use digital media and technology to learn in these informal settings rather than using formal education models to inform the design of informal learning spaces. Learning from informal settings requires a shift in the way we understand the function of technology in instruction; instead of using technology to fulfill already existing academic goals, we challenge educators to imagine how they might use technology to reinvigorate educational arrangements. This is not to say we want to pull informal learning activities, arrangements, and communities directly into formal learning settings—we already know that this approach is problematic for students (Ito et al., 2010). Rather, we look to the ethos of informal, digital cultures to inform the design of NLP-based formal learning environments. In meeting this challenge, educators must contend with a variety of implementation issues.

Finding and Accessing Expertise

Inevitably, when students engage in digital production and share their work with audiences, access to domain-area expertise becomes a primary concern. When asking students to engage in authentic production tasks, students will want to have access to people who participate in this form of production in the normal course of their lives. This creates a potential gap between what instructors know, can do, and practice, and what students want from teachers and mentors. Informal learning settings often address this disconnect by involving artists-in-residence as part of the production process. These more experienced others serve as consultants on the production, creation, and sharing process without taking on instructor tasks such as assessment and monitoring. Other programs ask experts to participate from a distance, via Skype or asynchronously. These strategies are not common in formal learning environments for a variety of logistical reasons as well as a belief that everything students need should be housed within their classroom walls.

Regardless, as instructors begin to implement NLP strategies, it is crucial to bring people into the space who are seen as legitimate practitioners of the design grammar students are emulating. During the course of implementation, these people should offer technical, content, and representational advice. If domain-area experts are unavailable, then instructors must at the very least be prepared to draw upon, explain, and apply professional resources. Librarians and other resource professionals may be useful collaborators in these circumstances.

In our own work in college classrooms, we created a layered instructional model: instructors—who were not domain experts but rather experts in cognitive apprenticeship—guided student mentors in learning how to learn (Collins, 2006). In turn, these student-mentors served as learning guides for their less experienced peers. For design advice, we invited out-of-class experts to share their expertise through guest lectures and to consult with learners upon their own projects.

As may be clear from this description, our approach is not efficient time-wise or economically. This is an implementation concern for educators who may see their time with students as limited and their access to people and resources as highly constrained. Our NLP approach requires that instructors let go of some of their assumptions about the relationship between efficiency and content coverage and to focus instead on inefficiency and depth of learning for students.

Access to Resources

NLP is a resource-heavy instructional framework. While digital production software packages are widely available—often for free—they still require 1) a machine powerful enough to run them efficiently, and 2) the know-how to use them. Ensuring that all students have access to capable computers in the classroom becomes a primary implementation concern. While it is common for many students to bring their own laptop computers to class, instructors cannot expect this to be the case. The migration toward collaborative design projects using mobile devices and media further complicates this issue. We suggest adopting cloud computing options whenever possible; such software runs on almost all machines and allows students to asynchronously work together from various locales.

Public school teachers may find some of this software blocked on school computers; working directly with a librarian or digital media specialist may help to open up more venues for online production, collaboration, and storage tools. Furthermore, even if all learners have access to computers and cloud-based software, instructors cannot expect that they will know how to use these tools effectively. As we have discussed, understanding of how to use these tools may be distributed across instructors, students, and online resources; implementation is greatly aided by the understanding that the teacher does not know the answers to all technical questions all the time, but rather helps to structure the learning environment so that students may seek out ways to use technologies effectively.

Issues of "Time"

In any instructional framework, educators must reconcile competing demands for time. In NLP, time becomes a multifaceted, acute concern. Learner-centered production is a lengthy process, involving iterative cycles of conceiving, creating, debugging, sharing, and refining. Coupling these activities with scheduled critique and reflection sessions causes the duration of digital media design projects to range anywhere from a minimum of three weeks to an entire semester. At a maximum, learners commonly complete no more than three to four projects a semester.[*] Consequently, as instructors implement NLP, it is important to consider the breadth of project assignments. In assigning and implementing NLP projects, consider first the goals of the course.[**] If instructors expect students to master a digital genre, a depth approach is appropriate. If instructors wish to introduce students to New Literacies more generally, we suggest implementing a variety of projects.[***]

In our own use of NLP, we varied the depth of projects so that we could delve into a range of design grammars. For example, in our course we began with a data visualization using Adobe Illustrator, then moved to a longer video remixing project using iMovie, and ended with a much deeper design project during which students made a narrative-based activity on a mobile augmented reality mobile platform. Balancing the depth and breadth within given time constraints is particularly important in order to develop both technical and conceptual skills. To aid this balancing act, we offer suggestions based upon the approach toward implementation. If taking a "breadth" approach, instructors should assign projects that consecutively build in complexity or expand upon a theme, concept, or cultural resource. If instructors prefer the "depth" approach, it is expected that project due dates will extend from weeks to months. In this case, it is important to track learners' intra-project progress by asking for drafts of work and journals so that instructors can ensure the development of learners' skills and thinking.

VI. Closing Remarks

Taken separately, none of the ideas discussed in this chapter may seem especially original. Educators, literacy scholars and learning scientists have been arguing for a more project-based, student-centered approach to teaching since John Dewey. Over the past 30 years Seymour Papert's constructionism and the New Literacies movement have re-energized reform efforts to take seriously the role of production in learning and to turn toward student-centered learning environments. So why, then, does instruction look largely the same now as it did in 1985? Research hints at a possible cause: educational practitioners and policymakers typically apply new theory and technologies in ways that support prior assumptions of how people learn and what new tools are for (Collins & Halverson, 2009). While the tendency to use new tools for old ideas is a deep problem, evidence indicates that it is primarily an attitudinal rather than practical obstacle (Scardamalia & Bereiter, 1994). This may be especially true at institutions of higher education where access to the most up-to-date technologies and tools is not an issue.

We believe trends in digital culture and the convergence of literacy-learning research have shifted attitudes toward change, opening avenues for participating in the production of meaning and knowledge. Digital culture, especially within the past five years, is beginning to instigate a shift in attitudes. This makes NLP a new idea worth considering. To clarify, we point to a simple fact: NLP combines educational research in a way that aligns with the current affordances of new technologies and the demands of emerging digital culture.

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Notes

* *Editors' note: In this chapter the authors do not designate a "Values" section, but include discussion of fundamental instructional values in the introduction and theoretical foundations sections.*

* *Editors' note: As Toffler (1980) has pointed out, the shift from the Industrial Age to the Information Age is ushering in many paradigm shifts throughout society.*

* *Editors' note: In this section, the authors describe values of authenticity, the New Ethos, and learner-centered design.*

* *Editors' note: In this chapter, the authors integrate the description of universal and situational principles in*

this section, rather than describing each in its own section.

* *Editors' note: This is a common theme in the learner-centered paradigm, whereby courses are replaced by projects as vehicles for mastering standards, as in the Minnesota New Country School. It is unclear here the extent to which students design, or at least select, their own projects, as in the MNCS.*

* *Editors' note: This is similar to Principle 5 in Chapter 2, Principles for Competency-Based Education.*

** *Editors' note: Talking in terms of a class places this within the Industrial-Age paradigm. The more likely unit is a team (or possibly an individual) working on a project.*

*** *Editors' note: Just-in-time is another common theme for the learner-centered paradigm (see Chapter 1, Principle 1, and Chapter 15).*

* *Editors' note: For the learner-centered paradigm, student progress should be based on learning rather than time, so class time and semester time are no longer relevant constraints.*

* *Editors' note: This is a common method in most learner-centered instruction (see Principle 3 in Chapter 1, Principle 5 in Chapter 3, Principle 5 in Chapter 4, Principle 5 in Chapter 6, Principle 6 in Chapter 10, Principle 2 in Chapter 11, and Principle 1 in Chapter 12.*

* *Editors' note: Of course, in the learner-centered paradigm, student progress is based on learning rather than time, so there are no such time constraints, except ones that are self-imposed in a student's personal learning plan or learning contract.*

* *Editors' note: This distinction is the same as that described in Principle 4 of Chapter 1 and is implicit in virtually all the other chapters in Units 1 and 2.*

* *Editors' note: This is an Industrial-Age notion that epitomizes the teacher-centered paradigm of education.*

** *Editors' note: In a certain sense it is revolutionary, for it is antithetical to the teacher-centered paradigm.*

*** *Editor's note: Here we disagree. An important aspect of the learner-centered paradigm is self-regulated learning (see Chapter 9). A good mentor should be helping each learner to steer his or her own ship.*

* *Editors' note: For younger learners, more projects that are smaller are likely to be optimal, as in Montessori schools.*

** *Editors' note: We look forward to the time when projects replace courses, rather than taking place within them, as is already being done at the Minnesota New Country School and several other project-based schools.*

*** *Editors' note: We also look forward to when students will make these decisions (with guidance from a mentor as needed), rather than the instructor making the decisions.*

8

DESIGNING GAMES FOR LEARNING

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EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *All content.*

Learners

- *All students.*

Learning environments

- *Designed environments that have rich, immersive experiences that simulate to some degree relevant real-world conditions and challenge learners with authentic, situated, and increasingly difficult problems.*

Instructional development constraints

- *Likely significant, depending on design decisions regarding the scope of rich media and the complexity of immersive experiences.*

Values (opinions about what is important)

About ends (learning goals)

- *The development of situated problem solving skills (which games promote by presenting learners with obstacles that require reasoned actions to overcome) is highly valued.*
- *The promotion of transfer to real-world tasks (which games foster through authenticity and learning by doing) is highly valued.*
- *The enhancement of feelings of self-efficacy (which games support by providing a safe environment for risk-taking, by enabling collaboration and social learning, and by providing various forms of scaffolding) is highly valued.*
- *The appreciation of play as a fundamental source of learning experiences is highly valued.*

About priorities (criteria for successful instruction)

- *Effectiveness and appeal are highly valued, but efficiency in terms of the time and expense to develop a game may affect the decision to use this approach.*
- *The ability of games to foster intrinsic motivation is highly valued.*

About means (instructional methods)

- *Aligning the goals of the game with the learning goals is highly valued.*
- *Using authentic settings and tasks that promote learning by doing is highly valued.*
- *Providing interesting challenges that are optimized for the learner's current knowledge and skills to promote immersion and flow is highly valued.*
- *The learner's actions should result in natural consequences and, when appropriate, additional explanatory feedback.*

- *Including scaffolding that adjusts difficulty, provides guidance and support, and offers part-task practice when needed is highly valued.*
- *Requiring cooperative play and authentic roles for players is highly valued when learning goals include team development and collaboration skills.*

About power (to make decisions about the previous three)

- *In a rich, immersive game, the learner may have great latitude in choosing which challenges to undertake as well as when and how.*
- *The learner should have significant control over the frequency of non-diegetic instruction (instruction that is not an inherent part of the game).*

Universal Principles

1. Creating a vision of the game

A holistic, "fuzzy" vision of the game guides design decisions regarding the game space and the instructional space.

- *Learning goals: Specify what the learner will know, be able to do, and feel as a result of undergoing the game-based learning experience.*
- *Authenticity: The dimensions of authenticity should be consistent with whole, real-world tasks, including portrayal of values, attitudes, beliefs, and cultures and provision of situational understandings.*
- *Levels of difficulty: A game should be designed as a series of levels of increasing complexity and difficulty, each of which must be mastered before the next level is "unlocked." Each level is a version of the task and is made up of many individual performances of the task that share the characteristics of that version.*
- *Scaffolding and mastery assessment: A game's instructional overlay encompasses all aspects that are intended to enhance the effectiveness and efficiency of learning.*
- *Feedback: A game has four different kinds of feedback: natural consequences of decisions/actions, explanations, debriefing, and immediate feedback in the form of hints or explanations of causal influences or reasoning.*
- *Motivation: Various aspects of games stimulate intrinsic and extrinsic motivation. Motivation may be enhanced by collaboration with others, authenticity and relevance of the scenario and role, and confidence or expectancy for success.*

2. Designing the game space

- *Goals: The actions and strategies needed to succeed in the game should be aligned with those needed to achieve the desired learning outcomes.*
- *Game mechanics: Conceive or translate the desired learning outcomes into actions (including cognitive actions) that form the basis for playing the game.*
- *Rules: Rules should generate outcomes and feedback consistent with the real world to promote transfer.*
- *Players: Create roles for players to engage with the game either alone or in competition or cooperation with other players and non-player characters.*
- *Environment: Make design decisions regarding the environment based on the learning goals, the appropriate degree of fidelity, and the type or genre of game.*
- *Objects: Create game objects (components of the game system) that embody and enable the game mechanics or are affected by the player's use of the game mechanics.*
- *Information: Provide several types of information that players use to make decisions regarding*

which actions or choices will lead toward a goal.

- *Technology: Select equipment (physical objects) required to play the game, likely including a computing device with various forms of input and output, a network, and data storage.*
- *Narrative: Use narrative to provide both a familiar frame for experience and a cognitive frame of reference (schema) to promote recall.*
- *Aesthetics: Make design decisions for all of the other game components in such a way as to create the overall aesthetic experience of the game—the emotional responses and felt experiences that arise in the player(s) through interaction with/in the game system.*

3. Designing the instructional space

- *Adjusting: Adjust aspects of the game to provide an appropriate level of difficulty for the player, thereby placing the player in his or her zone of proximal development.*
- *Coaching: Provide coaching (a form of scaffolding) that provides cognitive and/or emotional support to the player by providing information, tips, or a short demonstration.*
- *Instructing: Instructing should be used just-in-time whenever a significant amount of learning effort is required. This may include a significant amount of information to be memorized, a difficult understanding to be acquired, a difficult skill to be acquired, including appropriate levels of transfer and automatization, or a significant attitude change to be made.*

Situational Principles

Considerations for designing the game space

- *Kinds of game mechanics: Core mechanics are most fundamental in accomplishing the goal(s) of the game and should be introduced early and recur frequently. Compound mechanics consist of two or more core mechanics combined by a rule. Peripheral mechanics are optional or non-vital. Decisions about each of these kinds of mechanics will vary depending on situational variables for each game.*
- *Parts of the game environment: The game environment consists of structure (discrete or continuous), dimensionality (linear, rectilinear, 2D, or 3D), perspective (the player's view), physics (how objects move), and time (real, compressed, extended, or variable). Decisions on each of these parts will vary depending on situational variables for each game.*
- *Kinds of information: Information about avatars, objects, events, the environment, and the system may be more or less accessible to the player depending on authenticity, level of difficulty, and cognitive load.*

Considerations for designing the instructional space

- *Kinds of adjusting: Difficulty adjustment may involve sequencing cases from easier to more difficult, or dynamically adjusting difficulty based on the learner's current zone of proximal development. Artificial prompts and automated task performance are alternative adjustments that may be used to scaffold the learner toward the desired performance.*
- *Kinds of coaching: Coaching can take the form of providing information, providing a hint or tip, or providing an understanding. It is typically provided when the learner just needs a little help to perform a part of his/her role.*
- *Timing of support: Instructional support may be provided to the player "just in time," or it can be triggered by certain player actions, or the player can request it at any time.*
- *Kinds of learning and appropriate instructional strategies: Different kinds of learning, such as memorization, skills, understanding, and attitudes and values, require different instructional and assessment strategies.*

– C.M.R., B.J.B., & R.D.M.

DESIGNING GAMES FOR LEARNING

I. Introduction

The game-based approach to instruction seeks to promote learning through rich, immersive experiences in designed environments that simulate to some degree relevant real-world conditions and challenge learners with authentic, situated, and increasingly difficult problems. This approach draws on several other instructional-design approaches, including the experiential approach (Lindsey & Berger, 2009), the simulation approach (Gibbons, McConkie, Seo, & Wiley, 2009), and the problem-based approach (Savery, 2009). Designers undertaking a game-based approach should be familiar with the principles and methods of these approaches.

Reasons for Using Games for Learning

Games capitalize on the relationship between action and cognition (learning by doing).[*] A well-designed game can provide authentic practice in thinking and working in specific roles and contexts. Rather than acquiring knowledge divorced from instrumentality, a player must use acquired knowledge (and continue to acquire new knowledge, often on a just-in-time basis) within the game environment to solve problems in order to overcome obstacles and proceed toward the goal. This generally involves formulating strategies by using inductive and heuristic reasoning, logic, and hypothesis testing. Through the gaming experience, players learn to reflect on their failures and successes because those new insights will be crucial in subsequent attempts as well as in new situations.[**]

Games promote team development, social learning, and social cohesion. All games provide some sort of competition, whether it is between a single player and the game system or between multiple players or multiple teams. However, games can also be designed to require cooperation among players. Again, the competition may be between a team and the game system or between teams of players. Multiplayer games provide shared experiences that can be collectively examined, discussed, and recalled when relevant to new situations. When players take on roles within cooperative games, they develop and learn to utilize distributed knowledge, that is, they learn to recognize and draw on the resources of their fellow players, which is a critical component of effective teamwork. Cooperative gameplay provides practice in these and other teaming skills and leads to increases in the collective efficacy of the players.[***]

Games enhance learner engagement and effort. Recent advances in our understanding of the neurology of learning have found that games trigger our brain's dopamine-reward system, generating feelings of pleasure and increasing motivation. The sense of immersion and flow that a player experiences while playing a well-designed game leads to prolonged and focused engagement. When learners devote more time to learning tasks, they naturally learn more (Berliner, 1990). In the game cycle of playing, failing, reflecting, and trying again until success, players gain a sense of control and autonomy. The resultant feeling of self-efficacy is an important influence on persistence and willingness to undertake new learning tasks (Schunk, 1991).

Games provide a safe environment for learning.[†] Many professions that involve hazardous conditions and/or responsibility for the health and safety of others (e.g., military, police, fire fighting, surgery) have turned to games and simulations to provide practice in thinking and acting under pressure in critical situations. While it is necessary eventually to train in real-world settings, games and simulations can scaffold learners toward the required competencies before risking life and limb.

Games are customizable. Games can be designed so that they provide appropriate and variable levels of authenticity, which can be useful in reducing cognitive load for novices so that they can focus on the most critical aspects of a task. At the same time, the level of difficulty can be dynamically tailored to the learner's current knowledge and skills to provide optimal challenge. For a game to adapt appropriately, tasks in the game must be related to learning objectives so that they serve as formative assessment of the learner's progress. Furthermore, if the learner is failing to attain the objectives, the game can provide various types of just-in-time instruction via scaffolding.*

When a game incorporates formative assessment combined into scaffolding, the need for human instructors is greatly reduced, with the potential to greatly lower costs. Furthermore, learners have greater flexibility for when and where they participate in instruction. While developing a complex game for learning can be labor intensive, the overall cost efficiency for instruction can make the endeavor worthwhile if a sufficient number of learners is available.

II. Values

The values considered most important for the design of game-based learning are closely aligned with many of the reasons cited above for using games for learning, and they inform many of the design principles that follow.

Values about ends (learning goals) include:

- The development of situated problem solving skills, which games promote by presenting learners with obstacles that require reasoned actions to overcome.
- The promotion of transfer to real-world tasks, which games foster through authenticity and learning by doing.
- The enhancement of feelings of self-efficacy, which games support by providing a safe environment for risk-taking, by enabling collaboration and social learning, and by providing various forms of scaffolding.
- The appreciation of play as a fundamental source of learning experiences.

In terms of values about priorities, games value effectiveness and appeal over efficiency. Consideration must be given to both a) the time and cost required to develop the instruction (a game can take longer and be more expensive than traditional instruction) and b) the time required to reach mastery (a game with scaffolding can take less time and, given a sufficient number of learners, less expense than traditional instruction).

Values about means (instructional methods) include:

- The goals of the game should be closely aligned with the learning goals.
- The game should involve authentic settings and tasks that promote learning by doing.
- The game should provide interesting challenges that are optimized for the learner's current knowledge and skills to promote immersion and flow.
- The learner's actions should result in natural consequences and, when appropriate, additional explanatory feedback.
- The game should include scaffolding that adjusts difficulty, provides guidance and support, and offers part-task practice when needed.
- When learning goals include team development and collaboration skills, the game should require cooperative play and authentic roles for players.

In terms of values about power, the learner should have significant control over the frequency of non-diegetic instruction (instruction that is not an inherent part of the game).

III. Universal Principles

Universal principles applicable to designing games for learning may be grouped into three categories: those used for creating a vision of the game, those used for designing the game space, and those used for designing the instructional space.

Category 1: Creating a Vision of the Game

Games designed to promote learning are instructional systems with myriad components that interact on the basis of rules. The results of these complex interactions are often unpredictable, and game designers can quickly become mired in fine-tuning components and rules. Therefore, it is useful to begin by creating a holistic, "fuzzy" vision of the game that will guide design decisions regarding the game space and the instructional space. The following six universal principles are intended to assist designers in creating a vision of the game that focuses on helping learners to achieve the desired learning outcomes. The six principles are learning goals, authenticity, levels of difficulty, scaffolding and mastery assessment, feedback, and motivation.

Principle 1.1: Learning goals

Specify what the learner will know, be able to do, and feel as a result of undergoing the game-based learning experience. Because the primary purpose of designing the game is to promote learning in an effective and engaging manner, these learning goals should inform other decisions regarding the design of the game.

Principle 1.2: Authenticity

The dimensions of authenticity should be consistent with whole, real-world tasks, including portrayal of values, attitudes, beliefs, and cultures, and provision of situational understandings. This means that the game is usually multiplayer, though non-player characters (NPCs) may be created to play some or all of the other roles. Many of these dimensions are covered in more detail in the discussion of the game space.

Scenario. The scenario is a description of the sequence of actions and settings that form the plot. While a story is not a necessary part of all games, role-playing games generally have some sort of narrative framework within which the player makes decisions and takes action. The scenario should have high authenticity, so as to enhance motivation and transfer of expertise to the real world.

Objects. Objects are the components of the game system that embody and enable the game mechanics (actions governed by rules), including avatars (players' representation in the game space) and NPCs. The objects should also have high authenticity, so as to enhance transfer of expertise to the real world.

Roles. A role defines the possible actions that a particular object may employ to effect change on the game state. An avatar's role usually includes special abilities and functions. Roles may be played by NPCs. However, a multiplayer game in which all real-world team members interact can serve an important team-building function. Each role, whether played by a learner or a NPC, should have high authenticity to enhance motivation and transfer to the real world.

Tools. Tools are objects that the players are able to manipulate to perform their roles. Authenticity of tools enhances both motivation and transfer of skills to the real world.

Actions. Actions are moves that can be made by any of the players or NPCs. They should have high authenticity to enhance transfer.

Causal dynamics (consequences of actions). Causal dynamics are the way the game system responds to the player's actions based on the rules that govern the associated game mechanics. Authenticity enhances the development of mental models and skills that are aligned with the real world.

Setting/contextual factors. The setting is the situation in which the scenario unfolds. It is a set of contextual factors that may or may not influence the objects and tools available and the actions that are possible. The setting, with all its contextual factors, should not only be authentic, but also be varied systematically from one episode of the game to another, to represent the full range of divergence that the player is likely to encounter in the real world (which enhances motivation and transfer).

Representations. Representation is the fidelity with which visual, audio, tactile, and movement elements of the game are portrayed. If cognitive or perceptual overload is likely, then the representations should initially have lower fidelity or authenticity, but should progress to high fidelity by the end of each level of difficulty.

Principle 1.3: Levels of difficulty

A complex task has many versions of the task. Each version can be thought of as a class of performances or cases of the task that are similar in many ways. Some versions of the task are more complex and therefore more difficult than others (Reigeluth, 1999). Instruction that starts with the most complex version of a task usually creates cognitive overload (Sweller, 1994). Therefore, a game should be designed as a series of levels of increasing complexity and difficulty, each of which must be mastered before the next level is "unlocked."* Each level is a version of the task and is made up of many individual performances of the task that share the characteristics of that version.**

Versions should be arranged in a progression of difficulty by using the Simplifying Conditions Method (Reigeluth, 1999) to identify the conditions that distinguish more complex versions from simpler versions. Levels of complexity should be identified (where the versions all build on each other), but dimensions of complexity should also be identified (where they do not build on each other, so any dimension can be done before any other). Different dimensions of complexity offer opportunities for flexibility in sequencing, based on such factors as learner preferences, frequency of encounter in the real world, risk to personnel or assets, and much more.

There is often a lot of variation within a version of the task. In such cases, mastery is required by each learner (role), not just on one performance of the version of the task (the level of difficulty), but on several divergent performances that represent the full range of "dimensions of divergence" for that version of the task. Some dimensions of divergence may be more difficult than others, in which case the performances can be arranged in an easy-to-difficult sequence if cognitive load is a concern. And cognitive load may be further reduced, if necessary, by reducing representational fidelity.

Principle 1.4: Scaffolding and mastery assessment

A game's scaffolding encompasses all aspects that are intended to enhance the effectiveness and efficiency of learning. Support may be provided to the player "just in time," or it can be triggered by certain player actions, or the player can request it at any time. *Diegetic* instruction seamlessly occurs within the context and actions of the game through naturally occurring consequences. Diegetic instruction may be improved by tracking the player's performance and dynamically adjusting the tasks to provide optimal difficulty and promote immersion and flow. *Non-diegetic* instruction occurs outside the normal game activities as coaching (providing cognitive and/or emotional support) or instructing (activities that do not affect game progress but prepare the learner to perform in the game). Further details regarding the scaffolding are discussed as principles for designing the instructional space.

When a learner is performing the task in a version of the game, he or she may begin a new part of the task only to find that he or she lacks certain knowledge, skills, and attitudes (KSAs) to be successful, at which point he or she (or a virtual mentor) pauses the game and activates the scaffolding. Alternatively, the virtual mentor may step in prior to the negative consequences and advise the learner that he or she needs some preparation for the next part of the task. Either way, part-task instruction (van Merriënboer, 1997; van Merriënboer, Clark, & de Croock, 2002) is initiated, and it is fully integrated with an assessment function—each learner continues to do the practice activities for each of the KSAs in his or her part of the task until the established criteria (usually for accuracy and/or speed of performance) are attained. At that point, a record of the attainment is automatically entered into the learner's file, time is unfrozen for the game, and the player uses the KSAs just acquired to perform his or her part of the task, until additional coaching or instruction is needed. This cycle of game play—instruction/assessment, and game play again—is repeated throughout the game, utilizing both criterion-referenced testing (Cronbach, 1970; Glaser, 1963; Haertel, 1985) and mastery learning (Block, 1971; Bloom, 1968; Carroll, 1963).

It is important to note that the practice and accompanying criteria include the full range of *divergence* (Merrill, Reigeluth, & Faust, 1979) expected in the real world (for skills and understandings), the level of *automatization* (Anderson, 1983, 1996) required in the real world (for memorization and lower-level skills), and the level of *consolidation* (Kamradt & Kamradt, 1999) required in the real world (for attitudes and values).

Principle 1.5: Feedback

The game has four major kinds of feedback. Foremost is *natural consequences* (Baek, 2009), which are built into the logic of the game. This is a major aspect of experiential learning and promotes a variety of higher-order thinking skills, including anticipation, diagnosis, and strategic planning. A second kind of feedback is *explanations* of natural consequences of the learner's actions and of other learners' perspectives and actions that are relevant to the learner's performance. The action is often reviewed with "instant replays" from a "god's-eye view" that encompasses the learner's role and other relevant roles. The virtual mentor provides this feedback either upon request of the learner or when the system is programmed to offer it (at which point the learner can reject it). However, this kind of feedback is only provided when it does not interrupt the flow of the game.

A third kind of feedback is *debriefing* (Fanning & Gaba, 2007; McDonnell, Jobe, & Desmukes, 1997; Raemer, Anderson, Cheng, Fanning, Nadkarni, & Savoldelli, 2011), which is similar to explanations except that the virtual mentor provides it at the end of an episode (which is a part of the whole task for a given level of difficulty). The virtual mentor attempts to cultivate heuristic reasoning and mental model formation by eliciting or providing explanations about the performances, not just performances of the learner, but also of other characters involved in that episode of the task, as well as contextual factors and cultural issues.

Finally, *immediate feedback* is provided in the scaffolding. This feedback is often given in the form of hints or explanations of causal influences or reasoning to encourage more active cognitive processing and mental model development, but it may also take the form of simple confirmation, and it has motivational elements when warranted.

Principle 1.6: Motivation

Motivation is key to the acceleration and quality of learning. A motivated learner is enthusiastic, engaged, focused, and persistent (Garris, Ahlers, & Driscoll, 2002), and games foster these traits by inducing a state of flow (Csíkszentmihályi, 1990) for extended periods of time. Various aspects of games stimulate intrinsic and extrinsic motivation. Malone and Lepper (1987) argue that games promote intrinsic motivation through challenge (providing optimal difficulty for the player), curiosity (providing novelty, uncertainty of outcomes, and incongruity with existing mental models), control (promoting a sense of agency in taking on challenges), and fantasy (providing an appealing setting and a compelling narrative context).

Furthermore, many elements of games contribute to extrinsic motivation. One element is *scorekeeping*.[*] The quality of the learner's performance is reflected by a score that is often displayed continuously or at the end of an episode of play. In a multiplayer game, each player has his or her own score, but there may also be a team score. The score may take the form of points or objects (e.g., new tools or virtual currency) or a variety of other forms. Peer recognition of one's mastery can be highly motivating, so individual and team achievements in multiplayer online games are often posted for all to see.

Motivation is enhanced by *collaboration* with others—through personal friendships and loyalties, peer recognition, not wanting to let down one's teammates, and for some people, the need for affiliation (McClelland, 1976). Collaboration is appropriate when the real-world task itself entails collaboration. Motivation is also enhanced by the *authenticity* and *relevance* of the scenario and role (Jonassen, Howland, Marra, & Crismond, 2008). Most people want to be successful in their lives, so the more authentic and relevant the task is to the real world, the more motivated they tend to be.

TABLE 8.1 Summary of Principles in Category 1: Creating a Vision of the Game

A holistic, "fuzzy" vision of the game based on the following six principles guides design decisions regarding the game space and the instructional space.		
1.1	Learning goals	Specify what the learner will know, be able to do, and feel as a result of undergoing the game-based learning experience.
1.2	Authenticity	The dimensions of authenticity should be consistent with whole, real-world tasks, including portrayal of values, attitudes, beliefs, and cultures and provision of situational understandings.
1.3	Levels of difficulty	A game should be designed as a series of levels of increasing complexity and difficulty, each of which must be mastered before the next level is "unlocked." Each level is a version of the task and is made up of many individual performances of the task that share the characteristics of that version.
1.4	Scaffolding and mastery assessment	A game's scaffolding encompasses all aspects that are intended to enhance the effectiveness and efficiency of learning. Support may be provided to the player "just in time," or it can be triggered by certain player actions, or the player can request it at any time.
1.5	Feedback	A game has four different kinds of feedback: natural consequences of decisions/actions, explanations, debriefing, and immediate feedback in the form of hints or explanations of causal influences or reasoning.
1.6	Motivation	Various aspects of games stimulate intrinsic and extrinsic motivation. Motivation may be enhanced by collaboration with others, authenticity and relevance of the scenario and role, and confidence or expectancy for success.

Finally, motivation is enhanced by building *confidence* through appropriate levels of difficulty (Keller, 1983, 1987). Confidence, or expectancy for success, is an important motivator for learning. Receiving training that is within their zone of proximal development (Vygotsky, 1978) is important to building learners' expectancy for success, and the levels of difficulty help to keep instruction within their zone of proximal development. Table 8.1 shows a summary of the six principles in Category 1. In the next section, we describe universal principles related to the elements that create the game space in which play and learning occur.

Category 2: Designing the Game Space

To transform the fuzzy vision into a designed learning environment, designers must understand the game space, the essential elements that comprise that space, and the kinds of decisions they must make regarding those elements.

*The **game space** is the context in which the rules of a game pertain*. The game space may encircle a literal space (e.g., a board, field, or screen) or simply be an agreement among people to play, thereby transforming their shared space into a *magic circle* (Huizinga, 1955; Klabbers, 2009). From a systems perspective, the magic circle is a boundary which players cross to engage with and within the game system. The game space created by designers contains the potential for experiences that are realized through rule-based play.

*The **elements** of the game space are all of the aspects of the game that must be designed in order to create the necessary conditions for the game experience.* Various game designers and game scholars have described the elements of the game space in different ways but with some consistency in terminology and meaning (Avedon, 1971; Brathwaite & Schreiber, 2009; Koster, 2005; Schell, 2008). We have synthesized these attempts to identify standard game elements, using as a foundation Järvinen's (2008) approach, which is based on a thorough empirical analysis of over a hundred games of various types. Our intent is to provide guidance regarding the kinds of decisions that instructional designers must make in designing games for learning. Therefore, we focus on the *elements that must be designed* rather than aspects that emerge during the game experience. For example, game state is the configuration of game elements at a given time during gameplay. It is an important aspect of gameplay and is useful in analyzing gameplay, but it is not directly created by the game designers. The ten elements we discuss are goals, game mechanics, rules, players, environment, objects, information, technology, narrative, and aesthetics.

There is no single standard or "correct" way to undertake the design of a game. The elements of a game system are so intricately inter-related that decisions regarding one influence decisions regarding others. Some games are conceived based on theme or scenario, while others are born of the designers' desire to explore a (set of) mechanic(s). If the purpose of the game includes identity transformation (not only learning something but also becoming something; see Brown & Duguid, 2000; Gee, 2003; Shaffer, 2008; Squire, 2006), then the designers may choose to begin by determining an appropriate role for the player.

Principle 2.1: Goals

*The **goal** of a game is to achieve a configuration of game elements that matches the winning state defined in the rules*. In games for learning, the goal of the game should require accomplishment of the learning goals identified in the vision of the game. Therefore, the actions and strategies needed to succeed in the game should be aligned with those needed to achieve the desired learning outcomes. This kind of activity-goal alignment also helps to ensure that the game elements that are intended to increase engagement and motivation do not distract from the meaningfulness of the activities from a learning perspective (Shelton & Scoresby, 2011). If a player is able to achieve the goal of the game without also achieving the desired learning outcomes, this is a design failure that calls for redesign. This design failure is avoided by making the goals and tasks of the game functionally the same as the goals and tasks that the learner must attain in the post-instructional environment (the principle of authenticity).

The subgoals of a game can be conceived as two types. The most common conception is related to subtasks whereby the performance of all subtasks is combined to perform the task, and the achievement of all subgoals is combined to achieve the goal of the game. The second conception is related to typical games in which players master one level before moving on to another level of the game. In this conception, each subgoal represents a different level—a different version of the task corresponding to progressively higher levels of complexity or difficulty. Therefore, design decisions regarding goals and subgoals may be influenced primarily by the universal principles of authenticity, levels of difficulty, and motivation.

To facilitate integration and transfer, goals should require the completion of whole, authentic tasks that have an appropriate degree of fidelity with the real world. Subgoals should be created for the various levels of difficulty within and across task classes. These subgoals should be obtainable only by completing interesting and challenging tasks of optimal difficulty for the player. The player's intrinsic motivation is fueled by cycles of acquiring abilities and tools required to complete the tasks, developing skillfulness through repeated attempts at the tasks, and finally achieving the subgoal through mastery.

Principle 2.2: Game mechanics

The term *game mechanics* is commonly used in the field of game design, but there seems to be no standard definition (Lundgren & Björk, 2003; Sicart, 2008). Avedon (1971) makes a clear distinction between mechanics and rules, with mechanics being a "procedure for action" and rules governing the action and the results. This distinction is useful for designers as it facilitates thinking about an *action* separate from all of the possible *constraints* on and *outcomes* of that action, which may vary greatly from game to game.

Following this approach, *a **game mechanic** is an action governed by rules that a player may take with or on one or more other game elements*. It is important to note that a mechanic may consist of several discrete actions combined into a procedure. A mechanic usually involves several elements at once, often including the player's avatar, one or more game objects, the game environment, and the associated rules. Kinds of game mechanics are discussed as situational principles for designing the game space.

Through interaction with game mechanics, players come to understand the underlying rules of the game and to formulate strategies for leveraging those rules. It follows that instructional designers should conceive of or translate the desired learning outcomes into actions (including cognitive actions) that form the basis for playing the game (the principle of authenticity). The range of possible actions and the rules for the results of these actions should be directly related to the prior attainments of the learner and his or her current abilities and skills.

Principle 2.3: Rules

***Rules** define the possibilities of and constraints on actions in a game, as well as the rewards and penalties for those actions*. Thus, they are tightly bound with mechanics, and together these elements make different games both similar (by using common mechanics) and unique (by governing their use in distinctive ways). When players encounter a mechanic, they have certain expectations based on their prior experiences with that mechanic in other games. Therefore, when creating the rules of a game, designers often rely on precedent established by other games and then tweak their mechanics and rules to fit the particular game being designed. Instructional games may further need to align their rules with outcomes and feedback consistent with the real world to promote transfer (the principles of authenticity and feedback).

Principle 2.4: Players

*The **players** are the individuals who choose to enter the magic circle and undergo the experience of a game.* Designers must decide whether a game will be single-player or multiplayer, and if the latter, the possible configurations of players. These configuration patterns may include NPCs and other players in cooperation or competition (see Avedon, 1971).

***Game dynamics** are the emergent patterns of interplay between mechanics, rules, and players*, and for this reason are not discussed as a separate designed element. In poker, for example, bluffing is not mentioned in the rules. It is a strategy that emerged as a result of players interacting with the specified mechanics and rules of the game. ***Game balancing** is the art of designing the relationships among all of the elements of a game to promote the desired game experience*. There is no standard process for balancing a game other than the use of playtesting. ***Playtesting** is a method used throughout the game design process to systematically test the game elements and their relationships to each other*. Playtesting is an important method for determining whether players' interactions with game mechanics (and with each other) are resulting in unexpected dynamics and undesired experiences.

Principle 2.5: Environment

*The **environment** is the setting in which the action of the game takes place and the diegetic objects* (see **Objects** below) *of the game reside*. Video game environments may have numerous settings, such as the spaceship and locations on several planets in *Mass Effect* (BioWare Corp., 2007). Aspects of the environment include structure, dimensionality, physics, and time, and these are discussed as situational principles for designing the game space.

Principle 2.6: Objects

***Game objects** are the components of the game system that embody and enable the game mechanics or are affected by the player's use of the game mechanics.* Diegetic objects exist in the game setting and, when the game includes an avatar, are accessible to the avatar. Non-diegetic objects exist outside the game setting and are accessible to the player but not to the avatar, mainly through the virtual (on-screen) interface. These may include menus, heads-up displays (HUDs), and other means of obtaining information about or controlling the game.

Objects have properties (or attributes) with either static or dynamic states (Schell, 2008). For example, a gun may have a static property for the amount of ammunition it can hold and a dynamic property for the amount of ammunition it currently holds. In order to be usable, objects should have affordances (Norman, 1988) that make apparent how the object is used.

Principle 2.7: Information

Gameplay is goal-directed and rule-based action within a system. Every action creates a change in the state of the game system. Players' decisions regarding actions are guided by the available information about the game state. Many game objects are conduits for information, which may be presented as text (e.g., a popup window with instructions; a letter from a NPC), icons (e.g., an icon that indicates which weapon is currently active; a health meter), or visual/aural attributes of objects that serve as cues of state (e.g., a clicking sound to indicate that the chosen door is locked). Five types of information may be available to the player—information about avatars, objects, events, environment, and system; these are discussed as situational principles for designing the game space.

Principle 2.8: Technology

Equipment *consists of the physical pieces required to play the game*. Video game equipment generally includes some sort of computing device (a *platform*), a screen and speaker(s), and a *physical interface* for interacting with the game system, usually via a *virtual interface* designed to enable the particular mechanics of the game.

Other technology considerations for video games include a network and data storage. A ***network*** is a group of connected devices that, in this case, facilitates multiplayer game experiences. In video games, ***data storage*** is used to preserve game state and game history. Data may be stored locally (on the gaming device), portably (on a memory card), or remotely (on a server). For learning games in particular, designers should ensure that relevant performance data are captured and stored for analysis as "interaction trails" (Myers, 2012). If the game is designed so that the learning objectives are directly tied to the use of game mechanics, capturing data for these events alone may provide sufficient evidence of mastery.

Principle 2.9: Narrative

A ***narrative*** *is a sequence of events that tells a story*. From a learning perspective, the use of narrative in games utilizes the power of episodic memory for structuring and storing our experiences as narratives (Bruner, 1991). Designing a game with a clear narrative structure, especially a monomythic pattern such as the hero's journey described by Campbell (1968), provides both a familiar frame for experience (an idea of what to expect) and a cognitive frame of reference (schema) to promote recall.

The use of narrative in a game may be influenced by game genre. For example, a first-person shooter game such as *Halo* (Microsoft Corporation, 2001) may have some narrative trappings like a one-dimensional character and a simple, linear plot held together by cut scenes (brief, non-interactive in-game movies that move the plot forward), but it is primarily focused on developing skills associated with game mechanics; on the other hand, a role-playing game such as *Oblivion* (Bethesda Softworks, 2006) is likely to have a customizable avatar and multiple storylines that vary according to the player's actions and choices. But even within a particular genre, narrative may be employed in very different ways.

Game designers have tremendous leeway in deciding how to incorporate narrative into a game. For example, a narrative structure (or *plot*) may be linear, branching, or foldback (with multiple branches that all eventually lead to a single event [Adams, 2010]) and may use devices like flashbacks and cut scenes. Game narratives are often divided into episodes (levels/missions/quests), each with its own buildup of dramatic tension and release.

Games often require the player to assume a *role* within the narrative and to take action in a manner consistent with that role. Shaffer (2006) has argued that a player's role in a game for learning should be based on an epistemic frame, which he defines as a set of "skills, knowledge, identities, values, and epistemology that professionals use to think in innovative ways" (p. 12). Clearly this approach is related to the authenticity of a game. One viable option for game designers is to begin by identifying the real-world role, the attributes of its epistemic frame, and the whole set of tasks associated with the role. These constraints can then be used to determine the game mechanics and rules (which the player experiences as causal dynamics within the game) that will enable the player to develop proficiency in thinking and acting in the role. With these key decisions made, the designers can envision a scenario that provides a context for the role and mechanics. As the design process proceeds, decisions regarding the sequencing of tasks and levels of difficulty will influence the emerging narrative structure, and the original fuzzy vision of the game will come into sharper focus.

Game designers should also consider the roles that might be played by NPCs. The most common roles for NPCs are adversaries, teammates, and information sources. As adversaries, NPCs provide obstacles that the player must overcome in order to reach goals. The level of difficulty may be adjusted by changing the number of adversaries or by changing the skill levels of the adversaries. Similarly, NPCs as teammates can also be used to adjust difficulty by having them provide more or less assistance. In some games, the player may make high-level tactical decisions about the placement and actions of NPC teammates in order to carry out strategies. NPCs (either adversaries or teammates) may also function as information sources, although the player may need to judge the trustworthiness of the NPC.

Principle 2.10: Aesthetics

For the purposes of this discussion, *aesthetics* refers to the emotional responses and felt experiences (McCarthy & Wright, 2004) that arise in the player(s) through interaction with/in the game system. Design decisions for all of the other game components create the overall aesthetic experience of the game, so deciding how a player will feel while playing the game is a crucial part of the fuzzy vision early in the design of the game. Hunicke, LeBlanc, and Zubek (2004) proposed a short list of terms for describing the aesthetics of games, including feelings of challenge (game as obstacle course), fellowship (game as social framework), discovery (game as uncharted territory), expression (game as self-discovery), and fantasy (game as make-believe). Naturally, more than one of these feelings may be present at any given time, and all may occur throughout gameplay. If the game follows a narrative, the type and timing of events and their emotional flow may be dictated by the story arc.

Decisions regarding aesthetics are directly influenced by the degree of authenticity required to achieve learning and transfer. The dimensions of authenticity discussed above should be consistent in their levels of realism (or fidelity), where realism ranges from abstract to realistic. Types of realism include physical (feels real), perceptual (seems real), functional (acts real), cognitive (matches mental model), and emotional (evokes reality). In general, novices benefit from initial lower fidelity (to reduce cognitive load and promote automaticity), but as they approach mastery, higher fidelity promotes transfer.

A game is a designed experience comprised of the ten elements described above and summarized in Table 8.2. When designing these elements, game designers can create the conditions for the desired experience by applying the six universal principles for creating a vision of the game described in the previous section. Through this process, designers gradually refine the fuzzy vision of the game. However, as with any medium used for instruction, in games special attention must be given to the instructional methods to ensure that players attain the learning objectives. In the next section, we describe universal principles related to the elements of the scaffolding and strategies for promoting the desired KSAs.

Category 3: Designing the Instructional Space

The instructional space of a game for learning consists of three major types of scaffolding: adjusting, coaching, and instructing.* There are four major mechanisms for deciding when to use these types of scaffolding; the first three apply to adjusting and coaching, and all four apply to instructing. The first is *universal*, which, if the authentic situation allows, is offered within the game scenario to prepare the player for a new situation before the action starts, or even during the action. The second is *triggered*, in which its use is based on certain events (usually a mistake made by the player). The third is *requested*, in which the player asks for it when he or she feels the need for a little help to perform a part of his/her role. Finally, the virtual mentor could *suggest* pausing for some instruction but leave the decision up to the player.

Principle 3.1: Adjusting

The least intrusive type of instructional support is a variety of scaffolding (Cazden, 1983; Wood, Bruner, & Ross, 1976) that is achieved by *adjusting* aspects of the game to provide an appropriate level of difficulty for the player. The intent is to place the player within his or her zone of proximal development (Vygotsky, 1978). It is the least intrusive because it occurs "behind the scenes," leaving the player unaware that any instructional support has been provided.

Adjusting should be used when a task or part of a task (episode) is too difficult for a player to learn without support, as long as the adjusting is more efficient to use than either coaching or instructing. The kind of adjustment made to accommodate the learner depends on the particular situation; therefore, the major kinds of adjusting are discussed as situational principles for designing the instructional space.

TABLE 8.2 Summary of Principles in Category 2: Designing the Game Space

The game space is the context in which the rules of a game pertain. The following ten elements of the game space are all aspects of the game that must be designed in order to create the necessary conditions for the game experience.

2.1	Goals	The goal of the game should require accomplishment of the learning goals identified in the vision of the game. Therefore, the actions and strategies needed to succeed in the game should be aligned with those needed to achieve the desired learning outcomes.
2.2	Game mechanics	Through interaction with game mechanics, players come to understand the underlying rules of the game and to formulate strategies for leveraging those rules. Instructional designers should conceive of or translate the desired learning outcomes into actions (including cognitive actions) that form the basis for playing the game.
2.3	Rules	Rules define the possibilities and constraints on actions in a game. They should generate outcomes and feedback consistent with the real world to promote transfer.
2.4	Players	A player may engage with the game either alone or in competition or cooperation with other players and non-player characters.
2.5	Environment	The game environment is the setting(s) in which the action of the game takes place. Design decisions regarding the environment are influenced by the learning goals, the appropriate degree of fidelity, and the type or genre of game.
2.6	Objects	Game objects are the components of the game system that embody and enable the game mechanics or are affected by the player's use of the game mechanics.
2.7	Information	Games provide several types of information that players use to make decisions regarding which actions or choices will lead toward a goal.
2.8	Technology	Equipment consists of the physical pieces required to play the game and may include a computing device with various forms of input and output, a network, and data storage.
2.9	Narrative	A narrative structure can provide both a familiar frame for experience and a cognitive frame of reference (schema) to promote recall.
2.10	Aesthetics	Aesthetics refers to the emotional responses and felt experiences that arise in the player(s) through interaction with/in the game system. Design decisions for all of the other game components create the overall aesthetic experience of the game.

Principle 3.2: Coaching[*]

Coaching (Nowack & Wimer, 1997) is defined here as another form of scaffolding that provides cognitive and/or emotional support to the player, and also preferably a human element that is performed by a virtual mentor. It primarily entails providing information or tips to the player, though it can include providing a short demonstration of a skill. More extensive demonstrations and practice with feedback go beyond coaching and are considered instructing. To enhance authenticity, coaching usually requires freezing time in the game, as in a "time-out" in sports scrimmages.

Like adjusting, coaching should be used when a task or part of a task (episode) is too difficult for a learner to accomplish without support, as long as the coaching is more efficient to use than either adjusting or instructing. It is typically used when the player needs only a little help. Larger amounts of help are best provided through adjusting and/or instructing.

Coaching is most often provided or requested before or during a performance episode. It can also be provided after a performance in the form of a debriefing or reflection on action to learn from the experience. When universal coaching is authentic to the task, it can be done without freezing time in the game. However, triggered and requested coaching commonly require freezing time to provide the coaching, due to the inauthenticity of providing coaching in the middle of a performance. For requested coaching, the player asks a question of the virtual mentor or asks for clarification or elaboration, so the system must be able to understand and respond appropriately, or a menu-driven system must be in place for making requests for coaching. Kinds of coaching are discussed as situational principles for designing the instructional space.

Principle 3.3: Instructing

Instructing is a kind of support for learning that provides the player with appropriate activities for learning, as well as information to promote learning (Merrill, 2013). All instruction should be just-in-time (JIT), meaning that it only teaches KSAs that the player will use in the next episode of the task in the game.

Instructing should be used just-in-time whenever a significant amount of learning effort is required. This may include a significant amount of information to be memorized, a difficult understanding to be acquired, a difficult skill to be acquired, including appropriate levels of transfer and automatization, or a significant attitude change to be made.

TABLE 8.3 Summary of Principles in Category 3: Designing the Instructional Space

The instructional space of a game for learning consists of three major types of scaffolding: adjusting, coaching, and instructing.	
3.1 Adjusting	The purpose of adjusting aspects of the game is to provide an appropriate level of difficulty for the player thereby placing the player in his or her zone of proximal development.
3.2 Coaching	Coaching is defined here as a form of scaffolding that provides cognitive and/or emotional support to the player by providing information, tips, or a short demonstration.
3.3 Instructing	Instructing should be used just-in-time whenever a significant amount of learning effort is required. This may include a significant amount of information to be memorized, a difficult understanding to be acquired, a difficult skill to be acquired, including appropriate levels of transfer and automatization, or a significant attitude change to be made.

There is a variety of formats in which the instruction can occur, each of which exists on a continuum. One continuum is *part-task selection*, which concerns whether the system diagnoses each player's needs regarding instruction on one extreme or just teaches all the part-tasks to all players in a given role on the other extreme. A midpoint on this continuum is for the instruction on each part-task to start with medium-difficulty practice (with feedback) using a computer-adaptive testing algorithm, and then provide richer instruction as needed. A second continuum for format is *use of a virtual mentor*, which ranges from extensive use of virtual mentor at all stages of the instruction to no use of a virtual mentor for any stages of it. A third continuum is *integration with the game*, which ranges from the instruction taking place as a natural activity within the game to pausing the game and offering the instruction completely separately and decontextualized, other than the player knowing that he or she will need to learn the KSAs to succeed in the next episode of the game.

Table 8.3 shows a summary of the three principles in this category. The kinds of instructional strategies used depend on the kinds of learning required; therefore, these are discussed as situational principles for designing the instructional space.

IV. Situational Principles

Some of the universal principles described above for designing the game and instructional spaces require further guidance in their application because certain design decisions are necessary only in some situations (Reigeluth & Carr-Chellman, 2009).

Category 4: Considerations for Designing the Game Space

Situational principles for the game space include kinds of game mechanics, parts of the game environment, and kinds of information available to the learner.

Principle 4.1: Kinds of game mechanics

The literature contains many proposed classifications of game mechanics (Järvinen, 2008; Salen & Zimmerman, 2004; Sicart, 2008). In this discussion, the classification consists of three types: core, compound, and peripheral.

Core mechanics *are most fundamental in accomplishing the goal(s) of the game*. If a player fails to master a core mechanic, he or she cannot achieve the goal(s) of the game. Core mechanics should be introduced early in the game and recur frequently. Therefore, they should quickly become skill-based (automatic) through practice, including part-task practice in the instructional space, if necessary. Sometimes it may be desirable to challenge players by modifying a core mechanic (or the elements upon which it acts) once it has been mastered. For example, once a player has mastered the driving mechanic in a video game, a faster car may become available that requires increased proficiency by the player.

Compound mechanics *consist of two or more core mechanics combined by a rule*. They are also necessary in accomplishing the goal(s) of the game, but they recur less frequently. They may remain rule-based or become skill-based, depending on the availability of practice for the player. For example, a player may need to learn how to use the driving mechanic and the shooting mechanic simultaneously to solve a problem and proceed toward the end state of the game.

Peripheral mechanics *are optional or non-vital in accomplishing the goal(s) of the game*. They are usually novel (non-recurrent) and knowledge-based (i.e., require more cognitive processing). For example, in *Assassin's Creed: Brotherhood* (Ubisoft, 2010) if the player's avatar enters a body of water, a prompt informs the player about which game controls to use to make the avatar swim. However, swimming is not necessary to achieve the end state of the game.

Fabricatore (2007) describes a progression of mechanics usage. First, the player must learn the mechanic itself—how it is achieved using the game controls—and then gain some proficiency with it through practice. Second, the player must recognize an appropriate time to use the mechanic and then use it to achieve an end. Third, the player must increase proficiency with the mechanic in order to use it in more complex situations (sometimes in combination with other mechanics) to achieve a subgoal of the game. This kind of elaboration is common in video games (Gee, 2003) and is usually associated with levels of difficulty.

Because game mechanics are the elemental building blocks of games, design decisions should be guided by all six universal principles used in creating a vision of the game. Mechanics should function as they do in the real world and provide authentic feedback if their use is to transfer outside the game context. Decisions regarding the progression of mechanics usage described above should be informed by the concepts relevant to designing levels of difficulty (e.g., cognitive load, simplifying conditions, etc.). If players are unable to master core mechanics through practice in the game, the scaffolding should provide appropriate assistance in the game or part-task practice until mastery is achieved.

Principle 4.2: Parts of the game environment

In designing the game environment, four main aspects must be considered: structure, dimensionality, physics, and time. Movement in a game is determined by two primary aspects of the environment. First, the *structure* of the environment may be discrete or continuous (or a combination of the two). In the video game *Mass Effect* (BioWare Corp. 2007), the environment is divided into large discrete locations. Movement between locations (e.g., from planet to planet) is similar to moving from square to square in a board game, that is, jumping from one place to another. Movement within those locations is continuous, with the player using a controller to move his avatar to explore the location with few constraints.

The second aspect of the environment that affects movement is *dimensionality*. An environment may be linear (1D), rectilinear, 2D, or 3D (Björk & Holopainen, 2005). In many board games, the player's token moves linearly around the board. In a rectilinear environment, movement is constrained to paths between nodes, which is the case in strategy games such as *Risk* where an army may only move into an adjacent region. Movement is limited to two dimensions in a 2D environment such as chess. Many video games take place in environments with three dimensions (3D) and fluid, continuous movement.

Perspective or point of view in video games is the vantage from which the player visually perceives the environment. Many simulation and strategy games use either an isometric or a top-down perspective, which gives the player the feeling of acting *on* the environment from above rather than *in* the environment. By the early 1990s, personal computer technology was capable of simulating three dimensions, and shooting games like *Wolfenstein 3D* (id Software, 1992) and *Doom* (id Software, 1993) allowed players to maneuver avatars through hallways and rooms from a first-person perspective (hence the name *first-person shooter*), albeit with a fairly narrow field of vision. The third person perspective broadens the field of vision by moving out of the avatar's point of view and watching the avatar from a slightly removed position. Many games now refer to this perspective metaphorically as a "camera" that can be moved around the avatar as though it were on a crane (Poole, 2001). Games may also allow the player to switch between first- and third-person views.

While *physics* is an important aspect of some non-digital games (e.g., billiards, tiddlywinks), many video games require a physics engine, which is *a computer program that handles the rules governing how objects in the environment move and respond to force*, as in *Angry Birds* (Rovio Entertainment, 2009). A deeper exploration of design options for game physics is beyond the scope of this paper, but designers should consider the degree of fidelity required to achieve the desired learning outcomes.

Another aspect of the game environment is the rate at which game *time* passes. Juul (2004) notes that the difference between the real world and a game world is reflected in the "duality of *play time* (the time the player takes to play) and *event time* (the time taken in the game world)" (p. 131). Event time in a game may be characterized as real, compressed (speeded up), extended (slowed down), or variable. The rate of event time may vary by event (e.g., eight hours of sleep for the avatar may pass in a few seconds), or event time may be manipulated by the designer to adjust difficulty and challenge for the player.

Design decisions regarding the structure, dimensionality, physics, and time of the game environment, along with the available perspective(s) for the player, are greatly influenced by the learning goals of the game and the type or genre of game.

Principle 4.3: Kinds of information

Five main kinds of information may be available to the player—information about avatars, objects, events, environment, and system. In general it is helpful to think of the player's access to information as being on an accessible-inaccessible continuum, the exact position depending on a number of factors, including authenticity (how much the player would know in the real-world situation being simulated), level of difficulty (withholding information can increase difficulty), and cognitive load (too much information overloads working memory).

- **Information about avatars** includes the role and attribute states of the avatar (e.g., current values for strength, speed, intelligence, etc.), the inventory of available resources and locations, and the avatar's current location.
- **Information about objects** primarily includes attribute states related to game mechanics. For example, a number or a graphic representation might indicate the amount of ammunition in a weapon, which might prompt the player to use the *reload* mechanic or the *switch weapon* mechanic. A special type of information conveyed by objects is perceived affordance, an indication of likely actions that may be taken with an object (Norman, 1988).
- **Information about events** is of two types: feedback and narrative.
    - Feedback is the immediate result and consequences of the use of game mechanics expressed in one or more sensory forms. In video games, players learn the operational rules of a game by

experimenting with game mechanics and interpreting the meaning of the feedback.

- Narrative information about events includes salient descriptions (or recordings) of past performance in the game, usually key events from levels/missions/quests. It may also include backstory, cut scenes (non-interactive animated sequences that segue between playable sequences), listings of pending missions, reminders of tasks to be completed, and other information related to the unfolding story.

- **Information about the environment** includes maps of known and accessible locations. It also includes sensory cues (e.g., lighting, music) that convey the tone and mood of the environment. A well-designed environment creates in the player a sense of immersion and presence (Tamborini & Skalski, 2006).
- **Information about the system** includes indications of the current game state and the available procedures at the system level, for example, entering and leaving the game space, returning to a previous game state, accessing the scaffolding, etc.

The principles for Category 4 are summarized in Table 8.4.

Category 5: Considerations for Designing the Instructional Space

Situational principles for the instructional space include kinds of adjusting, kinds of coaching, and kinds of instructional strategies.

Principle 5.1: Kinds of adjusting

Three major kinds of adjusting include difficulty adjustment, artificial prompts or cues, and automated task performance.

- **Difficulty adjustment** may be as simple as sequencing cases so that easier cases are first, or preferably it may involve determining the learner's current zone of proximal development and adjusting the difficulty of the case accordingly. The latter approach requires collecting data to assess the learner's ongoing performance and attainments.

TABLE 8.4 Summary of Principles in Category 4: Considerations for Designing the Game Space

The following situational principles provide more precise guidance regarding the design of three elements of the game space.

4.1	Kinds of game mechanics	Core mechanics are most fundamental in accomplishing the goal(s) of the game and should be introduced early and recur frequently. Compound mechanics consist of two or more core mechanics combined by a rule. Peripheral mechanics are optional or non-vital.
4.2	Parts of the game environment	The game environment consists of structure (discrete or continuous), dimensionality (linear, rectilinear, 2D, or 3D), perspective (the player's view), physics (how objects move), and time (real, compressed, extended, or variable).
4.3	Kinds of information	Information about avatars, objects, events, the environment, and the system may be more or less accessible to the player depending on authenticity, level of difficulty, and cognitive load.

- **Artificial prompts or cues** (ones not present in an authentic case) may be provided to guide the learner's performance, though these should be removed from cases in which the learner will be summatively assessed.
- **Automated task performance** of parts of a task may help the learner to see the actions and understanding required for a particular case. This may be thought of as a partially worked example.

Principle 5.2: Kinds of coaching

Coaching can take the form of providing information, providing a hint or tip, or providing an understanding. It is typically provided when the learner just needs a little help to perform a part of his/her role.

- **Providing information** involves disclosure beyond what is normally available to the learner as described above in the discussion of kinds of information. For example, the learner may be shown a map of the game environment that includes one or more locations that are not normally displayed.
- **Providing a hint or tip** and **providing an understanding** go a bit further than providing information by guiding the learner toward a course of action. The *inquisitory form* of this approach occurs as questions to the learner that help the learner to discover an appropriate hint or understanding, as occurs in a Socratic dialogue. The *expository form* occurs as statements or visuals that provide the hint or stimulate the understanding.

Principle 5.3: Kinds of learning and appropriate instructional strategies

While space precludes an in-depth discussion, below we address kinds of learning that have the greatest impact on selection of instructional and assessment strategies.

- **Memorization** of information (rote knowledge) is achieved most effectively through drill and practice (Salisbury, 1990). Primary strategies for instruction are to present what is to be memorized and to practice recalling or recognizing it. Secondary strategies include repetition, chunking, spacing, prompting, and mnemonics.
- **Application of skills** (including higher-order thinking skills) is achieved through tutorial instruction that includes demonstrations of the skill, usually simultaneously with the primary strategy of explanations (generalities), and practice with immediate feedback until the player reaches the specified criteria for accuracy and speed of performance (Merrill, 1983; 2013; Romiszowski, 2009).
- **Understanding of causal relationships** is developed through observation and manipulation of causes and/or effects (Corrigan & Denton, 1996; Perkins & Grotzer, 2005; Reigeluth, 1983). Primary strategies for instruction are acquisition through either exploration or telling and showing the causal relationships, and application by providing opportunities to use the causal relationships (practice) with immediate feedback.
- **Understanding of natural processes** is developed through observation of the sequence of events that comprise the natural process, as well as descriptions of what preceded or followed any given event (Reigeluth & Schwartz, 1989). The primary strategies for instruction are to tell the player what the events in the natural process are (*generality*), show the player what they are (*demonstration*), and provide opportunities for the player to use the natural process (*practice*), with immediate *feedback*.
- **Conceptual understanding** is primarily a matter of understanding the relationships among concepts. Different kinds of relationships constitute different dimensions of understanding. The major types of relationships include: superordinate, coordinate, and subordinate (in which the concepts may be either parts or kinds of each other), analogical, and experiential (Reigeluth, 1983). The primary strategies for instruction are to portray the relationship (*description*) and to provide opportunities for the player to use the conceptual relationship (*application*), with immediate *feedback*. Demonstrations or examples do not exist as they do for skills, causal understanding, and process understanding, but they are used whenever the experiential relationship is important.

TABLE 8.5 Summary of Principles in Category 5: Considerations for Designing the Instructional Space

The following situational principles provide more precise guidance regarding the design of the instructional space.

5.1	Kinds of adjusting	Difficulty adjustment may involve sequencing cases from easier to more difficult or dynamically adjusting difficulty based on the learner's current zone of proximal development. Artificial prompts or automated task performance are adjustments that may be used to scaffold the learner toward the desired performance.
5.2	Kinds of coaching	Coaching can take the form of providing information, providing a hint or tip, or providing an understanding. It is typically provided when the learner just needs a little help to perform a part of his/her role.
5.3	Kinds of learning and appropriate instructional strategies	Different kinds of learning, such as memorization, skills, understanding, and attitudes and values, require different instructional and assessment strategies.

- **Attitudes and values** have three major components: cognitive, affective, and psychomotor (or behavioral) (Kamradt & Kamradt, 1999). Each requires a different primary strategy. The cognitive component requires *persuasion* through cognitive reasoning. The affective component requires *operant conditioning* to develop positive feelings about the attitude or values. This can be done vicariously through social modeling, such as observing a person with whom one can easily empathize in a film. The psychomotor component requires *demonstrations and practice with feedback* to develop the appropriate behaviors.

The principles for Category 5 are summarized in Table 8.5.

V. Conclusion

Games can provide engaging and motivating learning experiences in which players take on roles to solve authentic and increasingly difficult problems in situated contexts. We have discussed three categories of universal principles applicable to designing games for learning: creating a vision of the game, designing the game space, and designing the instructional space. The principles within each category (see Table 8.6 for a summary) describe what we think are the most important considerations for creating a game that effectively promotes the desired learning outcomes. Certainly more can and should be said about each of these principles to develop more fully a common knowledge base. In particular, we hope that designers of games for learning will add to and elaborate on the situational principles to provide more detailed guidance on designing various types of games and game mechanics to achieve different learning outcomes.

TABLE 8.6 Summary of Universal and Situational Principles

Category 1: Creating a Vision of the Game		
A holistic, "fuzzy" vision of the game based on the following six principles guides design decisions regarding the game space and the instructional space.		
1.1	Learning goals	Specify what the learner will know, be able to do, and feel as a result of undergoing the game-based learning experience.
1.2	Authenticity	The dimensions of authenticity should be consistent with whole, real-world tasks, including portrayal of values, attitudes, beliefs, and cultures and provision of situational understandings.
1.3	Levels of difficulty	A game should be designed as a series of levels of increasing complexity and difficulty, each of which must be mastered before the next level is "unlocked." Each level is a version of the task and is made up of many individual performances of the task that share the characteristics of that version.
1.4	Scaffolding and mastery assessment	A game's scaffolding encompasses all aspects that are intended to enhance the effectiveness and efficiency of learning. Support may be provided to the player "just in time," or it can be triggered by certain player actions, or the player can request it at any time.
1.5	Feedback	A game has four different kinds of feedback: natural consequences of decisions/actions, explanations, debriefing, and immediate feedback in the form of hints or explanations of causal influences or reasoning.
1.6	Motivation	Various aspects of games stimulate intrinsic and extrinsic motivation. Motivation may be enhanced by collaboration with others, authenticity and relevance of the scenario and role, and confidence or expectancy for success.
Category 2: Designing the Game Space		
The game space is the context in which the rules of a game pertain. The following ten elements of the game space are all aspects of the game that must be designed in order to create the necessary conditions for the game experience.		
2.1	Goals	The goal of the game should require accomplishment of the learning goals identified in the vision of the game. Therefore, the actions and strategies needed to succeed in the game should be aligned with those needed to achieve the desired learning outcomes.
2.2	Game mechanics	Through interaction with game mechanics, players come to understand the underlying rules of the game and to formulate strategies for leveraging those rules. Instructional designers should conceive of or translate the desired learning outcomes into actions (including cognitive actions) that form the basis for playing the game.

2.3	Rules	Rules define the possibilities and constraints on actions in a game. They should generate outcomes and feedback consistent with the real world to promote transfer.
2.4	Players	A player may engage with the game either alone or in competition or cooperation with other players and non-player characters.
2.5	Environment	The game environment is the setting(s) in which the action of the game takes place. Design decisions regarding the environment are influenced by the learning goals, the appropriate degree of fidelity, and the type or genre of game.
2.6	Objects	Game objects are the components of the game system that embody and enable the game mechanics or are affected by the player's use of the game mechanics.
2.7	Information	Games provide several types of information that players use to make decisions regarding which actions or choices will lead toward a goal.
2.8	Technology	Equipment consists of the physical pieces required to play the game and may include a computing device with various forms of input and output, a network, and data storage.
2.9	Narrative	A narrative structure can provide both a familiar frame for experience and a cognitive frame of reference (schema) to promote recall.
2.10	Aesthetics	Aesthetics refers to the emotional responses and felt experiences that arise in the player(s) through interaction with/in the game system. Design decisions for all of the other game components create the overall aesthetic experience of the game.

Category 3: Designing the Instructional Space

The instructional space of a game for learning consists of three major types of scaffolding: adjusting, coaching, and instructing.

3.1	Adjusting	The purpose of adjusting aspects of the game is to provide an appropriate level of difficulty for the player thereby placing the player in his or her zone of proximal development.
3.2	Coaching	Coaching is defined here as a form of scaffolding that provides cognitive and/or emotional support to the player by providing information, tips, or a short demonstration.
3.3	Instructing	Instructing should be used just-in-time whenever a significant amount of learning effort is required. This may include a significant amount of information to be memorized, a difficult understanding to be acquired, a difficult skill to be acquired, including appropriate levels of transfer and automatization, or a significant attitude change to be made.

TABLE 8.6 *(continued)*

Category 4: Considerations for Designing the Game Space		
The following situational principles provide more precise guidance regarding the design of three elements of the game space.		
4.1	Kinds of game mechanics	Core mechanics are most fundamental in accomplishing the goal(s) of the game and should be introduced early and recur frequently. Compound mechanics consist of two or more core mechanics combined by a rule. Peripheral mechanics are optional or non-vital.
4.2	Parts of the game environment	The game environment consists of structure (discrete or continuous), dimensionality (linear, rectilinear, 2D, or 3D), perspective (the player's view), physics (how objects move), and time (real, compressed, extended, or variable).
4.3	Kinds of information	Information about avatars, objects, events, the environment, and the system may be more or less accessible to the player depending on authenticity, level of difficulty, and cognitive load.
Category 5: Considerations for Designing the Instructional Space		
The following situational principles provide more precise guidance regarding the design of the instructional space.		
5.1	Kinds of adjusting	Difficulty adjustment may involve sequencing cases from easier to more difficult or dynamically adjusting difficulty based on the learner's current zone of proximal development. Artificial prompts or automated task performance are adjustments that may be used to scaffold the learner toward the desired performance.
5.2	Kinds of coaching	Coaching can take the form of providing information, providing a hint or tip, or providing an understanding. It is typically provided when the learner just needs a little help to perform a part of his/her role.
5.3	Kinds of learning and appropriate instructional strategies	Different kinds of learning, such as memorization, skills, understanding, and attitudes and values, require different instructional and assessment strategies.

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Notes

* *Editors' note: As discussed in Chapter 1, active learning is highly valued in the learner-centered paradigm of instruction.*

** *Editors' note: Compare this with the continuous-change framework of planning, performing, and reflecting discussed in Chapter 9 on self-regulated learning.*

*** *Editors' note: See Chapter 1 on the importance of learning from peers through collaboration.*

† *Editors' note: The principles of gamification discussed in Chapter 13 also emphasize the importance of providing a safe environment for learning.*

* *Editors' note: Customizing instruction and providing instructional support when it is needed are highly valued in the learner-centered paradigm.*

* *Editors' note: This mastery approach is consistent with attainment-based instruction as described in Chapter 1 and competency-based education described in Chapter 2.*

** *Editors' note: For more on task-centered instruction, see Chapters 1 and 2.*

* *Editors' note: Scorekeeping is an important aspect of structural gamification as described in Chapter 13.*

* *Editors' note: Scaffolding in task-centered instruction is also discussed in Chapters 1, 3 (Principle 1), 4 (Principle 3), 6 (Principle 6), and 13 (Principle 3).*

* *Editors' note: Coaching is a natural part of task-centered instruction and is discussed in some detail in Chapters 1 (Principle 2), 3 (Principle 4), and 10 (throughout).*

9

DESIGNING INSTRUCTION FOR SELF-REGULATED LEARNING

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EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *All content.*

Learners

- *All students.*

Learning environments

- *Learner-centered rather than teacher-centered (learning is more important than "covering" content).*

Instructional development constraints

- *Minimal.*

Values (opinions about what is important)

About ends (learning goals)

- *Helping each learner to further develop self-regulation skills is highly valued.*
- *Helping learners to develop each other's self-regulation skills is highly valued.*

About means (instructional methods)

- *Treating each learner with respect and caring is highly valued.*
- *Embracing individual differences, capitalizing on individual strengths, and addressing individual weaknesses are highly valued.*

About priorities (criteria for successful instruction)

- *Efficiency is less important than effectiveness and appeal.*

About power (to make decisions about the previous three)

- *Providing as much learner control over what to learn, how to learn it, and when and where to learn it as the learner can deal with effectively is highly valued.*

Universal Principles

1. Use a problem- or project-oriented task

- *Choice of task: The teacher should help the learner develop SRL skills to identify a task of considerable learner interest that encompasses the learning of multiple standards across several content domains.*

- *Instructional approach: Teacher-centered instruction should be replaced by such learner-centered options as problem-based learning, project-based learning, and inquiry-based learning.*

2. Provide enough time and guidance for preparation

- *Help the learner to develop SRL strategies to set learning and task goals, performance standards, and processes and strategies.*
- *Embrace individual differences in goals, given learners' different goal orientations.*
- *Help learners develop the SRL skills to recall relevant prior knowledge and experience.*

3. Ensure ongoing assessment

- *Formative ongoing assessment: The teacher should help learners develop the SRL skill of ongoing self-assessment—to keep asking themselves questions such as "Is my strategy working?" throughout the SRL process.*
- *Summative authentic integrated assessment: Teachers should assess two things: task performance and attainment of competencies.*
- *Feedback from others: Provide learners with timely feedback from peer learners as well as teachers.*

4. Model SRL for learners

- *Teacher modeling: Teachers should model SRL both within and outside the classroom.*
- *Peer modeling: Peer modeling promotes learners' self-efficacy with SRL skills and processes.*

5. Provide learners with opportunities for application

- *Facilitate learners' application skills by grouping them and having them demonstrate what they do well in terms of SRL to their peers.*
- *Provide opportunities for the learners to explore new ways to use their SRL skills in everyday life.*

6. Provide learners with instruction on SRL skills and knowledge

- *Micro-level instruction: Utilize Merrill's (2006, 2007) three-part skill development model: Generality, Demonstration, and Practice with Feedback.*
- *Macro-level instruction: Based on the Elaboration Theory's Simplifying Conditions Method, include all three phases of the entire SRL process: Planning, Performing, and Reflecting.*

Situational Principles

When class size is large

- *Actively utilize team-based learning activities to meet different learners' needs, since large class size may lead to reduced ability to embrace individual student differences and meet individual needs.*

When time is limited

- *Design and implement interdisciplinary and multidisciplinary instruction to help improve efficiency while maintaining core characteristics of SRL instruction and learner-centered* *instruction.*

When learners are young

- *Use differentiated guidance to better support early education learners' SRL.*

Implementation issues

- ***Teacher acceptance of SRL:*** *Teachers who do not understand or accept the veracity of SRL may not be effective implementers.*
- ***Teacher experience with SRL:*** *Teachers new to SRL may need professional development and mentoring.*
- ***Teachers need time to prepare and implement SRL:*** *Administration must be willing to provide time and schedule flexibility to support teacher planning and for the implementation of SRL in courses.*

– C.M.R., B.J.B., & R.D.M.

DESIGNING INSTRUCTION FOR SELF-REGULATED LEARNING

I. Introduction

Self-regulated learning (SRL) refers to an ability of learners to actively and intentionally set goals for their learning and to monitor, regulate, control, and evaluate their cognition, behavior, motivation, and environments to achieve those goals (Pintrich, 2004; Zimmerman, 2000). SRL was one of the hottest topics of study from the 1980s to early 2000s, especially among educational psychologists. Recently SRL has once again gained much attention in the field of education, which can be understood by the growing interest in learner-centered instruction and the development of empowering educational technologies.

Why Is SRL More Important in Learner-Centered Instruction?

We are now living in the Information Age, having passed through the Agrarian and Industrial Ages (Toffler, 1980). After the Industrial Age, the role of education changed from producing factory workers for mass production to producing knowledge workers for continuous innovation and knowledge creation. Thus, the focus of education has also moved from sorting students to promoting learning for all students (Reigeluth et al., 2008). The Information-Age paradigm of education is learner-centered rather than teacher-centered, and learning activities for students are more customized than standardized, as described in Chapter 1.

The American Psychological Association (APA) and McCombs and Whisler (1997) have explored learner-centered instruction. The APA issued a report on learner-centered psychological principles with research evidence, and also examined special features of learner-centered classrooms and schools (APA Work Group of the Board of Educational Affairs, 1997). Among the principles they prescribed are students' ability and responsibility to self-direct and self-regulate their learning to eventually become life-long learners.

In learner-centered instruction, there is an assumption that students need to play a more active role in their learning processes. In a traditional classroom, teachers play a significant role in students' learning, such as deciding what to learn, when to learn, and how to learn. In contrast, students in learner-centered instruction have more control over their learning activities. The phrase "From a sage on the stage to a guide on the side" well represents the new roles of teachers and students in learner-centered instruction. With increased learner control, the ability of learners to regulate their learning has become more important for their success. In the current Information-Age paradigm of education, learner-centered instruction is central (Reigeluth et al., 2008), and SRL has been noted as an essential skill or competency for 21st-century learners (Wolters, 2010).

From time to time SRL is used interchangeably with self-directed learning (SDL). The concept of SDL was derived from andragogy (Knowles, 1968) and adult learning (Merriam, 2001). SRL and SDL share many characteristics, but the biggest difference is that SDL assumes learners initiate learning because they feel the need for new knowledge based on their experience. For example, a marketing associate feels that she has difficulties in answering some of the client's questions and needs more knowledge in accounting for her job responsibility, so she decides to enroll in online accounting courses at one of the online universities. She can be defined as a self-directed learner. SRL is a more process-oriented concept wherein learners regulate their cognition, behavior, motivation, and environments to achieve their goals.

In this chapter, the focus is mainly on K-12 contexts in which there is a curriculum and learners are not completely free to choose what they want to learn, so SRL is more suitable. However, it is our hope that K-12 students will eventually be encouraged to be self-directed learners in the learner-centered paradigm of education, and an ability to self-regulate their learning from early grades in the K-12 system will definitely help them ultimately become self-directed learners and effective, avid, life-long learners.

Why Is SRL More Important with the Development of Educational Technology?

Personalized learning (Clarke, 2003) is one of the essential characteristics of the learner-centered paradigm of instruction.[*] Every learner is different. Learners have different learning styles, different paces of learning, different interests, different career goals, and so on. In teacher-centered classroom instruction that is based on the Industrial-Age paradigm of education, students are supposed to receive the same instruction and move forward at the same pace regardless of their individual differences and varying degrees of mastery of content.

However, in learner-centered instruction, students take ownership of their learning, and learning is customized to their individual differences. When describing the concept of learning for mastery, Bloom (1968) noted that every learner can reach mastery if instructional methods and time can vary for them. In addition, based on a number of research studies that were implemented to test Bloom's concept of mastery learning, private tutoring was found to be the best instructional method for customizing learning experiences, whereby each tutor adjusted learning strategies and/or pace of learning based on each individual student's differences (Guskey, 2007). However, Guskey argued that private tutoring was impossible to accomplish because of the lack of such resources as budget, time, and available tutors.

Recently with the development of technology, we see more possibilities for personalized and customized learning, and consequently SRL. The development of technology has allowed new forms of learning in education, such as authentic online multi-media learning environments and computer-based, adaptive tutorials,[**] which facilitate SRL considerably more than traditional forms of learning can. As witnessed in many cases of online and blended learning, students can take courses they like at their own pace whenever and wherever they want (e.g., the Khan Academy). Because they are taking courses via Web-based instruction on their own, the ability to regulate their learning becomes more critical for them to achieve their learning goals and accomplish desired learning outcomes.

Theoretical Background

There are multiple theoretical explanations and perspectives on SRL such as social cognitive theory, volitional theory, and phenomenology (Zimmerman, 2001). However, social cognitive theory is the most popular theoretical explanation for SRL (Bandura, 1977, 1986). In social cognitive theory, Bandura views human functioning as a triadic and dynamic interplay of personal, behavioral, and environmental influences (see Figure 9.1). People are viewed to have certain capabilities, such as to symbolize, to plan strategies, to self-regulate, and to self-reflect, which make up major characteristics of SRL (Bandura, 1986).

In Figure 9.1 the bidirectional arrows stand for self-regulation of a person between the two determinants. For example, if a learner finds a Starbucks has become too noisy for study, she may move to a library. In this case, an environmental determinant (i.e., a noisy place for study) influenced her behavior (i.e., moving to a library). The opposite is also true in that how she interprets the result of her behavior also alters the environment. If she finds that moving to a less noisy place was successful for her study, she may remove a television from her room or install curtains on windows for future study.

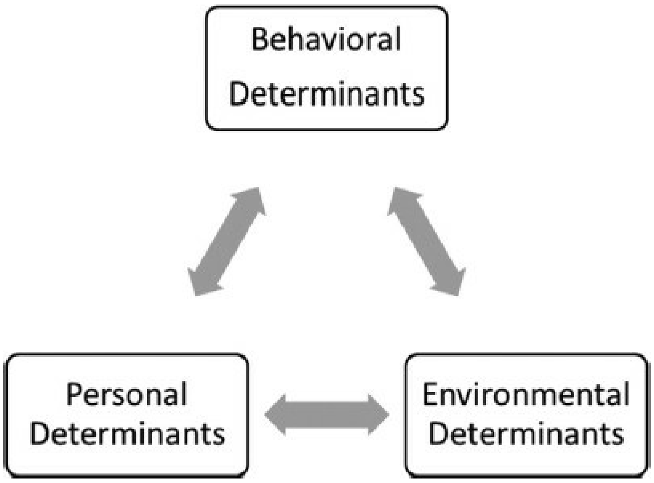

FIGURE 9.1 Triadic Interplay in Social Cognitive Theory

TABLE 9.1 Key Concepts of Past SRL Frameworks

Schunk (1990)	*Boekaerts (1996)*	*Zimmerman (2002)*	*Pintrich (2004)*
Goal setting Self-efficacy Self-regulation • Self-observation a. Self-monitoring b. Self-recording • Self-judgment a. Comparing performance with goals • Self-reaction a. Belief/ Satisfaction	Regulatory systems • Cognitive information processing system • Motivational-emotional system Levels within systems • Domain-specific knowledge • Strategy use • Goals	Forethought phase • Task analysis • Self-motivation beliefs Performance phase • Self-control • Self-observation Self-reflection phase • Self-judgment • Self-reaction	Phases • Forethought, planning, and activation • Monitoring • Control • Reaction and reflection Areas of regulation • Cognition • Motivation/ Affect • Behavior • Context

Several researchers have developed conceptual frameworks to better understand SRL. Table 9.1 shows a summary of the four major conceptual frameworks of SRL.

Even though they seem slightly different, all four frameworks share similar elements of SRL and the notion of phases. Based on the past conceptual frameworks, the first author has developed a modified conceptual framework to present the entire SRL process with sub-processes, along with overarching roles of self-efficacy and motivation belief (see Figure 9.2).

II. Values

Self-regulated learning can be applied to any contexts of learning (e.g., traditional brick-and-mortar school instruction as well as online virtual instruction), any content area and most learner populations, including K-12 students and adult learners.

It is important that both teachers and learners acknowledge the importance of SRL in achieving learning goals. The ability to self-regulate learning not only helps learners accomplish learning tasks and achieve the goals, but also helps learners become effective life-long learners, which is important now because we are living in a knowledge society where continuous learning and innovation are so important.

Effectiveness and appeal are important values underlying SRL instruction. Self-regulation skills improve the effectiveness of instruction, and self-regulation improves the appeal by offering control and pursuit of interests to learners

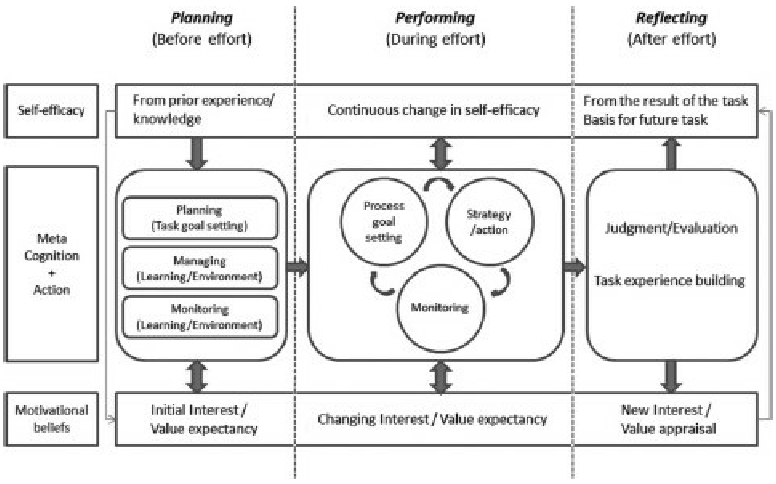

FIGURE 9.2 The Continuous-Change Framework for Self-egulated Learning

(Huh & Reigeluth, 2015)

Instructional methods for SRL should always:

- Provide as much learner control over what to learn, how to learn it, and when and where to learn it as the learner can deal with effectively.
- Help each learner to further develop his or her self-regulation skills.
- Help learners to develop each other's self-regulation skills"
- Treat each learner with respect and caring.
- Embrace individual differences, capitalize on individual strengths, and address individual weaknesses.

III. Universal Principles and Methods for SRL

There are two ways to understand SRL instruction. On one hand, teachers can redesign current content-based instruction to facilitate learners' SRL by utilizing certain instructional approaches and methods and providing specific learning environments. For example, teachers may ask learners to set goals for their learning, which is one of the essential parts of SRL, and they may utilize project-based learning with a one-to-one computer ratio as a learning environment to support learners' SRL. In this case, learning goals are still content-specific knowledge and skills, but SRL is a method that learners utilize to achieve their goals. On the other hand, teachers can specifically design and implement instruction to teach learners SRL skills utilizing various content domains. There is agreement among researchers that SRL is a skill that can be taught (Boekaerts, 1997; Zimmerman, 2002). Thus specific instruction or coaching may be utilized to teach learners SRL skills, as is done in Montessori classrooms. In this case, the primary learning goal is SRL skills, and various other kinds of methods should be utilized by instructors.

The focus of this chapter lies on the former: how to facilitate learners' SRL by redesigning current instruction using various instructional principles and methods, including providing a different kind of learning environment and culture. However the latter, designing instruction to better teach learners SRL skills, is also of great interest and importance, and one of the six universal principles describes how to better design such instruction.

1. Use a Problem- or Project-Oriented Task

Learning is better promoted when learners are engaged in real-world tasks* (M.D. Merrill, 2002, 2007, 2009), and this is especially true for SRL. Motivation is one of the overarching elements that affects learning, self-efficacy, and learners' exercise of SRL skills (Huh & Reigeluth, 2015). Moreover, learner interest (Eccles & Wigfield, 2002) and value expectancy (Wigfield, 1994) help learners develop higher motivation (Keller, 1983). That means the learner should have a high level of interest in the task and/or accomplishing its goal in order to have higher motivation for SRL.**

Choice of task

The task for the project or problem should be of considerable learner interest and encompass the learning of multiple standards across several content domains. Teachers should encourage each learner to identify real-world problems or issues that they are facing in their everyday lives or that are otherwise of interest to them, should match those with required standards, and should choose one of them as their task. It is important to invite learners to make decisions at the very first stage of their learning to give them responsibility and ownership. When learners are looking for a task, the teacher should encourage them to come up with a rationale for choosing it and the benefits its successful completion would bring to them or to others. Learners can identify several tasks at first, then narrow them down to the best one. In this process, teachers and peer learners can help each learner determine the final task. For example, teachers should take time to have each individual present their ideas to their peers, discuss the pros and cons of each task, and help the presenter choose the best one. Learners may want to work individually on their task or form a team around a task of mutual interest.

Instructional approaches

Some instructional approaches offer more opportunities for SRL than others. Teacher-centered instruction should be replaced by such learner-centered options as problem-based learning, project-based learning, and inquiry-based learning. In these instructional approaches, teachers play the role of a guide or a mentor instead of an instructor.*

2. Provide Learners with Enough Time and Guidance for Preparation

Preparation means planning for accomplishing the task in the planning phase.** It entails the learner setting a task goal, setting process goal(s), identifying resources, and planning for strategies. This is one of the most critical principles of SRL instruction for its success. Traditionally teachers do not have to allocate much time to preparation because every learner receives instruction with the same learning goals, process goals, resources, and time to complete them, so teachers directly jump into planning instructional content. However, in learner-centered instruction, teachers must direct much attention, time, and effort to accommodate various individual differences.

Articulate learning goals and tasks clearly

Good SRL skills include: a) setting one's learning goals based on state standards, career interests, and other learner interests; b) selecting a task and setting performance goals and standards (criteria for success) for the task based on their learning goals; and c) identifying processes and strategies for performing the task. Learner understanding about the task and its related learning goals are central to effective SRL. Teachers should help each learner to develop the SRL skills to do this well.

Embrace individual differences in goals

When learners set goals for their learning, teachers should embrace individual differences in such goals. Teachers should acknowledge that different learners have different competencies that need to be exploited. In addition, for the same competencies, different learners may have different levels of prior knowledge, experience, and skills, which require them to start in different places. Teachers also need to be aware that learners not only start in different places but also learn at different paces, which means some learners can accomplish more during a project period, and teachers need to think about how to further support their learning, such as preparing for additional, more advanced tasks.

Furthermore, any given complex task can be accomplished using different processes and strategies. Process goals are lower-level (instrumental) goals for achieving the task goals, given that a task consists of at least one process. For example, a learner has a task goal of writing up a 10-page essay on the U.S. Civil War. Process goals can include developing an outline, collecting data, writing the report, and proofreading. Given the same task, different learners may benefit from using different processes and different strategies.

Additionally, research shows that learners can be motivated by different goal orientations (Midgley et al., 2000). For example, one type of learner is motivated by their pure desire to learn. Their goal orientation is categorized as mastery goals, which in this case are synonymous with learning goals. Another type of learner is motivated by their desire to look good in front of their teachers and peers (i.e., performance approach goals) or not to look bad in front of them (i.e., performance avoidance goals). In cases when teachers are familiar with learners' goal orientations, the teacher may ask individual learners to set their goals in a way that is consistent with their goal orientation.

Ensure learners' recall of relevant past experience

Next, teachers should help learners develop the habit and SRL skills to recall relevant prior knowledge and experience.[*] In order to better help learners for this process, teachers may initially prepare some prompting questions such as "What was your past learning experience on this topic? Was it successful? Did you enjoy it?" "What kinds of strategies did you use to accomplish the task?" "Did any strategies not work well?" "Why do you think they did not work well?" and "How would you do it differently?" Teachers can encourage learners to use these questions now and in the future, individually and in teams.

3. Ensure Ongoing Assessment

Assessment in SRL is related to monitoring and feedback events. Assessment should be happening constantly and also be integrated into instruction.[**] As seen in Figure 9.2, the performing phase (i.e., during learning) requires the learner to go through at least one cycle of strategy use, monitoring, and evaluation; and often it requires multiple iterations of strategy use, monitoring, evaluation, and strategy re-planning. More complicated tasks may be divided into several processes, each of which may require multiple iterations of this SRL cycle.

For example, Ryan was asked to write a mock newspaper article about water pollution in the U.S. as an individual project. This task entailed multiple sub-processes, such as creating an outline, gathering data, analyzing data, interpreting data, writing, and proofreading. For the gathering-data process, Ryan set his process goal as to identify water pollution figures from such credible sources as government reports for at least 10 states within 30 minutes. His initial strategy was to use Google search because he had a computer with Internet access as a resource and he had successful past experiences in gathering data using Google search. He monitored his progress toward meeting his process goal, but he found that the data from Google search lacked credibility of the source and did not cover 10 states. Then he decided to change his strategy by asking experts.

Formative ongoing self-assessment

As seen, when there are multiple processes to complete a complex task, it is very important for learners to assess their progress and change their plan or strategy if necessary. Thus, the teacher should help learners develop the SRL skill of ongoing self-assessment—to keep asking themselves questions such as "Is my strategy working?" throughout the SRL process. This may include prompting learners to see whether they are doing fine and whether they need to make changes to their task process or strategy.

Summative authentic integrated assessment

Summative assessment is also important in that its results can improve performance on future tasks. For example, if a learner receives a positive and satisfactory result from the summative assessment on completion of a task, the successful experience contributes to learners' self-efficacy and motivation in related areas (Keller, 1983), and detailed success information such as strategies used will help them succeed in related tasks in the future.

It is helpful to think of assessment in two different areas. One is assessing learners' task performance and the other is assessing their attainment of competencies. Learners need to attain certain competencies in order to accomplish their tasks successfully. In SRL instruction, summative assessment can be done in the form of authentic integrated assessment to see learners' task performance. Authentic assessment means assessing learners' performance in a way that is consistent with the real-world context where the performance would normally occur (Gulikers, Bastiaens, & Kirschner, 2004). Especially in SRL instruction, learners' task performance can be assessed by their project outcomes. And teachers may invite experts or other community members into the assessment procedure. For example, in a secondary social studies class, a learning objective was to understand the reasons why World War II broke out. Learners were asked to create a website presenting various reasons behind the war. Teachers, of course, participated in the assessment, but also they invited local university experts in international relations and politics for the assessment process.

On the other hand, teachers also need to assess whether learners have attained certain competencies throughout the process of completing the project. The fact that a learner completed a project once does not always mean the learner mastered the necessary competencies, and moreover in a team-based project some learners may have mastered the competencies while others have not, even though there was still had a good project outcome. Thus teachers also need to assess learners' attainment of competencies. Especially in SRL instruction and when the class size is large with team-based activities going on, it can be very difficult for teachers to assess individual learners' attainment of competencies. Teachers in this situation can integrate assessment of competencies, such as a quiz or practice in the learners' instruction, and also help learners set their goals with conditions for mastery, such as getting the quiz questions right five times in a row or summarizing a three-page article in one paragraph in 15 minutes. Moreover, teachers can create a checklist for assessing attainment of competencies and provide learners with it for promoting their self-assessment skills, too. In all assessments, teachers should make sure there is an alignment between the goals and the assessment.

Feedback from others

Another important kind of assessment is to give learners feedback. It is extremely important to provide learners with timely feedback when the need is identified. Feedback can come from both teachers and peer learners. The feedback should be both informative (so the learner can improve their performance) and motivational (positive). As noted before, self-efficacy is one of the important elements of SRL, and it is promoted when learners receive positive feedback from teachers, peers, and digital systems. Teachers can provide feedback to learners when monitoring their progress and playing the role of a guide or mentor, and peer feedback activities can entail learners discussing their progress and products and giving each other feedback. If necessary, teachers may give a lesson to learners on how to give positive and informative feedback.

4. Model SRL for Learners

This universal principle is well aligned with Merrill's demonstration principle[*] (M.D. Merrill, 2002, 2013). Teachers are encouraged to model SRL so that learners can learn from observation. Demonstration and modeling are more powerful ways to promote learning than mere description of what to do and how to do it. Bandura (1986) also presented modeling as one of the five core elements of his social cognitive theory. Modeling can be of two kinds based on who is the role model: teacher or peer.

Teacher modeling

Along with Bandura's social cognitive theory, other social learning theorists such as Vygotsky also emphasized the importance of a model (Vygotsky, 1978). When he discussed the learner's zone of proximal development (ZPD), the importance of more knowledgeable others (MKO) is emphasized. That is, learners can learn from a MKO, and they are likely to learn more from an MKO who has greater credibility. Hence teachers are perfect matches for a MKO, given their considerable credibility. The teacher's role as a self-regulated learner was also described in Volume II of this series (Corno & Randi, 1999).

Teacher modeling should happen both within and outside instruction. Outside instruction means any time period other than instruction, such as a break or lunchtime. During instruction teachers can integrate SRL modeling into their pedagogy. For example, when teaching the concept "mammal" to early education learners, a teacher chose to use direct instruction to provide the learners with characteristics of a mammal based on her previous teaching experience and let them solve the practice questions to identify mammals among multiple options. The teacher walked around the classroom and monitored how they were doing with answering the questions, and she realized most of the learners were doing poorly. Then she decided to use a different instructional strategy in that she gave examples and non-examples of mammals with an explanation of why each is or is not a mammal using the provided characteristics. This is an example of a teacher modeling SRL in terms of strategy planning, implementation, monitoring, evaluation, and another cycle of strategy planning, implementation, monitoring, and evaluation.

When modeling SRL, teachers also have to make sure they take some time to communicate what they are doing and debrief their SRL process to learners. This can be done by labeling their activities, providing learners with a summary, and engaging learners in reflection activity. Modeling does not always mean a live demonstration, and a written document such as a summary paper or a reflective essay can be an example of indirect modeling (Pajares, 2002).

Peer modeling

Peer learners are another good agent for modeling SRL, and peer modeling is also a good way to promote learners' self-efficacy. As mentioned earlier, self-efficacy is an overarching element in the entire SRL process, along with motivation. In addition, self-efficacy has been shown to have a strong positive relationship with learners' SRL in that learners with higher self-efficacy are likely to show higher levels of SRL and subsequently higher learning outcomes (Harrison, Rainer Jr, Hochwarter, & Thompson, 1997; Schunk, 1984; Schunk & Ertmer, 2000; Williams & Williams, 2010). The reason that peer modeling is effective in promoting self-efficacy is that learners are likely to develop self-efficacy by vicariously observing other learners doing well in the task. Moreover if learners think the model shares many similar characteristics with them, they can develop even greater self-efficacy. Hence, if Jane saw that her friend Kate did a wonderful job in goal setting tasks and she thinks Kate is very similar to her in many ways, such as GPA, academic ability, personality, and even height and looks, Jane would be likely to develop higher self-efficacy by believing she could also do a good job in goal setting. Thus, teachers may pick a learner and ask her to demonstrate SRL to the class or utilize a method such as reciprocal teaching and group presentation so that learners have an opportunity to model SRL to each other.

As in teacher modeling, it is also important for teachers to take time to discuss examples of SRL witnessed in peer modeling. For example, a teacher could have a class debrief session in which a learner or a group of learners demonstrates what they did regarding SRL, and the entire class could participate in discussion on what they did, how well they did, and what they would do differently.

5. Provide Learners with Opportunities for Application

In Merrill's first principles of instruction, the application principle states that learning is promoted when learners use their knowledge or skill to solve problems[*] (M.D. Merrill, 2002). Because SRL is encouraged based on a problem-based or a project-based task, learners have plenty of opportunities to apply their new knowledge and skills of SRL to perform the task and learn from it.

Teachers can facilitate learners' application stage by grouping them and having them demonstrate what they do well in terms of SRL to their peers. Group members can discuss each other's SRL practice, and teachers should give helpful feedback or comments on it.

In addition, teachers can ask learners to practice SRL or any SRL processes in their everyday lives outside the class[**] and have them create a short report on their SRL practices. For example, the report may include description of the task, what goals they set, what strategies and resources they used, how they monitored their progress and modified their plan if necessary, and how well they achieved their goals and how they reflected on the experience. Based on this report, learners can give group presentations to provide an opportunity to learn from each other.

6. Provide Learners with Direct Instruction on SRL Skills and Knowledge

As noted before, from time to time teachers may need to teach SRL skills and knowledge to learners to promote their SRL, because each learner's level of SRL can vary tremendously. If learners are not familiar with certain SRL skills and related knowledge, providing them with ownership and responsibility for learning does not guarantee their successful learning. In the worst case, those learners may experience difficulties in SRL and eventually lose interest in and motivation for learning.

Hence, teachers may need to design instruction to teach learners SRL skills and knowledge, and the guidelines on how to do this are as follows. There are two levels in instruction to teach SRL skills: micro and macro.

Micro-level instruction

First, micro-level instruction covers teaching individual elements of SRL (e.g., goal setting, monitoring, evaluating). Since the instruction deals with knowledge on "how to," teachers can refer to Merrill's (2006, 2007) standard three-part skill development model.[*] Figure 9.3 depicts the three-part model.

Generality. It is helpful for teachers to provide learners with a general description of what the elements of SRL are. For example, teachers can explain what learning goals are, including the characteristics of learning goals, why learning goals are important for learners, and when they need to set up goals. Basically learners receive information about the skill that they are going to learn. Another aspect of the generality provides learners with a description of how to do it. With the same goal setting example, teachers should describe to learners how to set learning goals. For example, teachers might explain a step-by-step procedure of how to set learning goals, or they could describe what the criteria are to determine a good learning goal.

FIGURE 9.3 Merrill's Three-Part Skill Development Model

Demonstration. Demonstration is where teachers demonstrate what was just described in the generality part of the micro-level instruction. Teachers demonstrate what it is and how to do it. One of the effective methods to demonstrate a concept-classification skill is to utilize examples and non-examples. Using some of the information provided in the generality (e.g., criteria for a good learning goal), teachers can demonstrate how to set a good learning goal, and they can provide examples and non-examples of a good goal setting process in order to promote learners' understanding. It is typically beneficial that teachers describe the skill and demonstrate it at the same time.

Practice with feedback. The last part of micro-level instruction is having learners practice the skill by themselves and providing them with immediate feedback when they are practicing it.

Macro-level instruction

The second level of instruction is the macro level. While micro-level instruction teaches each individual SRL element, such as goal setting or monitoring, macro-level instruction covers an entire SRL process. The entire SRL process has three phases, and each phase includes several sub elements (see Figure 9.2). Learners' being able to do individual SRL elements does not necessarily mean they are able to successfully complete the entire SRL process. It is necessary for learners to understand and accomplish the entire SRL process.

The elaboration theory's simplifying conditions method (Reigeluth, 1999)[*] and the whole-task approach (P.F. Merrill, 1980; van Merriënboer, Clark, & de Croock, 2002) present methods for scope and sequence decisions for a whole SRL process. The instruction can be designed for an entire phase or even the entire SRL process at once in the whole-task approach, for which it would be wise to use the elaboration theory's simplifying conditions method (Reigeluth, 1999) to avoid cognitive overload. This entails first teaching the simplest real-world version of the performance of SRL, before teaching progressively more complex versions. Even artificial simplifying conditions can be created to make sure the first version is simple enough to avoid cognitive overload for teaching a complete SRL process. For instance, in the planning phase, a task goal can be given to the students so that they can move to the next phase with minimal cognitive load and get experience in the whole SRL process quickly and easily. Once they master a version of the whole SRL process that meets the simplifying conditions, they can move on to more complex versions of SRL.

IV. Situational Principles

In addition to the abovementioned universal principles, it is evident that there are situations that may affect how instruction should be designed differently (Reigeluth & Carr-Chellman, 2009). Some of the major situationalities for SRL instruction include class sizes, time constraints, learners' developmental levels, learners' SRL levels.

When Class Size Is Large

It is true that the principles for SRL instruction are more suitable for small class sizes.[*] Because learner-centered instruction and SRL both embrace individual differences and let learners have as much responsibility for and ownership of their learning as possible, it is much harder for teachers to implement such instruction in a large class. From a research effort to identify learner-centered schools in the U.S., many of the identified learner-centered schools are charter schools or schools with small class sizes, such as the schools in Chugach, Alaska (Reigeluth & Karnopp, 2013).

If the class size is large, teachers may have to sacrifice a certain degree of embracing individual differences and meeting individual needs. However, teachers can actively utilize team-based learning activities** to meet different learners' needs. For example, instead of letting each learner choose the task of their interest, teachers may group learners based on similarities in interests and have them complete the same task as a team. In most cases, project-based learning and problem-based learning are implemented in teams to promote collaborative learning. In addition, when forming a team, purposive grouping can be done to include learners with different degrees of understanding in the same team, which promotes social learning, peer coaching, and peer tutoring. Constructs such as individual leadership traits can also be used for purposive grouping, which can promote collective efficacy of a team (Huh, Reigeluth, & Lee, 2014). Other examples of team-based learning activities include peer review, group discussion, and peer feedback on presentations.

When Time Is Limited

This situationality is closely related to the first one (i.e., when class size is large). Instructional approaches more suitable for SRL (e.g., task-based learning) typically require more time for preparation and implementation than traditional, teacher-led, direct instruction. Moreover, with a large class teachers may feel more time constraints than they may with a smaller class.

If time is limited,* designing and implementing interdisciplinary and multidisciplinary instruction can help improve efficiency while maintaining core characteristics of SRL instruction and learner-centered instruction. For example, instead of having one project cover one subject area, teachers from different subject areas can collaborate to create a project that encompasses multiple subject areas and multiple academic standards. Hence, teachers can reduce time demands by implementing one project for multiple subject areas.

Furthermore, if teachers feel time constraints, they may not be able to provide learners with necessary instruction on SRL skills. Such instruction is needed for learners who have low levels of SRL skills and experience. However, that instruction is not directly related to the content domain, so it can be difficult for teachers to take the time. If this is the case, a relatively new but popular instructional strategy, the flipped classroom, can be one solution (Bergmann & Sams, 2012). For example, instead of using class time to give content-area instruction to learners, teachers can create a podcast or video recording of the instruction and let learners watch it and bring questions about it to class, so that the teacher and learners can save some class time for developing SRL skills.

When Learners Are Young

Some people may argue that young learners such as kindergartners and grade 1–3 learners do not possess enough skills for SRL developmentally. This may seem logical because SRL is a higher-order skill set that includes metacognitive skills, and learners typically develop SRL by accumulated experience and observation. However, research findings suggest that even elementary school students show a decent degree of SRL (Dignath, Buettner, & Langfeldt, 2008; Schunk & Zimmerman, 2007), and the experience in Montessori schools bears this out. Even though younger students showed some degree of SRL, it is apparent that their SRL skills are typically less than those of older learners.

Therefore, differentiated guidance may better support early education learners' SRL. Reigeluth's simplifying conditions method (Reigeluth, 1999) as well as van Merriënboer's design model, the four-component instructional design (4C/ID)-Model for complex learning (van Merriënboer et al., 2002) can be utilized for this type of differentiation. The simplifying conditions method calls for giving students who lack many SRL skills several simple, whole, real-world self-regulation tasks (a simple version of SRL tasks) first until simple SRL skills have been mastered. Once they get experience from cases that meet the simplifying conditions, they can move on to more complex versions of SRL. Similar to that, the 4C/ID-Model recommends simple-to-complex versions of the whole task, progressing from simple versions with a high level of embedded support to complex versions with a lower level of support. For example, a very young learner might assume the task of cleaning a table after having snacks. Her teacher would prompt her to set the goal and standards to be met, recalling any relevant prior experience, then plan the process and strategies for cleaning the table, seek formative feedback, and finally self-evaluate the final result and reflect on ways she might do the task differently in the future. With repetition, this process will become automatic, and she is ready to take on a slightly more complex case of SRL.

V. Implementation Issues

In order to implement SRL instruction as the universal and situational principles describe, the following issues can be anticipated. First of all, teachers must value SRL and learner-centered instruction. Teachers who do not believe that learners should have more control and ownership over their learning will not use SRL successfully. Second, teachers need experience in utilizing SRL and learner-centered instruction, because both require massive changes in teachers' roles and skills, based on being a mentor or a guide instead of a "sage on the stage."

Schools may utilize professional development opportunities for educating teachers on the importance of SRL and learner-centered instruction and on how to do them. Moreover, pairing novice SRL teachers with expert SRL teachers can help transform their mindset and develop their skills in implementing SRL instruction. This is a sort of apprenticeship in which novice teachers learn from experts by observing what and how they are designing and implementing SRL and learner-centered instruction and by asking questions.

Another important implementation issue is related to administrative structure and flexibility. SRL instruction requires learner-centered instructional approaches such as problem based learning or project based learning (PBL), and those usually require more preparation and implementation time. Moreover, in order to improve efficiency, multi-disciplinary tasks are beneficial. However, in general teachers do not have as much time as they need for PBL or to collaborate with other teachers to design and implement multi-disciplinary projects. Thus, organizational flexibility is a key implementation issue for successful SRL instruction. Teachers might use a "proof of concept" approach by starting with a small task to show administrators the effectiveness of SRL and get their support to expand the concept to the entire school.

VI. Closing Remarks

For a long time, self-regulated learning has been studied as an effective way to promote learning. Learners who have higher levels of SRL skills are likely to have higher learning outcomes compared to those who have lower levels. Moreover, online learning and learner-centered instruction are gaining popularity, and SRL is an essential part of both because learners must assume greater responsibility for, and ownership of, their learning.

Successful SRL instruction can be achieved by implementing the universal principles in this chapter and using the situational principles in appropriate situations. SRL instruction should use a problem- or project-oriented task in which learners play an active and central role in their learning. Teachers should make sure they allow learners to have enough time and guidance for planning, and make sure to embrace individual differences in the planning phase. Ongoing assessment should be realized throughout the entire SRL process, and both teachers and learners should be responsible for modeling SRL to learners. Finally, teachers should provide opportunities for learners to practice the SRL skills and knowledge with feedback, and if necessary teachers should also provide instruction on SRL skills.

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Notes

* *Editors' note: See Chapter 4, Principles for Personalized Instruction.*

** *Editors' note: See Chapter 11, Designing Technology for the Learner-Centered Paradigm of Education.*

* *Editors' note: This is addressed by Principle 2 in Chapter 1, all of Chapter 3, Principle 2 in Chapter 4, much of Chapters 6 and 7, and Principle 2 of Chapter 8.*

** *Editors' note: Enhancing intrinsic motivation is an extremely important principle for the learner-centered paradigm of education and is inherent in most of the theories in this volume.*

* *Editors' note: This new role for the teacher is also an extremely important principle for the learner-centered paradigm (see Principle 4 in Chapter 1, Implementation Issues in Chapter 5, and Principle 4 in Chapter 7); and it is an implicit part of most of the other theories.*

** *Editors' note: Planning for instruction is a crucial design principle addressed as Principle 4 in Chapter 1, Principle 1 in Chapter 4, Principle 2 in Chapter 10, and Principle 2 in Chapter 11. However, what is planned, how, and by whom tend to vary from design theory to design theory.*

* *Editors' note: This is one of Merrill's five "first principles" (M.D. Merrill, 2013) and is described by Principle 2 in Chapter 3.*

** *Editors' note: These are consistent themes for the learner-centered paradigm, addressed by Principle 1 in Chapter 1, Principles 4–6 in Chapter 2, Principle 4 in Chapter 3, Principle 4 in Chapter 4, and Principle 2 in Chapter 7.*

* *Editors' note: See Principle 3 in Chapter 3, Principles for Task-Centered Instruction, and Chapter 3 in Volume III.*

* *Editors' note: See Principle 4 in Chapter 3, and Chapter 3 in Volume III.*

** *Editors' note: Linking learning to the learner's life is an important principle and is addressed by Merrill's integration principle (see Chapter 3 in Volume III), Principle 5 in Chapter 3, Principle 7 in Chapter 6. This principle is similar to selecting real-world tasks that the learner will perform after the designed instruction has ended.*

* *Editors' note: See also Volume I, Chapter 9, Component Display Theory.*

* *Editors' note: This is Chapter 18 in Volume II.*

* *Editors' note: As the leaner-centered paradigm organizes learning around projects rather than courses, class size becomes the issue of how many students a teacher is responsible for.*

** *Editors' note: Team-based learning activities are beneficial not only when the class size is large, but also when the class is smaller.*

* *Editors' note: Since the learner-centered paradigm uses learning-based student progress rather than time-based student progress, this will largely cease to be a problem in the future.*

10

DESIGNING INSTRUCTIONAL COACHING

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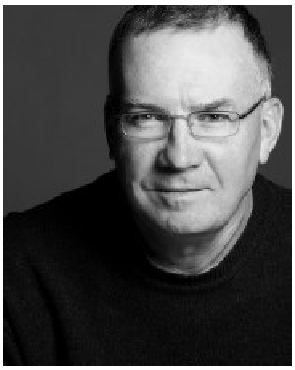

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EDITORS' FOREWORD

Preconditions (when to use the theory)

Content *

- *Instructional coaching focuses on helping teachers improve, leading to better student learning. The content of the coaching is related to instructional design.*
- *Instructional coaching principles described in this chapter may be applicable to other coaching situations as well (e.g., a teacher coaching students).*

Learners

- *Teachers are the primary target of instructional coaching. Ultimately, the students of these teachers are the beneficiaries of effective implementation, and these "second order" learners can be anyone.*

Learning environments

- *Contexts within which teachers teach; situations in which teachers are available to work one-on-one with coaches.*

Instructional development constraints

- *Minimal.*

Values (opinions about what is important)

About ends (learning goals)

- *Adoption by teachers of* ***research-based instructional practices*** *is highly valued.*
- *Reflection on and* ***practice*** *of personally relevant ideas are highly valued.*

About priorities (criteria for successful instruction)

- *Efficiency (in terms of cost) is a concern.*

About means (instructional methods)

- ***Dialogue****, or learning conversations, between coach and teacher are highly valued.*
- *A* ***multi-vocal*** *partnership providing opportunities for both parties to express their point of view is highly valued.*
- *A* ***reciprocal*** *learning perspective is highly valued; both coaching partners benefit.*
- *Integration of goal setting, questioning, and data gathering with* ***explanation****,* ***modeling****, and* ***feedback*** *is highly valued.*
- *The use of video of the teacher's classroom performance to prompt* ***self-reflection*** *and changes to practice is highly valued.*

About power (to make decisions about the previous three)

- *Partnership between **equals** is highly valued, with coaches being responsible for facilitating improvement of teachers but not for evaluating performance.*
- *Individual and collaborative **choices** are highly valued.*

Universal Principles[*]

1. Observation and goals

- *Gather data on what is currently happening in a teacher's classroom (or other coaching context).*
- *Share the data gathered with the teacher for her or his review.*
- *Collaborate together to identify a performance goal that is compelling to the teacher.*
- ***Situational variation**: If a teacher seems uneasy about this activity, then the teacher should watch the video alone first. The teacher can make notes of positive aspects and challenges they observe in the video and bring these to their meeting with the coach.*

2. High-leverage practices

- ***Content planning:** The coach helps the teacher plan effective courses, units, and lessons.*
- ***Formative assessment practices:** The coach helps the teacher use formative assessment to identify precisely what the students are to learn, how to assess student understanding, and how to provide feedback to students on their progress.*
- ***Instructional practices:** The coach helps the teacher develop effective instructional practices—ones that increase engagement and mastery during lessons.*
- ***Community building:** The coach helps the teacher create safe and productive learning environments.*
- ***Self-regulated**: All coaching is done only in the service of the teacher's goals.*

3. Explicit explanations

- *The coach provides explanations that are clear and easy to act on; this requires deep, complete understanding of the practices.*
- *The coach explains how to adapt practices to be best suited to the needs of the individual teacher.*

4. Modeling

- *The coach demonstrates a new practice in the teacher's classroom, explaining how a particular practice could be implemented; the teacher observes the coach.*
- ***Situational variation**: If traditional approaches to modeling are not feasible or preferred, then the coach should use alternate methods of modeling, such as teaching without students present, co-teaching with the teacher, suggesting that the teacher observe other classrooms in the school, or sharing videos of other teachers.*

5. Deliberate practice and progress toward the goal

- *Provide opportunities for the teacher to practice the new skills as the coach gathers and shares data on the impact of the practice, until the goal (criterion for success) is reached.*

6. Reflection

- *The coach helps the teacher reflect on what she or he is learning, and the coach reflects on her or his own learning; reflection often leads to new or revised goals.*
- ***Situational variation**: If the teacher decides to pursue a second or third goal, then the coach should encourage the teacher's reflection to focus on identifying new goals.*

– C.M.R., B.J.B., & R.D.M.

DESIGNING INSTRUCTIONAL COACHING

I. Introduction

In the past two decades, there has been a growing interest in how coaching of teachers (as professional development) can be implemented in schools. Broadly defined, coaching involves one-on-one training of a teacher by a coach with the goal of improving instruction and student learning (Knight, 2011a). A growing consensus among scholars and practitioners suggests traditional professional development alone, involving short-term workshops disconnected from teachers' local context or subject area, is unlikely to improve outcomes for teachers and students (Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). However, when quality professional development is closely linked with teacher coaching, instructional change significantly improves (Showers & Joyce, 1996). In addition, coaching may be instituted without formal, large-group, professional development when teachers and coaches work together in partnership to analyze student and pedagogical needs and select interventions that support new instructional practice (Killion, 2006). One approach to coaching that is being widely implemented in U.S. schools with measureable success is Instructional Coaching (Knight, 2007). During instructional coaching, the goal setting, questioning, and data gathering typical of one-to-one coaching are integrated with explanation, modeling, and feedback.

In this chapter, we focus on helping teachers improve their performance through coaching, leading to more effective learning in their classrooms. In our example of learner-centered instruction for this volume, classroom teachers take the role of students. The coaching process is a learner-centered instructional approach that can be used in many settings, not just in coaching teachers. Our purpose is to provide: a) a brief overview of coaching in general, b) a definition of a specific model called *Instructional Coaching*, c) an explanation of the underlying theory behind this approach to coaching, d) a description of the principles that guide the instructional coaching process, and e) a discussion of how instructional coaching might be implemented in schools.

Current Status of Coaching

Since the passing of the No Child Left Behind Act in 2001, which placed greater emphasis on evidence-based teacher professional development, educators have sharpened their focus on identifying effective models for professional learning (Hamilton et al., 2007; Overbaugh & Lu, 2008). Several other federal policies, including Reading First and Striving Readers, have encouraged the use of coaching in teacher professional development (Marsh, McCombs, & Martorell, 2009). Recently, adoption of the Common Core State Standards (CCSS) has some educators thinking about the use of coaching to support teachers as they make significant changes in instructional practices that are aligned with the CCSS (Santos, Darling-Hammond & Cheuk, 2012). Despite these trends, nine out of ten teachers included in the 2003–04 School and Staffing Survey reported participating in short-term conferences or workshops, whereas far fewer reported having access to extended learning opportunities such as mentoring or coaching (Darling-Hammond et al., 2009). More recent figures from the Beginning Teacher Longitudinal Survey suggest that coaching and mentoring are still underutilized in practice (Gray & Taie, 2015). In the following section, we describe some of the obstacles school districts face in implementing coaching programs.

II. Theoretical Foundations

Enormous expense and effort has been dedicated to identifying, codifying, and validating the practices of effective teachers (e.g., Hattie, 2009; Marzano, 2001). As a result, professional learning in education is frequently dedicated to teaching teachers how to implement those practices. Unfortunately, when leaders are positioned as experts and teachers are positioned as novices to be trained by those experts, the inherent inequality of the training relationship interferes with the likelihood that the practices will be implemented. Coaching expert Timothy Gallwey (2001) summarizes why the traditional expert–novice relationship often fails:

> Change is viewed as a movement from bad to good, defined and initiated by someone other than the one who is making the change. It is done in a judgmental context that usually brings with it resistance, doubt, and fear of failure on the part of the student. Neither student nor teacher is likely to be aware that this approach to change undermines the student's innate eagerness and responsibility for learning. (p. 6)

Recognizing the ineffectiveness of traditional training, many professional developers have adopted an alternative approach to coaching, in which they choose not to share ideas, instead believing that those being coached hold within them the answers to their challenges, and that the goal of coaching, therefore, should be to assist others as they identify opportunities, unleash solutions, and focus their efforts.* While honoring the professionalism of teachers, this approach is not designed to help teachers learn proven practices. By comparison, instructional coaching does both—it honors teachers but is also designed to ensure teachers learn the best practices.

Instructional coaches partner with teachers to help them incorporate research-based instructional practices into their teaching. Like mentors, specialist coaches, and collaborative coaches, instructional coaches employ effective listening, dialogical questioning, and other communication and relationship-building strategies. What distinguishes this model from other approaches is that instructional coaches *teach* others how to learn very specific, evidence-based teaching practices such as formative assessment (Stiggins, Arter, Chappuis, & Chappuis, 2009) or cooperative learning (Slavin, 1983). Instructional coaches have a thorough knowledge of the teaching practices and frequently provide model lessons, observe teachers, and simplify explanations of the teaching practices they share with teachers.

In the remainder of this chapter, we discuss the theory underlying instructional coaching and provide an overview of the specific components of coaching that grew out of our ongoing study of onsite professional development. The chapter also describes the framework we use to identify where to start with teachers and several factors that we have found to be important when it comes to the success of coaching programs. While further research is warranted, several small-scale studies showing promising results have been conducted to develop, validate, and refine this approach to improving instruction (Knight et al., 2011; Knight & Cornett, 2009; Knight et al., 2010).

III. Values in Instructional Coaching: The Partnership Approach

The partnership approach is the theory behind instructional coaching. Instructional coaches honor the professionalism of teachers by grounding their work in the foundational belief that the coach and teacher see their relationship as an authentic partnership between equals and not a relationship between an expert and a novice. This partnership is articulated in values (Knight, 2011b) that shape everything an instructional coach does. Coaches use the partnership values to evaluate the effectiveness of previous actions, to make decisions in the midst of interactions, and to plan future interactions. The values are as follows.

1. **Equality.** Partnership involves relationships between equals (Block, 1993; Eisler, 1988; Schein, 2009). Thus, everyone's thoughts and beliefs are held to be valuable, and although each individual is different, no individual decides for another.
2. **Choice.** In a partnership, one individual does not make decisions for another (Block 1993; Senge, 1990). Because partners are equal, they make their own individual choices and make decisions collaboratively.
3. **Dialogue.** To arrive at mutually acceptable decisions, partners engage in dialogue (Bernstein, 1983; Bohm, 1996, 1998; Isaacs, 1999). In a partnership, one individual does not impose, dominate, or

control. Instead, partners engage in conversation, learning together as they explore ideas.

4. **Praxis.** The purpose of partnership is to enable individuals to have more meaningful experiences. In partnership relationships, meaning arises when people reflect on ideas and then put those ideas into practice (Freire, 1980; Gadamer, 1975; Senge, 1990). A requirement for partnership is that each individual is free to reconstruct and use content the way he or she considers it to be most useful.
5. **Voice.** Partnership is multi-vocal rather than univocal, and all individuals in a partnership have many opportunities to express their point of view (Argyris, 1999; Bohm, 1996; Isaacs, 1999; Vella, 1995). Indeed, a primary benefit of a partnership is that each partner gets to learn from others, rather than just repeating what he or she already knows.
6. **Reciprocity.** In a partnership, everyone benefits from the success, learning, or experience of everyone else (Freire, 1980; Senge, 1990; Vella, 1995). Therefore, people taking the partnership approach go into conversations expecting to learn.

IV. Universal Design Principles for Instructional Coaching

The partnership values described above come alive in the process of instructional coaching. The instructional coaching process is not employed as a blueprint to be followed step-by-step, but as a framework to be adapted by the coach so as to fit each coaching situation. The process usually involves the following six components, which may be conceived as "universal design principles": observation and goals, high-leverage practices, explicit explanation, modeling, deliberate practice and progress toward the goal, and reflection. Below we expand on each of these components of coaching. Throughout this discussion we also refer to "situational design principles" that provide the reader with specific examples of recommended coaching behaviors.

1. Observation and Goals

More than two decades ago, Robert Fritz (1989) suggested that two factors are important for personal growth: a) a clear picture of current reality, and b) a clear goal that motivates an individual to move beyond that current reality.[*] Knowing where we are and knowing where we want to go, Fritz argued, creates a tension that can only be resolved by growth. Peter Senge, in his seminal work, *The Fifth Discipline* (1990), summarized Fritz's ideas as follows:

> The juxtaposition of vision (what we want) and a clear picture of current reality (where we are relative to what we want) generates what we call "creative tension": a force to bring them together, caused by the natural tendency of tension to seek resolution. The essence of personal mastery is learning how to generate and sustain creative tension in our lives. (p. 132)

Instructional coaches begin the coaching process by partnering with teachers to set up this creative tension. First, to create a clear picture of current reality, they gather data on what is currently happening in a teacher's classroom. The data could consist of student achievement measures, student opinions gathered through surveys such as those developed by Harvard researcher Ron Ferguson in the Tripod Project, or more frequently, video data gathered in a teacher's classroom using a camera such as a Go Pro, iPhone, iPad, or Flip camera.

Instructional coaches share the data they gathered with teachers or share video with teachers for their review. Video has proven to be especially powerful since our experience suggests that teachers (like most professionals) are often unaware of what their professional practice looks like until they see video of their lessons—this is consistent with Prochaska's findings about pre-contemplation during change (Prochaska, Norcross, & DiClemente, 1994).

After teacher and coach have reviewed the data, together they identify a goal. Teachers who watch their teaching and their students on video are often especially committed to identifying a goal. An appropriate goal could be a student goal related to behavior (fewer than four disruptions per 10 minutes), achievement (95% mastery of informal checks for understanding), or attitudes (90% of students will say they enjoy reading on our quarterly survey). Effective goals are a) specific, b) measureable, and c) compelling to the people who set them. As Chip and Dan Heath have written, the best goal "kicks you in the gut" (2010, p. 76). People are rarely motivated by other people's goals (Pink, 2009), but when they have a clear understanding of current reality and a personally compelling specific goal to strive for, the professional growth of instructional coaching can begin.

Robert Hargrove (2008) further clarifies why goal setting is so important within instructional coaching by distinguishing between "push" and "pull" coaching. Push coaching, Hargrove writes, occurs when coaches start with a series of ideas and then try to convince others to implement them. Learning in push coaching is pushed along by the coach. Pull coaching, on the other hand, occurs when coaches begin the coaching process by asking others what they would like to do in the future. Instructional coaching, like pull coaching, is pulled along by the goals and desires of the learners.

Situational variation

Teachers may find it difficult or uncomfortable to view video of their classroom for the first time with a coach (Bradley et al., 2013). One situational design principle we have identified through research on the coaching process relates to teachers' first experience viewing their video-recorded lessons. If a teacher has not experienced watching video of their own instruction or otherwise seems uneasy about this activity, then coaches should encourage teachers to watch the video first on their own. Teachers can make notes of positive aspects and challenges they observe in the video and bring these data to their meeting with the coach.

2. High-Leverage Practices

After the teacher has identified a goal, the coach suggests evidence-based practices the teacher might implement in an effort to meet the goal. These practices are often organized around four areas[*]: a) content planning, b) formative assessment, c) instructional practices, and d) community building.[**]

Content planning. Coaches help teachers plan effective courses, units, and lessons. Frequently utilized practices include *Understanding by Design* (Wiggins & McTighe, 2005), *Concept-based Curriculum and Instruction* by Lynn Erickson (2007), and Content Enhancement by Keith Lenz and colleagues (1993, 1994, 1998).

Formative assessment practices. Teachers can use formative assessment to identify precisely what students are to learn, how to assess student understanding, and how to provide feedback to students on their progress. Simply put, teachers use formative assessment practices so they can know how well students are progressing and so each student knows how well she or he is progressing[***] (Chapuis, 2009; Popham, 2008; Stiggins et al., 2009).

Instructional practices. Effective instructional practices increase engagement and mastery during lessons. High-yield instructional practices include cooperative learning (Slavin, 1983), stories (Denning, 2011), effective questions (Walsh & Sattes, 2004), experiential learning (Kolb, 1983), and challenging assignments (Rademacher, Deshler, Schumaker, & Lenz, 1998).[†]

Community building. The fourth high-leverage practice is community building, which refers to practices teachers use to create safe and productive learning environments. High-yield instructional practices include creating a learner-friendly culture, building relationships, teaching expectations (Sprick, 2009), and reinforcing expectations with effective, frequent praise and fluent corrections.[††]

During instructional coaching, the teaching practices are only used to help teachers achieve their goals for students—teachers don't implement a practice just for the practice's sake. Thus, while instructional coaches help teachers learn new practices, they do it only in the service of teachers' goals.[†††]

3. Explicit Explanations

To help ensure that teachers implement the new practices they identify with their coaches, coaches need to describe those practices in a way that makes it easiest for teachers to implement them effectively. This is a two-part process.

On the one hand, when coaches explain new teaching practices,[*] their explanations must be clear and easy to act on; otherwise, teachers will not be able to transfer them to the classroom. Thus, coaches must have deep, complete understanding of the practices they describe *and* must be able to explain those practices so that everyone can learn, internalize, and use them. Support for the importance of precise explanations is found in Gawande's studies of doctors and medical teams (2010) for the World Health Organization, which demonstrated that precise explanations embodied in checklists produced a much greater likelihood of a widespread, shared understanding of practices compared with teams who did not utilize checklists.

On the other hand, just telling teachers how to implement practices is inconsistent with the partnership approach of instructional coaching, so instructional coaches explain practices precisely, but provisionally. In other words, as coaches explain the aspects of a teaching practice, they also explain that those practices likely will need to be adapted to be best suited to the needs of individual students and teachers. Thus, as they explain each aspect of the practice, they ask teachers whether or not it needs to be adapted in any way to meet the unique strengths or needs of students or their own strengths or needs. In short, instructional coaches adopt Eric Lui's (2004) dictum that "Teaching is not one-size-fits-all; it's one-size-fits-one" (p. 47).

4. Modeling

Explanation introduces practices to teachers, but teachers usually need to see those practices in action to be ready to implement them fluently. For this reason, modeling is an important part of the learning that is at the heart of instructional coaching.[**] Most frequently, this occurs when a coach demonstrates a practice in a teacher's classroom. Instructional coaches do not teach the whole class. They just show how a particular practice could be implemented, and the teacher observes the coach, sometimes taking notes on a checklist or observation protocol that was developed jointly with coach and teacher.

Situational variation

Modeling can occur in several other ways, and not just in the teacher's classroom in front of his or her students. For example, the coach can demonstrate a practice in the teacher's classroom with only the coach and the teacher present, or the coach and teacher can co-teach. On some occasions, the coach and teacher can visit another teacher's classroom, or the teacher can visit another teacher's classroom while the coach covers the teacher's classroom. In yet other instances, modeling occurs when the teacher watches a video of the new practice implemented by some other teacher. Thus, another situational principle we have identified in our work relates to different forms of modeling: if traditional approaches to modeling are not feasible or preferred, then coaches should use alternate methods of modeling (Bradley et al., 2013).

5. Deliberate Practice and Progress Toward the Goal

Hearing about a new practice and seeing it modeled begin the process, but turning ideas into habits takes practice and feedback. Thus, during the process of instructional coaching, teachers practice the new practice, and coaches gather and share data on the impact of the practice.[*] Data might be gathered from looking at video, getting feedback from students through surveys (e.g., the Tripod survey), from formative assessments such as exit tickets (Syed, 2010), or from longer-term assessments such as standardized exams.

The purpose of gathering data is to monitor progress toward the goal. Thus, if the coach and teacher have identified 90% engagement or 95% correct answers on a summative assessment as a goal, they monitor until the goal is met. When the goal is reached, the coach and teacher identify another goal they would like to pursue.

6. Reflection

When an instructional coach moves through the components of coaching with a teacher, both the teacher and the coach should be learning.[**] The teacher is learning a new teaching practice. At the same time, the coach could be learning any number of new skills or insights related to working with teachers, providing model lessons, enrolling teachers in the instructional coaching process, building relationships, or addressing teachers' core concerns. Every day provides numerous learning experiences for even the most experienced coaches. In our work with instructional coaches in the Oregon school districts, teachers that achieved a goal through coaching often wanted to identify and work toward a new goal (Bradley et al., 2013). Reflection throughout the coaching process is an important step for identifying new goals.

Situational variation

A final situational principle we offer here relates to ongoing work between teachers and coaches. If teachers decide they want to pursue a second or third goal, then coaches should encourage the teacher's reflection to focus on identifying new goals (Bradley et al., 2013).

V. Implementation Issues

As federal and state policies are beginning to encourage coaching of teachers in schools, a number of challenges persist: definitions of coaching and mentoring are sometimes still ambiguous and overlapping, the perceived tension between coaching and performance management has not been resolved, there are no evidence-based educational coaching models focused on improving the practice of teaching, and extant research on coaching has paid little attention to cost (Knight, 2012).

Several coaching models are currently being implemented in schools, including Cognitive Coaching (Costa & Garmston, 2002), Peer Coaching (Showers & Joyce, 1996), Literacy Coaching (Deussen, Coskie, Robinson, & Autio, 2007), and Instructional Coaching (Knight, 2007). Ambiguity around the particular roles coaches should be serving in schools can inhibit coaches' goal of instructional improvement (Deussen et al., 2007; Killion & Harrison, 2006). Each coaching model takes a different stance on the role of the coach in facilitating instructional change. Disagreement about the roles and terminology (e.g., see Garvey, Stokes, & Megginson, 2009) poses a dilemma in educational settings: to what extent does a coach have to be familiar with a particular teaching and learning practice in order to support a colleague?

A second challenge is the tension between coaching and performance management. In education, as in occupational settings, the question of whether a leader can be both a coach and a line manager has been either ignored or avoided. According to Lofthouse, Leat, and Towler (2010), "schools are still grappling with the core tension of the relationship between performance management and coaching" (p. 17). For example, the relationship between an instructional coach and teacher is most effective when a level of trust has been established (Aguilar, 2013). When coaches are asked to act in the capacity of evaluators of a particular teacher's effectiveness, the level of trust is tested at best and more often severely harmed. Thus, defining the role of instructional coaches as being non-evaluative of teachers is a critical aspect of an effective coaching model (Knight, 2011a). The model of instructional coaching we describe below situates the teacher and coach on equal ground; coaches are not responsible for evaluating teachers.

A third challenge in implementing coaching in schools is the lack of an evidence-based coaching model. Research on coaching is still limited; however, a number of studies have demonstrated encouraging results (Biancarosa, Bryk, & Dexter, 2010; Marsh et al., 2009; Teemant, Wink, & Tyra, 2011; Vogt & Rogalla, 2009). Where rigorous studies do exist, it is unclear which components of the coaching model lead to improved outcomes. For instance, Biancarosa, Bryk, and Dexter (2010) attribute large increases in student achievement to the Literacy Collaborative, which relies heavily on coaching; however, the authors are only able to show that teachers receiving the overall support model tended to experience larger gains in their students' outcomes, compared to teachers not receiving coaching, or teachers that spend relatively less time with coaches.

A separate strand of research on teacher professional development investigates particular components, such as the content, delivery mode, and duration of time (e.g., Cohen & Hill, 2001; Desimone, 2009; Yoon et al., 2007). While this body of literature identifies the practices associated with coaching as most effective in promoting instructional change, the research does not focus on comparing the impact of various forms of coaching or of specific components of coaching models. One component of coaching, however, is emerging as a promising practice. When coaches and teachers use self-reflection on classroom practices using video of classroom instruction, teachers are able to change their practices and target student goals more effectively than when coaches and teachers only discuss challenges (Knight et al., 2012). To make continued progress and ensure consistent practice, an evidence-based, theoretically sound coaching model is needed.

Last, we note the challenge of cost in implementing instructional coaching programs. By one estimate, the yearly cost per teacher of instructional coaching is approximately 6 to 12 times greater than short-term workshops (Knight, 2012). Coaching programs in that study were generally less costly per teacher (or per pupil) when coaches partnered with a greater number of teachers throughout the year. The question for principals and school leaders is how to structure the work of coaches to ensure that the investment will be cost-effective. In the next section, we provide greater detail on a specific form of coaching called instructional coaching.

VI. Conclusion

Instructional coaches make a very important contribution to school improvement by partnering with teachers to help them find better ways to reach more students. In some cases, they might focus on high-leverage practices of 1) community building, 2) content enhancement, 3) instruction, and 4) formative assessment. Underlying the effective implementation of instructional coaching programs is a focus on the partnership approach outlined above. The principles described here apply equally well for teachers who assume the role of coaches for their students within the learner-centered paradigm as described in Chapter 1. Time and further study will tell us much more about what instructional coaching can mean for students.

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Notes

* *Editors' note: Instructional Coaching is described as an instructional method for mentors working with teachers—essentially a trainer–teacher relationship—yet many of the principles can be applied in a more traditional teacher–student relationship.*

* *Editors' note: In this chapter the authors describe situational principles as part of the discussion of universal principles in this section, rather than in a separate section.*

* *Editors' note: This is just as true for the teacher-student relationship as it is for the trainer-teacher relationship.*

* *Editors' note: Helping learners to set goals based on what they are interested in or valuing is an important part of the learner-centered paradigm and is addressed by Principles 2 and 3 in Chapter 1, Principle 1 in Chapter 4, Principle 3 in Chapter 6, and Principle 2 in Chapter 9.*

* *Editors' note: This is the content for instruction, not a method of instruction. The method is to choose high-leverage practices (high-leverage content).*

** *Editors' note: If a teacher were coaching a student, the "practices" being coached would relate to whatever task is being used to help the student meet the learning goals, as described in Chapter 3, Principles for Task-Centered Instruction.*

*** *Editors' note: This is very important for self-regulated learning, as described in Chapter 9, Designing Instruction for Self-Regulated Learning.*

† *Editors' note: In the move away from teacher-centered education, the instructional practices would focus on tasks, scaffolding, and attainment-based instruction (see Chapters 1, 2, and 3).*

†† *Editors' note: While these are the content for teaching teachers through instructional coaching, they are all also important instructional methods for the learner-centered paradigm.*

††† *Editors' note: This self-direction is an important part of self-regulated learning (see Chapter 9).*

* *Editors' note: These explanations are what were referred to as scaffolding in Chapter 1. The task is the teacher's instruction to students. The coaching explanations are just-in-time scaffolding to help the teacher perform the task well and thereby learn the competencies it entails.*

** *Editors' note: This is the same as Principle 3, Demonstration/Modeling, in Chapter 3, Principles for Task-Centered Instruction.*

* *Editors' note: For more about this, see Principle 4, Application, in Chapter 3. Here the focus may be on a single teaching method (part task) or on a set of related methods (whole task).*

** *Editors' note: This notion of coach (teacher) as learner is an important part of the learner-centered paradigm* *(see Reigeluth & Karnopp, 2013).*

11

DESIGNING TECHNOLOGY FOR THE LEARNER-CENTERED PARADIGM OF EDUCATION

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EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *All content.*

Learners

- *All students.*

Learning environments

- *Learner-centered and personalized rather than teacher-centered and one-size-fits-all.*

Instructional development constraints

- *Requires substantial integrated technology support for instruction, communication, collaboration and administration.*

Values (opinions about what is important)

About ends (learning goals)

- *All kinds of learning goals are supported.*
- *Development of self-regulation skills and group-process skills is highly valued.*

About means (instructional methods)

- *Immersive, authentic, motivating learning environments and tasks are highly valued.*
- *Supporting the work of the learner foremost and also supporting the work of the teacher are highly valued.*
- *Providing learners with just-in-time coaching and instructional support during performance of authentic tasks is highly valued.*
- *Personalizing instruction to individual learner needs and preferences is highly valued.*
- *Embedding authentic assessment within the learning environment, avoiding the need for separate tests to certify learner attainments, is highly valued.*
- *Freeing teachers from many of their routine, boring tasks is highly valued.*
- *Facilitating communication and collaboration among learners and between learners and teachers, learners and parents, and teachers and parents is highly valued.*
- *Seamless integration of technology-delivered functions into a single system that is modular, interoperable, and customizable is highly valued.*

About priorities (criteria for successful instruction)

- *Effectiveness, efficiency, and appeal are all highly valued.*

About power (to make decisions about the previous three)

- *Empowering learners and supporting their self-directed learning is highly valued.*

*Universal Principles**

1. Recordkeeping for student learning

- *Standards inventory: PIES should keep a list of all required and optional academic and nonacademic standards, offered by any source—national, state, local, and personal.*
- *Personal attainments inventory: PIES should keep track of each student's progress on all attainments.*
- *Personal characteristics inventory: PIES should keep record of each student's personal characteristics that are useful for promoting student learning, such as learning styles, profile of multiple intelligences, special needs, major life events, career goals and interests, and so forth.*

*2. Planning for student learning***

- *Career and long-term learning goals: PIES should help each student's advisory committee collaboratively decide on long-term life goals and interests as well as career goals, which can be a powerful force in motivating the student to learn, even during early childhood.*
- *Prospective attainments: PIES should list current prospective attainments – the full range of required and optional standards (defined broadly as all kinds of learning and development) that are within reach for each individual student – ones that the student can learn without first learning other standards.*
- *Short-term learning goals: PIES should help the student's advisory committee to select, from the list of current prospective attainments, those attainments that the student will work on next, based on the students' long-term learning goals, interests, opportunities, requirements, parents' values, and so forth.*
- *Activity: PIES should help a student to select or design tasks or other activities (e.g., readings with discussions, or tutorials) to attain her or his short-term learning goals.*
- *Team formation: For team tasks, PIES should identify other students who are interested in doing the same task during the same project period, and if different roles are needed, it should identify students interested in each role.*
- *Supporting roles: PIES should help the student's advisory committee to identify people to play supporting roles in helping the student learn, and should help them to define those roles.*
- *Learning contracts: PIES should help the advisory committee to develop learning contracts at two different levels: the student (or advisory committee) level and the task/activity level.*

3. Instruction for student learning

- *Tasks: PIES should:*

    1. *introduce tasks to the student,*
    2. *provide an authentic virtual environment within which to conduct the task or alternatively provide task elements that enhance real (community-based) task environments,*
    3. *help students organize and manage their tasks (time and resources),*
    4. *help teachers monitor the tasks,*
    5. *help students collaborate with peers using various documentation and communication tools, and*
    6. *guide students to resolve conflicts that arise during teamwork.*

- *Scaffolding: PIES should provide students with access to just-in-time (JIT) personalized coaching and instruction anytime and anywhere as they work on their tasks.*

4. Assessment for/of student learning

- *Assessing integrated performance: PIES should use tasks to present authentic tasks on which the student(s) can demonstrate integrated sets of knowledge, understanding, skills, and nonacademic attainments, and PIES should assist student reflection on the performance.*
- *Assessing individual learning: PIES should assess individual learning in the individual modules through such functions as formative assessment of knowledge as it is being developed, adjusting difficulty to individual students, and assessing the same knowledge at different times in different ways.*

Secondary Functions

- *PIES must seamlessly and systemically integrate the four primary functions (described above) with at least three additional functions: 1) communication and collaboration, 2) PIES administration, and 3) improvement of PIES.*

System Architecture

- *PIES should be designed as a cloud-based computing system where data are accessed by the users (students, parents, teachers, administrators, and community members) through Web browsers.*

– C.M.R., B.J.B., & R.D.M.

DESIGNING TECHNOLOGY FOR THE LEARNER-CENTERED PARADIGM OF EDUCATION

I. Introduction

For the learner-centered paradigm of education and training to work well and cost-effectively, powerful technological tools are crucial for several reasons (McCombs & Vakili, 2005; Reigeluth & Karnopp, 2013). First, they save huge amounts of teacher time, making it possible and cost-effective for teachers to provide truly personalized, attainment-based instruction and assessment. Second, they afford immersive task environments that enhance student motivation. Third, they provide infinitely patient and soundly designed tutorials at the moment a learner needs them. This article offers suggestions for many of the design features that such tools should have.

In 2006 a research team at Indiana University began to work on identifying the functions that technology should serve to support the learner-centered paradigm of education for primary and secondary schools. This resulted in several research studies (An & Reigeluth, 2011; Aslan, 2012; Aslan, Huh, Lee, & Reigeluth, 2011; Dutta, 2013; Yildirim, Reigeluth, Kwon, Kageto, & Shao, 2013) and a set of design specifications for an integrated technology system (Reigeluth, Watson, Watson, Dutta, Chen, & Powell, 2008). This system was subsequently called the Personalized Integrated Educational System—PIES (Reigeluth, 2014; Watson, Watson, & Reigeluth, 2012), because it is designed specifically for personalized instruction and it requires seamless integration of the full range of functions needed to support student learning. As the team continued this work and learned more from our research, we saw the need for significant enhancements to those initial specifications.

One way to think about PIES is in terms of:

- functions to support teachers,

- functions to support administrators,
- functions to support parents, and
- functions to support students.

Clearly, there is overlap among these functions, but in this chapter we focus on functions to support students, who are the most important stakeholders in the learner-centered paradigm of education. It appears that relatively minor modifications are needed to tailor PIES for such other learning contexts as homeschooling, higher education, corporate training, and informal learning.

Our research team still sees four major functions and several secondary functions to support students, all of which should be seamlessly integrated into a single, open-architecture system. The major functions are shown in Figure 11.1. The secondary functions include *communication and collaboration*, PIES *administration*, and *improvement* of PIES. In this article, each of PIES' major and secondary functions is discussed, followed by a description of the architecture for PIES. Figure 11.2 shows an information schematic of this proposed technology system.

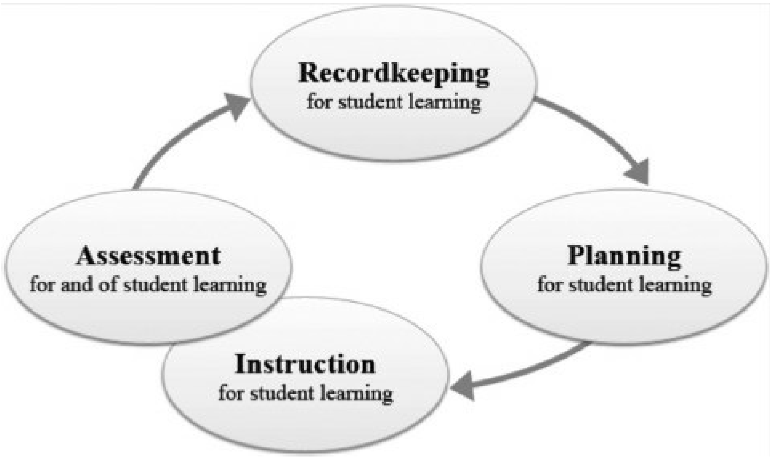

FIGURE 11.1 Proposed Major Functions Of Pies. Assessment Is Integrated With Instruction

II. Values

The values that underlie the design of PIES include:

- Technology should support the work of the learner foremost, and also support the work of the teacher.
- Technology should be designed to empower learners and support their self-directed learning.
- Technology should be used to create immersive, authentic, motivating learning environments and tasks.
- Technology should be used to provide learners with just-in-time coaching and instructional support during performance of authentic tasks.
- Technology should be used to embed authentic assessment within the learning environment, avoiding the need for separate tests to certify learner attainments.
- Technology should be used to personalize instruction to individual learner needs and preferences.
- Technology should free teachers from many of their routine, boring tasks.
- Technology should facilitate communication and collaboration among learners and between learners and teachers, learners and parents, and teachers and parents.

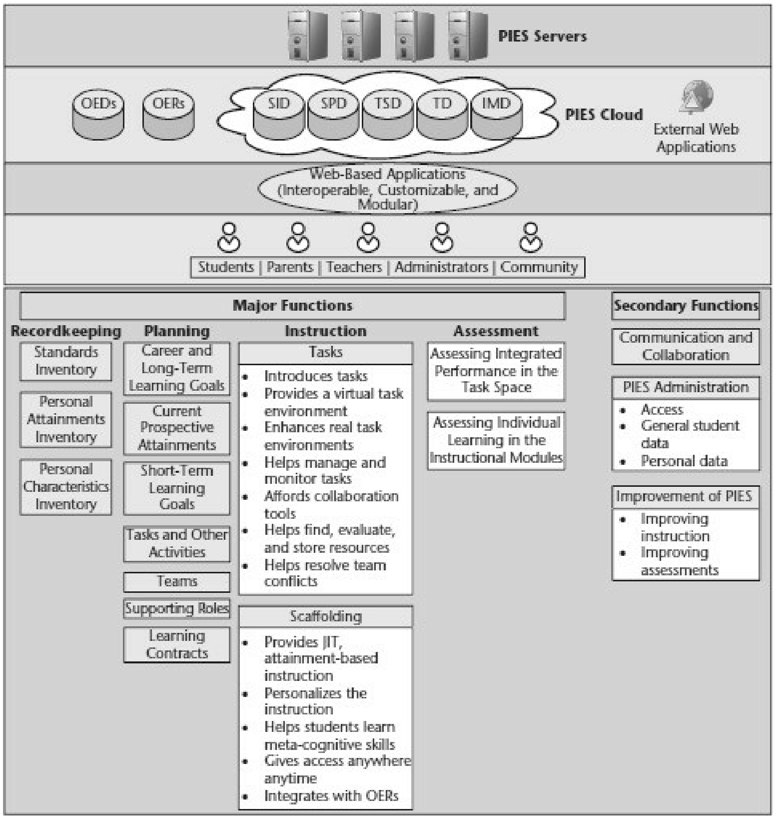

FIGURE 11.2 Proposed Information Schematic For Pies

Key: OED – Open Educational Database; OER – Open Educational Resource; SID – Standards Inventory Database; SPD – Student Profiles Database; TSD – Teammate Selection Database; TD – Task Database; IMD – Instructional Modules Database.

- All the functions that technology serves should be seamlessly integrated into a single system that is modular, interoperable, and customizable with Web APIs (Application Programming Interfaces), which allow developers to develop new modules or add-ons to existing programs.

III. Universal Principles

The universal principles for the design of PIES are grouped under the four major functions of PIES for supporting student learning: recordkeeping, planning, instruction, and assessment.

1. Recordkeeping for Student Learning

Attainment-based student progress is not possible without keeping track of what each student has learned. Report cards or transcripts serve a parallel function in the sorting-focused, industrial-age paradigm of education, except that these do not tell you specifically what each student has learned, only how well the student has done compared to other students in the class. The *recordkeeping* function of PIES replaces report cards and provides detailed information about student learning.[1] PIES' design principles specify three types of records: 1) a *standards inventory* that should include all the attainments that students must or could achieve in their lifetimes, including academic and nonacademic ones,[2] 2) a *personal attainments inventory* that should include all those attainments that each student has already achieved, along with useful learning analytics for each attainment, and 3) a *personal characteristics inventory* that should contain each student's personal characteristics that are demonstrated to be pertinent to student learning.

1.1 Standards inventory principle

PIES should keep a list of all required and optional academic and nonacademic standards, offered by any source—national, state, local, and personal. The standards should be broken down in a hierarchical manner to individual attainments such as skills, understandings, dispositions, and so on. The *standards inventory* should display the attainments in a customizable domain map or chart format based on Domain Theory (Bunderson, Wiley & McBride, 2009). Each domain map should include: a) major attainments with boundaries showing the easiest and hardest version of each attainment, b) categories of attainments, where each category represents a pathway for learning, and c) a difficulty-based sequence of attainments along each pathway. For each attainment in the map, there should be an indication as to whether or not it is a required standard, and if so, what level of difficulty is required. This map will enable the learner to navigate through the attainments within each subject domain such that when the learner masters one attainment, the map indicates the more advanced attainments that are now within reach—Vygotsky's (1978) "zone of proximal development" (see "2. Planning for Student Learning" below).

The *standards inventory* should include such currently optional standards as social, emotional, and character development (Goleman, 1995, 1998; Lewis, Watson, & Schaps, 1999; Lickona, 1991). Examples of a wide range of educational standards are offered by the Partnership for 21st Century Skills (n.d.), the International Society for Technology in Education (2007), the U.S. Department of Labor (1991), the Common Core (http://www.corestandards.org), and individuals like Daniel Goleman (1995, 1998) and Thomas Lickona (1991). However, most of these standards need to be further broken down into individual attainments. In Chapter 5, Prensky proposes organizing standards around the four key pillars of thinking effectively, acting effectively, relating effectively, and accomplishing effectively, rather than the current four pillars of math, language arts, science, and social studies. We propose that the *standards inventory* be organized around Prensky's standards.

Teachers and other experts who are involved in student learning should be able to customize the standards inventory based on student needs such as learning gaps and cross-disciplinary understanding (Dutta, 2013). In essence, the standards inventory should present a list of things that should or can be learned, along with levels, standards, and/or criteria at which they should or could be learned.

1.2 Personal attainments inventory principle

PIES should support student learning by keeping track of each student's progress on attainments.[*] Portions of the domain map in the *standards inventory* should be displayed in each student's *personal attainments inventory*, as in the Khan Academy. This way, all the authorized stakeholders (e.g., student, teachers, parents, administrators, employers) can easily see how she is doing and offer support when needed.

Also, a community may want all children to learn certain things within a reasonable age frame, especially for basic skills, in order to make sure that students are not overlooking foundational skills and knowledge. Thus, it may be important to foster some well-rounded development, rather than letting a student exclusively study things she wants when she wants, so the *personal attainments inventory* should also be able to report the student's attainments compared to the community's target age frames (if any) for mastery of required standards (adjusted automatically by the student's average speed of learning, which is continuously tracked by PIES over time, meaning slower learners have a later target within an age frame).

Each attainment, or set of related attainments, should be linked to a repository of evidence of its mastery in the form of summary data and/or original artifacts[**] that are automatically tagged according to the learning goals (Garrett, Thoms, Alrushiedat, & Ryan, 2009). Tags help students easily organize and find their artifacts and allow the student to easily pull out selected artifacts into different e-portfolios for different purposes (exportability). Furthermore, the *personal attainments inventory* should belong to the student, not the school system, so the student can use it throughout his life as a tool for lifelong learning.

In addition, a sharing feature should be provided in the *personal attainments inventory*. An individual student or a team should be able to set a final artifact or a video of their performance for selected others to see—or for public display, in which case it is searchable by the school community. When made public, the artifact should also be able to be linked to the task in the task bank (see "3.

Instruction for Student Learning") as a legacy (Schwartz, Lin, Brophy, & Bransford, 1999) for future students to access, either locally or broadly.

Lastly, for all the records of these personal attainments, the student should be able to flexibly control access and levels of security. For example, while a student, his teachers, and his parents have full access to the records, the student could give potential employers or community members limited or no access.

1.3 Personal characteristics inventory principle

PIES should keep records of each student's personal characteristics that are useful for promoting student learning. These characteristics are different from general student data, such as address, birthdate, and information about parents or guardians. Personal characteristics include learning styles, profile of multiple intelligences, special needs, major life events, career goals and interests, and so forth. Personal characteristics should be continuously updated through surveys and automatic collection of data from the *instruction* and *assessment* functions of PIES about which instructional methods work well for each student.

Personal characteristics are useful for a) decisions about learning goals and objectives, b) teacher coaching and advising for the student, and c) customization of PIES' tutorials, simulations, and even tasks.

The student should own and be able to flexibly control access to this inventory for security and privacy reasons. Level of access should typically be granted depending on the relationship with the student. For example, parents or legal guardians, a student's current teachers, and students themselves should usually be granted full access. However, students may give limited or no access to community mentors and other teachers and administrators.

Clearly, a customized paradigm of education requires keeping a lot of records. PIES should greatly alleviate the time, drudgery, and expense of maintaining and accessing those records. It should help ensure that appropriate standards are being met while customized attainments are achieved by each student.

2. Planning for Student Learning

Planning is one of the most important components of the learning process (N.J. Anderson, 2002). While planning was one of the major responsibilities of teachers in the industrial-age paradigm of education, the learner-centered paradigm requires students and even parents to be actively involved in the planning process, with guidance from the teacher.

Planning for student learning in the new paradigm should take place on three different levels: school, advisory group (traditionally called a classroom or homeroom), and individual student. At the *school level*, many schools want to have an annual school theme that is consistent with the overarching philosophy, mission, and vision of the school. All planning activities can then be informed by overarching school-wide academic and social themes (Dutta, 2013). For example, the Project School in Bloomington, IN, chose "power" as its theme one year, addressing such questions as what power is, how it moves, what it looks like from different perspectives, how it keeps things the same, and so forth. PIES' *planning* function should help all the teachers in a school to select and use an appropriate and powerful theme. It should also help for planning other aspects of school life, such as school plays, science fairs, art exhibits, and much more.

At the *advisory group level*, each mentor teacher[3] (often called a facilitator, guide, or adviser due to the radically different role) should plan ways in which all of that teacher's students can learn together in a collaborative environment. PIES' *planning* function should help each teacher decide on an appropriate culture or climate for the homeroom or workspace and ways to establish and maintain that culture, such as establishing ground rules collaboratively with the students and preparing in advance for the teacher to deal with typical events that may threaten that culture. The *planning* function should also provide advice on how to recognize and take advantage of "teachable moments" that can address emotional, social, and character development issues.[*] The function should help in diagnosing the causes of academic and social/emotional problems that arise and should recommend alternative actions for dealing effectively with those problems. The function can use both keyword search and menu-driven decision tree to accomplish this.

At the *individual student level*, each student needs a personal learning plan that sets out learning goals and ways to meet them. The planning function should help each student's advisory committee (the student, his parents, and mentor teacher) to collaboratively decide on career goals, long-term and short-term learning goals, tasks, teams, supporting roles, and learning contracts. Each of these sub-functions of individual student planning is described in detail in the following sections.

2.1 Career and long-term learning goals principle

Research by Schutz and Lanehart (1994) found that, "when long-term educational goals were accompanied by attempts at day-to-day educational sub-goals and useful learning strategies, high academic performance tended to occur" (p. 407). PIES should help each student's advisory committee collaboratively decide on long-term life goals and interests as well as career goals, which can be a powerful force in motivating the student to learn, even during early childhood.

First, PIES should help each student to explore career options. Questionnaires and existing information about the student's interests and aptitudes should be used to suggest careers that the student might want to explore. The student can then learn more about each of those careers through, for example, interactive video vignettes showing "a day in the life" of a person in that career. Because students typically change their life and career goals and interests often, the sub-function should encourage each student to rethink or reaffirm her career goals on a regular basis. The student should also be able to select more than one life or career goal if she has more than one area of interest.

Second, when the student selects an appropriate career goal, it should be entered into the student's *personal characteristics inventory* (along with all information about the student's interests and aptitudes), as such information can improve instruction. The sub-function should provide the student with information about the kinds of attainments one needs to achieve to succeed in that career, and those attainments should then be listed as long-term learning goals. For older students, the sub-function should provide information about potential community mentors[4] (e.g., a local engineer), grants, and scholarships to help them accomplish their long-term learning goals in pursuit of their career goals.

The *planning* function should provide anytime anywhere access to a report on the progress each student has made towards achieving his long-term goals. Goal setting is an important aspect of self-directed learning and consequently life-long learning (Zimmerman, 2002).

2.2 Prospective attainments principle

Current prospective attainments should be automatically listed by PIES. These attainments are the full range of required and optional standards (defined broadly as all kinds of learning and development) that are, as a set, within reach for each individual student—ones that the student can learn without first learning other sets of standards. PIES' *planning* function can do this by comparing a student's *personal attainments inventory* (the student's current attainments) with the *standards inventory* (all required and optional attainments) to generate a comprehensive list or map of sets of attainments that the student could choose to work on next without overreaching. The student's advisory committee should also have a tool for adding, revising, or deleting attainments on the list. Based on the student's progress as measured by the assessment function (see "4. Assessment for/of Student Learning" below), the list should be updated automatically by the system.

2.3 Short-term learning goals principle

PIES should help the student's advisory committee to select, from the list of *current prospective attainments*, those attainments that the student will work on next, based on the students' long-term learning goals, interests, opportunities, requirements, parents' values, and so forth.[*] These short-term learning goals should include all dimensions of human development—social, emotional, physical/health, ethical, artistic, and psychological, as well as intellectual. For example, some short-term goals may be established for helping others through volunteer work in the community.

In the move away from time-based student progress, we envision that most school systems will establish project periods, for several reasons. First, it would be difficult for students to form different groups for new tasks without set dates for the beginning of tasks. Second, in the real world people need to meet task deadlines, so it is important to prepare students for that. Third, human nature is to not get things done until they are due, so having a deadline is a motivational issue. With project periods, rate of student learning can be adjusted through selection of the *number* and *scope* of tasks undertaken during a project period. Faster learners can undertake more tasks and larger tasks. Records of how many hours per week a task has taken, on average, should be adjusted automatically by PIES for each student's history of rate of learning, to help select an appropriate learning load for each student. The length of the project period is determined by the school but differs depending on the developmental level of the learners—at lower levels, project periods are shorter.

At the beginning of each project period, short-term goals are chosen by the student's advisory committee (mostly by the student with guidance from the rest of the committee).

2.4 Task/activity planning principle

Task-centered learning is an important part of the learner-centered paradigm of education (McCombs, 2008, 2013; Reigeluth & Karnopp, 2013; United States Department of Education, 2010; Wolf, 2010), primarily because it can greatly enhance learner motivation and facilitate transfer of what is learned to the real world.[*]

PIES' *planning* function should help a student to *select* or *design* tasks or other activities (e.g., readings with discussions, or just tutorials) to attain her short-term learning goals. For selection, it should use those goals to identify tasks or other activities through which she could attain those goals. It should rank-order those tasks/activities on the basis of how many short-term goals each addresses, how well each aligns with the school's mission, vision, core principles, and current theme, and how well it aligns with the student's interests.

The student then selects (with input from her advisory committee) whatever combination of tasks/activities she wants, based on customized weekly time estimates for each task. User ratings and recommendation algorithms similar to those in Amazon and Netflix also help the student to make good choices. After one task/activity is selected, PIES should update the rank-order of tasks/activities for the remaining short-term goals, and the student selects additional tasks/activities until the student's available time is filled.

Alternatively, if the student's advisory committee wants the student to design her own tasks or other activities, the planning function should help her design them based on her short-term learning goals, the school's mission, vision, core principles, and current theme, the student's interests, and current opportunities.

If a task is selected, the *planning* function should allow the student (and her advisory committee) to customize and tailor task attributes, requirements, and assessment criteria to fully address her relevant short-term learning goals and interests. For example, it should allow the committee to select such methods of assessment as products, reports, presentations, contests, single expert review, panel of experts, and public display for each task. The function should help the advisory committee decide whether a task will be done solo, or collaboratively with all teammates sharing the same role, or cooperatively with each teammate performing a different role. If the third, the function should suggest roles that are best aligned with the student's short-term goals and personal characteristics. The function should also estimate the average number of hours per week to complete the task in the selected role given the length of the school's project period, and it should adjust that based on the student's speed of performance on prior tasks.

The task "bank" or database on which the *planning* function draws should be updated as new tasks are posted by all advisory committees worldwide and even by local community members. Improvements to, or variations on, old tasks should also be posted. Since service learning is a key tenet of the learner-centered paradigm (Billig, 2000; Reigeluth & Karnopp, 2013), the *planning* function should allow community organizations and businesses to post upcoming tasks to the local or regional section of the task bank.

The task bank should also store a variety of metadata for each task, such as the short-term learning goals (or attainments) that each task addresses, assessment criteria and standards of performance, recommended methods of assessment (e.g., contests, single expert, panel of experts, public display), whether the task requires multiple roles, average number of hours required for each role, previous students' evaluations of the task, and previous students' products if they choose to make them public (through each school's repository, where the student and advisory committee should be able to evaluate the products using a system similar to that used by Amazon customers to rate their purchases, and PIES should automatically generate a list of exemplary products). This also allows teachers to select exemplary artifacts to showcase student learning in their school.

For some short-term goals, such as learning about philosophy, a task may not be the most appropriate vehicle for meeting the goals. In such cases, PIES' *planning* function should help the advisory committee to plan other kinds of activities for meeting the goals.

2.5 Team formation principle

Students may occasionally choose to do solo tasks, though advisory committees should ensure that their students engage in sufficient team tasks to develop high levels of collaboration and conflict-resolution skills. Literature suggests that when students are collaborating with peers on academic tasks, they show higher intellectual performance than when working alone (Bandura, 1986; Vygotsky, 1978). Bruner (1985) also stated that students enhance their problem-solving skills through cooperation, as they have more opportunities for observing problem-solving skills.

For team tasks, the *planning* function should identify other students who are interested in doing the same task during the same project period, and if different roles are needed, it should identify students interested in each role. Then the function should help the students select teammates who are in the same or even different schools. Teachers, schools, and even districts should be able to add criteria to this selection process that ensure students don't only collaborate with their best friends—that they also team up with students of different gender, ability, compatibility, ethnicity, and socio-economic status. PIES should also use personality inventories (e.g., Myers-Briggs) to help students understand why their teammates may behave quite differently and how to deal with that.

2.6 Supporting roles principle

PIES should help the student's advisory committee to identify people—including themselves as well as other teachers, community or academic experts, senior students, parents, and guardians—to play supporting roles in helping the student learn from each task or other activity, and should help them to define those roles.

2.7 Learning contracts principle

"Learning contracts are practical devices helping one to bridge the gap between curricular requirements and self-initiated and self-directed learning" (Motschnig-Pitrik, Derntl & Mangler, 2003, n.p.). Each school or district can establish a project period appropriate for the developmental stage(s) of its students. Having the same start time makes it possible to form new teams for new tasks. However, some tasks can span two or more project periods, and individual tasks may span a fraction of a period. All local schools at the higher developmental levels typically coordinate the length and timing of project periods so that their students can collaborate with students from other schools.

As an essential part of the planning process, PIES should help the advisory committee to develop learning contracts at two different levels: the student (or advisory committee) level and the task/activity level. At the student level, the contract should specify the short-term learning goals and all the tasks/activities for a given project period. At the task/activity level it should be prepared and signed by all teammates and external collaborators (if any) and should specify the following for each task/activity: short-term learning goals, teammates (if any), student roles and responsibilities, mentor roles, roles of any external collaborators, deadlines, milestones, resources, assessment criteria, methods of assessment, and criteria for modifying the contract. Any modifications must be submitted through this function and be approved by the advisory committee. This *learning contracts* sub-function should be linked with a sub-function that helps students and their advisory committees manage each task/activity in the contract (see section 3.1.2 below).

3. Instruction for Student Learning

PIES' *instruction* function should contain sub-functions for *tasks* and for *scaffolding*. It should have a task database, a coaching database, and an instructional module database whose instructional modules are linked to specific points in tasks when instruction is needed just-in-time.

3.1 Task performance principle

PIES should a) introduce tasks to the student, b) provide an authentic virtual environment within which to conduct the task or alternatively provide task elements that enhance real (community-based) task environments, c) help students organize and manage their tasks (time and resources), and d) help teachers monitor the tasks. It should also e) help students collaborate with peers using various documentation and communication tools and f) guide students to resolve conflicts that arise during teamwork.

Introduce tasks. PIES should introduce the task to students, and also help teachers do so. Alternatively, it should help students initiate a task of their own design by helping them choose and use a checklist of considerations for initiating their task. Considerations should include getting more information about the task, identifying subtasks to perform with milestones for each, deciding who will do what and how they will work together, and identifying resources they will need. For pre-designed tasks, introducing the task should often be done through a simulation or virtual world, such as Bransford's STAR LEGACY (Schwartz et al., 1999).[*]

Provide a virtual task environment. In many cases,[**] PIES should provide a virtual world or simulation game in which the task is conducted. In such cases, it should provide natural consequences for student actions within the virtual environment. A virtual environment is "a computer-generated display that allows or compels the user (or users) to have a sense of being present in an environment other than the one they are actually in, and to interact with that environment" (Schroeder, 1996, p. 25). Many researchers have argued that virtual environments and simulations can be used to facilitate learning tasks that lead to increased understanding, motivation, engagement, collaboration, and knowledge transfer (Barab, Thomas, Dodge, Carteaux & Tuzun, 2005; Chittaro & Ranon, 2007; Dickey, 2005; Mennecke, Hassall & Triplett, 2008; Rieber, 1992). When appropriate, this function should also provide virtual coaching as students proceed, with a virtual coach appearing just-in-time to offer advice (but not instruction—that is described in the next section, though the same virtual agent could provide both advice and instruction seamlessly).

Enhance real task environments. Real-world tasks require students to solve authentic, hands-on, and interdisciplinary problems. In cases where a real-world environment is used for conducting the task,[***] PIES should enhance that environment by introducing task elements related to the real environment, such as key knowledge, quality standards, planning, self-management, and other related resources on mobile devices using augmented reality. It can also provide tools for students to use while conducting the task, such as data collection, data analysis, communication, and collaboration tools. When appropriate, virtual coaching should also be provided as students proceed. This helps connect their knowledge to the real world.

Help manage and monitor tasks. The *task performance* sub-function should help students organize and manage their task work, including identifying, assigning, and monitoring subtasks, managing time and resources, and documenting progress daily. Students should be able to log time they devote to each task each day to help their advisory committees keep track of their progress. This sub-function can also be used to organize and manage any non-task activities. The *task performance* sub-function should help teachers, parents, and other supporters monitor the tasks/activities, by flagging ones that require guidance, facilitation, and scaffolding. Artificial intelligence should be utilized, to provide expert guidance automatically, under the watchful eye and additional insights of the teacher. The artificial intelligence can be deployed partly through pedagogical agent software. Hawryszkiewycz (2004) and Hawryszkiewycz and Lin (2003) detail the infrastructure for such agents to take on much of the role of teacher and expert (coach), and interact with learners by perceiving the progress of students in their learning activities, and offering just-in-time assistance. The agents should also be able to facilitate the learning process by helping students set up and manage their workspaces.

Afford collaboration tools. Various collaboration tools (such as documentation and communication tools) and social apps should be used by students as collaborative and resource-sharing platforms. Social software and other cloud-based tools should be integrated into the system, offering students personal tools for production, presentation, reflection, and collaboration. Networks are created among students, teachers, and experts working within the field to maximize learning. For example, social software tools like blogs and wikis can make student work visible to other students, allow students to follow each other’s work, and give students access to each other’s networks of people and references. These networks also allow teachers to follow and potentially participate in the work of students. This should be supported through connections between students’ and teachers’ weblogs using RSS feeds and social bookmarking (Richardson, 2005).

Help find, evaluate, and store resources. The *task performance* sub-function should help students to find, evaluate, and store resources and links related to their task work, and cultivate information literacy (American Library Association, 2000) to locate, evaluate, and use the needed information. It should provide some guidance, demonstrations, and practice with feedback to develop good strategies for these activities. It should teach the concepts of personal knowledge management and how to retrieve, organize, and evaluate information from the Web. One way this can be done[*] is to integrate open-source tools (such as social bookmarking tools, knowledge logs, and task managers) into the system as a mashup,[5] with demonstrations on how these can be used for personal knowledge management (Weber, Thomas & Ras, 2008).

Help resolve team conflicts. PIES should help students and teachers address conflict resolution issues, since conflicts are inevitable in teamwork, not just in school, but also in family life and work life. Students thereby learn conflict resolution strategies, which include “constructive self-management (emotional, cognitive, and behavioral self-control), communication, social perspective-taking, cooperative interpersonal problem solving, and promoting respect for individual and group differences” (Garrard & Lipsey, 2007). These strategies are learned as students who encounter problems should have the option to either use a decision tree or keyword entry within the PIES system, which then suggests particular strategies for dealing with the problem. This sub-function should be available to both students and teachers as a resource. When needed, students may contact their teachers for help so that teachers can direct students to specific strategies or offer personal suggestions for resolving conflicts.

3.2 Scaffolding principle

The *scaffolding* sub-function should provide students with access to just-in-time (JIT) personalized coaching and instruction anytime and anywhere as they work on their tasks.[*] According to Hmelo-Silver, Duncan, and Chinn (2007), besides offering direct instruction when students experience the need to learn something, scaffolding may also make parts of the task harder, in order to force students to engage with key disciplinary frameworks and strategies. These redirect students to examine counterclaims, articulate explanations, and reflect on progress. Coaching should be provided by PIES just-in-time as needed,[**] typically[***] upon student request, but occasionally on a predetermined schedule or on student choice upon suggestion by the student's virtual pedagogical agent. For the instruction, PIES should use validated instructional theory to help students develop specific skills, understandings, facts, and dispositions through learning by doing, tutorials, mini-simulations, and so forth. Instruction should be tailored to each learner's learning style, kind of intelligence (Gardner, 1983), interests, preferences, knowledge, and background based on the student's *personal characteristics inventory*. Students should have great freedom to navigate through such instructional resources, including open educational resources, and should be taught to use metacognition and self-direction.

Provide JIT, attainment-based instruction. PIES' *scaffolding* sub-function should provide a just-in-time, personalized "instructional overlay" (such as simulations, tutorials, drill & practice, research tools, and student-expert academic communication tools) to support learning throughout each task. The emphasis of this sub-function should be on learning by doing multiple, authentic, divergent performances (to promote transfer) for individual skills, understandings, and other kinds of attainments until mastery, with the help of tutorials and demonstrations when appropriate, similar to the Khan Academy (https://www.khanacademy.org/). This instructional support should sometimes[*] be provided automatically to a student when he reaches a certain point in the task, sometimes suggested by his virtual pedagogical agent or teacher when he reaches that point, and sometimes left to the student to request the support whenever he wants it. This instruction promotes efficiency of learning, student motivation, and transfer of learning to diverse contexts, and develops automaticity of skills when appropriate (J.R. Anderson, 1996). Furthermore, PIES should automatically collect data on student performance on each attainment and make it available to the student and his advisory committee, to promote self-directed learning.

Personalize the instruction. In contrast to many learning management systems that focus on content management and administrative support, PIES should provide personalized instruction that is tailored to each learner's profile in terms of learning styles, multiple intelligences, goals, preferences, knowledge, and background. Using artificial intelligence techniques, such as intelligent tutoring systems, semantic webs, and adaptive systems, PIES should infer, update, and store information about the learner from each instructional module in order to adapt the instructional format, content, resources, feedback, and exercises to the individual learner in subsequent instructional modules. This is a customized, localized alternative to "big data." PIES should allow the learner to navigate the instruction by providing learning-path options tailored to each learner. In addition, PIES' instructional sub-functions should make extensive use of aural, visual, and dynamic as well as verbal modes of instruction, thus accommodating a greater variety of learning styles and enhancing motivation. As supported by research, PIES can be seen to function as an intelligent learning management system (Yacef, 2002)—a personalized environment for learning with a greater focus on student learning styles, difficulties, and progress that allows the system to diagnose and remediate and to adapt to changes in a student's personal characteristics. PIES should encourage personal knowledge management (Agnihotri & Troutt, 2009), with an emphasis on the learner's effort to discover, share, learn, and explore through different combinations of skills and technology. The learner should be able to customize screen appearance on PIES, rearrange learning content, and include/exclude learning services. Sub-learning spaces should also be able to be created to enable different types of collaboration (Ong & Hawryszkiewycz, 2003).

Help students learn meta-cognitive skills.[*] Researchers have found that meta-cognitive skills or cognitive self-regulation skills can be taught to students (Bandura, 1991; Zimmerman, 2002), and that there is a need to provide instructional strategies that inspire, motivate, and guide students to develop self-directed learning skills (Vovides, Sanchez-Alonso, Mitropoulou & Nickmans, 2007), such as determination of learning goals, learning and management strategies, instructional resources, and external resources. PIES' virtual pedagogical agent should address this need by providing rich resources in its instructional support for students to learn metacognitive skills, such as how to learn, monitor, evaluate, and reflect, and how to become self-directed learners (see Chapter 9 for details). Direct support should also be provided to nurture students' curiosity, creativity, everyday living skills, social skills, collaboration skills, character development, critical thinking, and problem-solving skills. Of course, such support is also provided by the student's teachers and mentor.

Give access anywhere anytime. As a Web-based educational system, PIES should connect students and guides across geographic, temporal, and cultural boundaries with a variety of portable and wearable devices.**

Integrate with open educational resources. PIES should serve as a portal to various OERs, such as those of the Khan Academy, OER Commons (https://www.oercommons.org/), and EngageNY (https://www.engageny.org). OERs should be easily integrated into PIES, similar to the way apps are integrated into a smart phone, except that the OERs should be seamlessly interoperable with the other apps (other parts of PIES)—they should be designed to share information with them—so the appropriate OER is called up automatically when the student encounters a learning need while working on a task, and the student's performance results are automatically fed from the OER to the student's *personal attainments inventory*. In essence, PIES' instructional modules should be seamlessly connected with educational resources that are available free or for a fee, hence enhancing students' learning options within a social constructive learning approach, while keeping the cost low for schools.

4. Assessment for/of Student Learning

PIES' fourth major function is *assessment for/of* student learning. Its sub-functions are: 1) *assessing performance outcomes* in the task, and 2) *assessing learning outcomes* in the instructional modules. When a group successfully completes a task or an activity, it may not necessarily indicate that each member of the group has attained all the associated learning outcomes to the desired degree of proficiency. But it is important to determine the individual learning attainments, in order to have learning-based student progress. Therefore, the *assessment* function should assess both *team performance* on the task and *individual student learning* through the instructional modules.

Also, PIES should assess attainments in all four pillars of the new curriculum: thinking effectively, acting effectively, relating effectively, and accomplishing effectively (see Chapter 5). Thus, it should assess not only academic outcomes, but also nonacademic ones, such as meta-cognitive thinking skills, collaboration and communication skills, work ethic, and other kinds of emotional, social, and character development. In doing so, PIES should enable assessment by non-teachers, including peers, community members, and parents. Student assessment data collected through the assessment function should automatically feed into the recordkeeping function of PIES.

Although *instruction* and *assessment* are discussed as two separate functions in PIES, they should be seamlessly integrated and take place simultaneously. This is an important difference between the Industrial-Age and Information-Age paradigms of education. In the Industrial-Age paradigm, instruction and assessment take place separately. However, in the Information-Age paradigm, assessment is embedded in instruction. In a task, the outcomes of the task should be evaluated to assess student or team performance. In the instructional modules, assessments should take place within the practice exercises. A student should continue with the exercises until she meets established criteria of competency or attainment. When she meets the criteria, she moves on to the next topic of instruction needed just-in-time for the task work. PIES should also note attainments that benefit from periodic review and should provide periodic opportunities for each student to use those attainments in tasks, as a form of review.

4.1 Assessing integrated performance principle

PIES' *assessment* sub-function should use authentic tasks on which the student(s) can demonstrate integrated sets of knowledge, understanding, skills, and other attainments. Simulations or virtual worlds make it easier, less expensive, and/or safer to do this, but some real-world performances may also be needed or desired, such as learning to back up a truck with a trailer or do a pirouette in ballet.

After a student or team has performed an authentic subtask in the task, the assessment sub-function should assist student or team reflection* on the performance as a part of developing self-direction in learners. It should help students reflect on several aspects, such as the strategies they used in the task, strengths and weaknesses of student performances, and apparent misconceptions. Then it should offer feedback on the student reflections by providing formative evaluation of performances on the authentic task, when appropriate and when the performance is done in a simulation. For real-world performances, it should provide criteria or a rubric for a teacher or other observer to use while observing the performance, preferably with a handheld device that uploads the evaluation results to PIES.

At the end of the task, the assessment sub-function should assist reflection on, and summative evaluation of, the final product or performance in any of several ways, using the specifications in the task contract: the assessment criteria, standards of performance, and methods of assessment. Some examples of methods of assessment include hosting a contest (i.e., competition), arranging a public display (i.e., invite students, teachers, parents and community members to attend; a rating system may or may not be used by them), and being evaluated by a single expert or a panel of experts.

The assessment sub-function should promote and assess nonacademic outcomes developed while performing tasks, such as metacognitive thinking, collaboration skills, and work ethic, by using self-, peer-, and expert-evaluations. For self-evaluation, the system should assist student reflection during and after each task. During reflection, students self-assess their own performance by reflecting on several aspects, including the strategies they used during tasks, the process through which they performed, the strengths and weaknesses of student performances, and their misconceptions. The system should provide different kinds of templates for different tasks to help students reflect on what they have learned and the process through which they performed. For peer-evaluation, their group members offer feedback on various aspects of their performance on the group task, such as collaboration and communication skills. The system should provide different templates and rubrics to aid the peer assessment. And for expert-evaluation, experts are invited to provide feedback on the final outcome as well as the process of the student's performance. The system should also provide customizable templates and rubrics for this assessment.

Lastly, the final task, artifacts, evaluations, and reflections of students should be stored in the system and linked to each student's inventory of attainments. Therefore, students and teachers have easy access to them for future use (e.g., creating portfolios or planning future learning activities).

4.2 Assessing individual learning principle

Students' individual learning outcomes should be assessed in the instructional modules. PIES should provide functionalities, including assessing knowledge as it is being developed, adjusting difficulty to individual students, and assessing the same knowledge at different times in different ways.

Each standard should be broken down into individual attainments in the *standards inventory* (otherwise some important attainments may not be assessed and mastered), and each attainment should be accompanied by criteria or a rubric for evaluating mastery. PIES' instructional modules should all require students to *do* things, both to promote learning-by-doing and to assess mastery of the attainment. When a student does not meet the criteria for a given performance, feedback (formative evaluation) should be provided through hints or explanations or demonstrating the correct performance. The criteria for mastery should include: a) criteria for a correct performance, b) a criterion for number of unaided correct performances in a row, and sometimes c) a criterion for speed of performance (or performing multiple tasks simultaneously, to ensure automatization of the skill). When the student has met all these criteria, then the summative evaluation is complete.[*] In this manner, formative and summative assessment are embedded in the instruction—there is no test. The student has reached mastery, upon which PIES should update the student's *personal attainments inventory*, including links to summary data and products, as appropriate.

When variability of a task is an issue (for near and far transfer), PIES should present the student with a representative variety of cases for the performances. The greater the variability, the larger the item pool, and the more performances the student needs to do correctly to reach mastery. Mere memorization is insufficient to perform well because the variety of cases is drawn from a large item pool. Students should be required to do even more performances when automatization of a skill is important. Authentic contextual information is provided for each of the cases, when appropriate.

When a set of related attainments (skills, understandings, memorizations, personal attributes, etc.) is mastered, a digital badge or a certificate should be awarded for that set of attainments. This motivates students and provides more valuable information for potential employers and other interested individuals. For instance, when a student masters a set of collaborative skills (e.g., helping teammates, coordinating tasks), he can be awarded a collaboration badge. Different badges can be awarded for different levels of attainment in collaboration.

In summary, PIES serves four major functions to support student learning in the information-age paradigm of education: *recordkeeping*, *planning*, *instruction*, and *assessment*. These must be seamlessly and systemically integrated with each other. In brief, the *recordkeeping* function should automatically provide necessary information to the *planning* function. The *planning* function should identify *instruction* functions (mainly tasks) for the student to use. The *assessment* function should be fully integrated with the *instruction* function. And the *assessment* function should feed information into the *recordkeeping* function.

5. Secondary Functions

In order for PIES to be most useful for the information-age paradigm of education, these four major functions to support student learning must be seamlessly and systemically integrated with at least three additional functions: 1) communication and collaboration, 2) PIES administration, and 3) improvement of PIES. These secondary functions support users in ways less directly related to the learning process. To see the design features for these functions, see Reigeluth et al. (in press).

6. System Architecture

PIES should be designed as a cloud-based computing system where data are accessed by the users (students, parents, teachers, administrators, and community members) through Web browsers. As the schematic diagram for PIES illustrates (see Figure 11.1), the PIES cloud is to be housed within PIES servers. This might be supported by the U.S. Department of Education or by private foundations. Each of the major functions of PIES (recordkeeping, planning, instruction, and assessment) and the secondary functions (communication and collaboration, administration, and improvement of PIES) are to be housed in individual modules within the PIES cloud. The major and secondary functions should be connected to five major databases in the PIES cloud:

1. The Standards Inventory Database (SID), which includes federal, state, and local standards
2. Student Profiles Database (SPD), which includes personal attainments, personal characteristics, and task contracts
3. The Teammate Selection Database (TSD), which shows other students interested in the same tasks at the beginning of each project period
4. The Tasks Database (TD), which contains fully developed tasks, as well as ideas for tasks to be developed by students
5. The Instructional Modules Database (IMD), which contains all the instructional modules, including mastery assessments in the form of practice.

In the Student Profiles Database, the personal attainments inventory should belong to the student, not the “school,” and can be accessed by the student at any time throughout her life, to promote lifelong learning and sharing of accomplishments.

In addition, the PIES cloud should be interoperable and seamlessly integrated with data systems that house OERs, external Web-based apps, and other open educational databases (OEDs). Features of the PIES cloud should include *interoperability*, *modularity*, and *customizability*. For descriptions of these design features, see Reigeluth et al. (in press).

VI. Closing Remarks

In summary, PIES is a set of design specifications for a technology system to support the learner-centered paradigm of education. It has four major functions, three secondary functions, and three architectural design features, as shown in Table 11.1.

TABLE 11.1 A Summary Of Pies' Design Features

Major Functions	1. Recordkeeping for student learning	1.1	Standards Inventory
		1.2	Personal Attainments Inventory
		1.3	Personal Characteristics Inventory
	2. Planning for student learning	2.1	Career and long-term learning goals
		2.2	Current prospective attainments
		2.3	Short-term learning goals
		2.4	Tasks and other activities
		2.5	Teams
		2.6	Supporting roles
		2.7	Learning contracts
	3. Instruction for student learning	3.1	Tasks: introduces, provides virtual environment, enhances real task environments, helps manage and monitor tasks, affords collaboration tools, helps find, evaluate, and store resources, and helps resolve team conflicts
		3.2	Scaffolding: provides JIT attainment-based instruction, personalizes the instruction, helps students learn metacognitive skills, gives access anywhere anytime, and integrates with OERs
	4. Assessment for/of student learning	4.1	Assessing integrated performances in the task space
		4.2	Assessing individual learning in the instructional modules
Secondary Functions		1.	Communications and collaboration
		2.	PIES administration: general student data, personnel data
		3.	Improvement of PIES: improving instruction, improving assessments
Architectural Features	Databases	1.	Standards Inventory Database
		2.	Student Profiles Database
		3.	Teammate Selection Database
		4.	Tasks Database
		5.	Instructional Modules Database
	Other features	1.	Interoperability
		2.	Modularity
		3.	Customizability

Fifty years of piecemeal educational reforms have left our public education systems increasingly inadequate to the educational needs of a post-industrial society, but there are over 140 school systems (mostly charter schools) that are pioneering the learner-centered paradigm (Reigeluth & Karnopp, 2013). The largest positive effect on increasing the current rate and success of paradigm change would likely be the development of technological tools appropriate for the learner-centered paradigm. Without such tools, it is difficult for teachers to truly personalize learning and base student progress on learning rather than on time. This chapter has presented a design of a system that could provide such tools, PIES. It is our hope that this chapter will inspire researchers to advance these design specifications and develop such a system.

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Notes

* *Editors' note: In this chapter, there are no identified situational principles.*

** *Editors' note: Of the multiple levels—school, advisory group, and individual student—only individual student is addressed in this chapter.*

1 Stanford University and Elon University are experimenting with alternatives to norm-referenced transcripts (see http://www.chroniclecareers.com/article/Making-Transcripts-More-Than/231595/).

2 Standards as currently conceived tend to include many individual attainments.

* *Editors' note: This is similar to Principle 7 in Chapter 2, Implement a CBE tracking system.*

** *Editors' note: This is the concept of a portfolio described by many chapters in this volume.*

3 A mentor teacher is the student's primary teacher or adviser—someone who gets to know the student well over a period of several years.

* *Editors' note: For more on this, see Chapters 21 and 22 in Volume II.*

4 Each student has only one "mentor teacher", who typically serves that role for three or more years. However, other people may also be mentors for a single project, including other teachers, community experts, other experts, parents, and guardians. According to Mcpartland and Nettles (1991), "[m]entoring is commonly defined as a one-to-one relationship between a caring adult and a student who needs support to achieve academic, career, social, or personal goals" (p. 568).

* *Editors' note: Goals are also addressed in Principle 3 of Chapter 1, Principle 1 of Chapter 2, Principle 1 of*

Chapter 4, Principle 1 in Chapter 6, Principle 1 in Chapter 8, Principle 2 in Chapter 9, and Principle 1 in Chapter 10.

* *Editors' note: For more about tasks, see especially Chapters 1 (Principle 2), 3 (throughout), 4 (Principle 2), 6 (Principle 4), 8 (Principle 1), 9 (Principle 1), and 15 (Principles 3–4).*

* *Editors' Note: This reference is Chapter 9 in Volume II.*

** *Editors' Note: This is a situational principle. The major situationality is cost-effectiveness of developing a virtual world or simulation game.*

*** *Editors' note: This is the situationality for this situational principle.*

* *Editors' note: This is a cue for a situational principle. The situationality is not identified here.*

5 Mashup is defined by Wikipedia as "a web page, or web application, that uses content from more than one source to create a single new service displayed in a single graphical interface."

* *Editors' note: Scaffolding for tasks is addressed by many theories in this volume, especially Chapters 1 (Principle 2), 3 (Principle 1), 4 (Principle 3), 6 (Principle 6), 8 (Principle 1), and 13 (Principle 3).*

** *Editors' note: "As needed" is a situationality.*

*** *Editors' note: This is a cue for another situationality, but the situational variables that lead to deciding among the following three options are not specified here.*

* *Editors' note: This is another cue for a situationality. Again, the situational variables are not specified for selecting among the three method variables.*

* *Editors' note: Metacognitive skills, or higher-order thinking skills, are a matter of curriculum theory, not instructional theory. However, as described in Chapter 1, the two are so highly interrelated that we have chosen to address both in this volume. Chapter 5 is dedicated to what-to-teach, and many other theories in this volume also address the importance of these skills.*

** *Editors' note: See Chapter 14, Design Considerations for Mobile Learning, for more about this.*

* *Editors' note: Reflection is an important part of the learner-centered paradigm and is crucial to self-regulated learning (see Chapter 9). It is advocated by many of the theories in this volume.*

* *Editors' note: Summative evaluation is essential for attainment-based student progress, one of the most fundamental characteristics of the learner-centered paradigm. However, it must be criterion-referenced rather than norm-referenced for reasons described in Chapter 1 (Principle 1).*

UNIT 3

Steps Toward the Learner-Centered Paradigm

Unit Foreword

As described in the chapters in Unit 1, student progress in the learner-centered paradigm should be based on learning rather than on time spent learning, should require the performance of authentic tasks, and should be personalized based on the learner's goals, interests, preferences, and prior learning. This paradigm shift requires changed roles for instructors, learners, and technology; and it requires a changed curriculum that is expanded to encompass emotional and social development and is restructured around effective thinking, acting, relating, and accomplishing.

The four chapters in Unit 3 present some emerging instructional-design theories that reimagine where and how instruction and learning take place, focusing in particular on learning that happens outside the classroom and how it can be tied to in-class instruction. Because these approaches are all working in (or perhaps more precisely, trying to work around) the current paradigm of content-focused and time-bound instruction, we see these as steps toward the new paradigm, attempts to employ some of the learner-centered principles to disrupt the current system from within.

In **Chapter 12**, *Designing Instruction for Flipped Classrooms*, Strayer prescribes the use of out-of-class tasks in which learners examine reified information to initiate construction of knowledge and provide responses that the instructor then uses to guide in-class activities. Class time is spent on shared reflection and on tasks that address learners' questions and misunderstandings and require learners to grapple with non-routine problems, communicate their thinking, and critique the reasoning of others. Flipped classroom instruction seeks to optimize the time that instructors and students spend with each other by making better use of the time they spend apart. As a result, students must take greater responsibility for their learning by preparing for class and participating fully in class activities. Strayer says that the universal principles of flipped classroom instruction are compatible with a variety of instructional approaches, and to demonstrate he provides situational principles for a direct instruction approach and a problem-based instruction approach.

In **Chapter 13**, *Gamification Designs for Instruction*, Kapp describes an approach to reimagining the content and structure of instruction to create and maintain student engagement and motivation. As with Strayer's flipped classroom instruction, Kapp emphasizes learning done outside the classroom, which is tracked and rewarded using computer-based technology. Content gamification is intended to generate intrinsic motivation and to foster feelings of autonomy, competence, and relatedness. Instructors can gamify content by incorporating game elements such as story, challenge, characters/avatars, mystery, and so forth. Gamification of course structure is intended to provide reinforcement and extrinsic motivation over longer periods of time. Instructors can gamify course structure by providing recognition for attainments in the form of points, badges, trophies, and so forth, and by maintaining a leaderboard. Gamification would seem to work well with personalization of instruction as one could imagine a course with multiple content paths that learners could navigate at their own pace.

In **Chapter 14**, *Design Considerations for Mobile Learning*, Cochrane and Narayan present principles for bridging formal and informal learning contexts by leveraging the affordances of mobile devices. Their instructional-design theory is founded on providing authentic learning experiences in which students must reconceptualize their role from passive reproducer of knowledge to active participant in learning communities. Projects are largely student-directed and require students to use tools on their mobile devices to communicate, collaborate on multimedia production, and share their creations with the public. Students and teachers together negotiate assessment activities, and teachers provide an ecology of resources to guide and support learning.

In **Chapter 15**, *Designing Just-in-Time Instruction*, Novak and Beatty describe an inductive approach to pedagogy that shares characteristics with the flipped classroom approach described in Chapter 12. Both approaches begin with out-of-class work designed to prepare learners for active learning in the classroom, and both prescribe adapting in-class activities based on learners' pre-class responses. The just-in-time approach provides more guidance regarding the pre-class activities with universal principles related to the design of whole-authentic tasks that are sequenced in increasing complexity and provide sufficient variability to promote construction of general schemata. The situational principles cover variations in methods based on pedagogical strategies and discipline-dependent thought processes.

As in Units 1 and 2, at the outset of each chapter we provide a summary of the key elements of each instructional design, highlighting important contextual factors and listing instructional values, universal design principles, situational design principles (when included by authors), and implementation considerations.

The four chapters in this unit present instructional-design theories intended to work within the current paradigm of instruction while employing some of the learner-centered design principles discussed in Unit 1. They all share an emphasis on making better use of the time learners spend outside the classroom. As you read these chapters, you might consider other ways in which instructional designers and teachers can use available technologies to take steps toward the learner-centered paradigm of instruction.

– C.M.R., B.J.B., & R.D.M.

12

DESIGNING INSTRUCTION FOR FLIPPED CLASSROOMS

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EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *The content during class must include learner-centered tasks that are completed as part of a learning community.*

Learners

- *All students.*

Learning environments

- *Students must meet regularly in a face-to-face setting.*
- *Students must have access to technology for communicating outside of class.*

Instructional development constraints

- *Time and possibly money and equipment are needed to prepare the out-of-class materials and activities.*

Values (opinions about what is important)

About ends (learning goals)

- *The development of student thinking, reasoning, and communication skills is highly valued.*

About priorities (criteria for successful instruction)

- *Efficiency is highly valued. Teachers use digital technologies to communicate with students outside of class to facilitate instructional efficiency.*

About means (instructional methods)

- *Learning by doing (active learning) is highly valued.*
- *Learning from peers by collaborating to solve non-routine problems is highly valued.*
- *Teachers should prepare students outside of class, to facilitate instructional efficiency in class.*

About power (to make decisions about the previous three)

- *Students should take responsibility for their learning both outside and inside the classroom.*

Universal Methods

1. Use out-of-class activities to encourage student reflection and elicit a response from students

- *Determine the information that is important for in-class tasks.*
- *Reify (concretize) the information.*
- *Convey reified information to students prior to class to initiate construction of knowledge.*
- *Elicit a response from students to assess understanding and guide in-class tasks.*

2. Use in-class tasks to build new knowledge as part of a learning community

- *Require students to reflect on and critique their reasoning and the reasoning of other community members.*
- *Use tasks that ask students to draw on past experience and/or initiate a new experience for students to consider in the classroom.*
- *Facilitate discussion with the goal of connecting students' thinking, strategies, and representations to relevant course content.*

3. Use the same instructional approach for out-of-class-activities and in-class tasks

Situational Principles

Situational principles are based on the instructional approach used and are determined by aligning the components (i.e., methods) of the approach with the universal principles for flipped instruction. The author provides situational principles for two instructional approaches as examples to guide application of flipped instruction to other approaches.

For a discussion approach

- *Use out-of-class activities to create opportunities for students to share what they have learned (e.g., their analyses and solutions) with the learning community.*
- *Use out-of-class activities to have students prepare responses to what their classmates have shared.*
- *Use in-class tasks to facilitate productive discussions that require students to critically respond to arguments made by others in the learning community.*
- *Use in-class tasks to create opportunities for students to draw conclusions supported by evidence, based on the information shared by members of the learning community.*

For a problem-based instruction approach

- *Use out-of-class activities to pose the problem under study and provide supporting content materials. Initial guidance/modeling for students may entail creating new media.*
- *During in-class tasks, require students to find and present solutions to authentic, complex, ill-structured problems while scaffolding their understanding and supporting reflection on learning.*
- *Use additional out-of-class activities to build on in-class work to support students' metacognitive processing and problem solving skills and support students' debriefing of the problem.*
- *Use additional in-class tasks to assess students' content knowledge and problem solving skill and connect to out-of-class activities that support debriefing of the problem.*

Implementation Issues

- *Care must be taken that flipped instruction does not devolve into lecture/homework cycles of instruction.*
- *Initially, students may react negatively.*
- *Teachers may find the approach time consuming.*
- *Teachers may have difficulties in addressing students' varied ways of thinking.*

– C.M.R., B.J.B., & R.D.M.

DESIGNING INSTRUCTION FOR FLIPPED CLASSROOMS

I. Introduction

Flipped Classroom Definition

The flipped classroom instructional model relies heavily on technology to shift instructional practices that are often implemented during class outside of the classroom. Typically, a primary goal for flipped classroom instruction is to provide time during class for students to make sense of course content together by completing meaningful and engaging tasks (Bennett et al., 2011; Bergmann & Sams, 2012; Lage, Platt, & Treglia, 2000). This kind of task-centered instruction[*] that encourages students to create and connect meaningful and coherent representations of knowledge is a hallmark of learner-centered instruction as noted by the authors of Chapter 1.

Flipped instruction was first designed and implemented under this name in university classrooms 15 years ago (Baker, 2000). Recent advances in educational technology have increased the flipped model's appeal to educators at all grade levels (K-16) (Bergmann & Sams, 2012; Brame, 2013). However, instructors have assigned textbook readings outside of class so students can complete learner-centered tasks during class long before the year 2000 (Mazur, 1997). What distinguishes more recent flipped designs is the interactive nature of the out-of-class communication that the latest technology makes possible.

Despite calls to implement flipped instruction widely (Bergmann & Sams, 2012), the model cannot be used in every learning environment. In flipped classrooms, students must meet regularly in a face-to-face setting, students must have ready access to whatever technology is used to communicate outside of class, and the designed in-class instruction must include learner-centered tasks that are completed as part of a learning community. In my experience as a mathematics educator and flipped classroom researcher, I have found that successfully implementing flipped instruction requires more than an instructional video lecture and traditional homework. Careful instructional design is necessary to create a learner-centered instructional experience using the flipped classroom model.

The goal of this chapter is to develop universal and situational principles for designing flipped instruction. Before sharing these principles, I establish the importance of and describe the values that drive flipped instruction. Then, I describe the social theories of learning and instructional design theories that ground the framework upon which the principles rest. In the closing sections, I present the universal and situational principles and highlight the importance of using a consistent instructional approach when designing and implementing flipped instruction.

The Importance of the Flipped Classroom Design

As the authors of Chapter 1 state, as education moves beyond the Industrial Age further into the Information Age, instructors' roles are profoundly changing. Most pertinent to the flipped instructional model is a move away from the instructor as the source of information in a course. While search engines and online sites provide both high- and low-quality specialized information to students, instructors must help students learn how to *think with* large amounts of easily located information. If teachers hope to accomplish this goal during class, they must enable students to communicate their thinking and critique the reasoning of others. This can take a great deal of time, and time is a precious commodity in the classroom. With high-stakes testing, end-of-course exams, and agreed-upon lists of content that specific courses are required to "cover," teachers face the challenge of helping students learn a long list of items in a given course. In this context, the flipped classroom provides a viable instructional model for practitioners who are concerned about both teaching in a learner-centered way and ensuring that all course content is addressed.*

Theoretical and Research Contexts for Designing Flipped Instruction

Teachers initially utilized instructional technology and the flipped classroom model to become a "guide by the side" during class (Baker, 2000). While "guide by the side" may be an ambiguous and overused phrase, it came to characterize instructional strategies that arose from the constructivist movement—a movement that continues to influence current instructional designs (Cronjé, 2006; Jonassen, 1999; Yanchar, South, Williams, Allen, & Wilson, 2010). Many theorists have contributed to the development of constructivist thinking. In this section, I will draw on the constructivist tradition to develop a theoretical framework (see Figure 12.1) from which the universal principles for flipped instructional design will be developed later in the chapter. I will close this section by reviewing the flipped classroom literature to situate the universal and situational principles within current developments in the field.

The theoretical framework I utilize in this chapter adheres to the following tenets:

- Both experience and the conveyance of information are important for learning (Dewey, 1990).
- Students build knowledge when they reflect on how they transform objects of thought (Piaget, 1970).
- Student understanding can perhaps best be understood when we observe what they can do with the assistance of others (Vygotsky, 1978).
- Instructional designers must account for the ways the learning community influences individual student learning (Lave & Wenger, 1991).

The connections between components in this theoretical framework are depicted in Figure 12.1. When viewing Figure 12.1, horizontal links should be read from left to right and vertical links should be read from top to bottom.

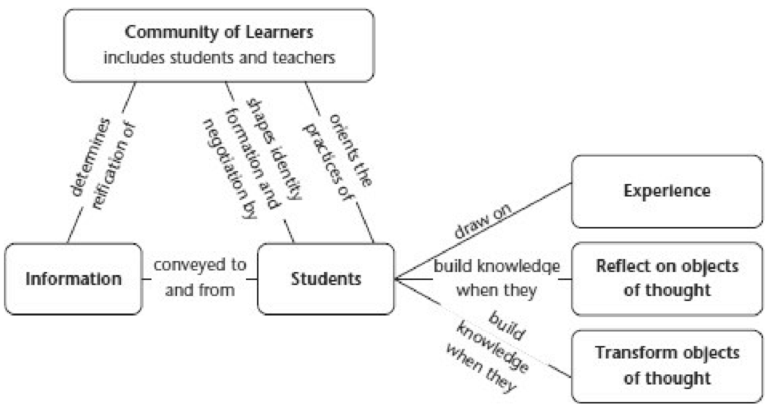

FIGURE 12.1 A Theoretical Framework for the Universal Principles for Flipped Instruction

Dewey argued that learning begins with experience. By giving primacy to students' experience in classroom instruction, teachers help students move from *what came before* to *what is to come*. According to Dewey, "every experience is a moving force. Its value can be judged only on the ground of what it moves toward and into" (Dewey, 1997, p. 38). It is the instructor's task, therefore, to attend to the direction in which students' experience is heading and to shape it so that students are not just "doing things" but are able to "get the idea of" what they are doing. This is accomplished when students conceptualize aspects of what they are doing and make specific ties between those conceptions and their experiences (Dewey, 1990). Dewey's theory shows the critical importance of effectively structuring the interaction between an out-of-class *conveyance of information* and the in-class *experiences* of the students during flipped instruction. Dewey expressed it in this way, "harmful as a substitute for experience, [conveyance of content] is all-important in interpreting and expanding experience" (Dewey, 1990, p. 85).

As we consider the role of experience in the learning process, Piaget helps us understand more fully the means by which students' minds progress from states of lower knowledge to states of higher knowledge through experience (Piaget, 1970). His genetic epistemology group established a parallel between the rational organization of knowledge and the psychological processes that facilitate the transformation from lower states to higher states. More specifically, any given state can be understood only by observing the transformations made possible by that state. This means human knowledge is fundamentally active. That is, humans build knowledge only when they have reflected on the coordinated actions they use to transform an object of thought in some way.

Piaget explains this process using an example of how a young boy came to an initial understating of the commutative property in mathematics by counting 10 pebbles in different ways (Piaget, 1970). First, the child placed the pebbles in a straight line and counted them from left to right. He counted again, this time from right to left, and was surprised the answer still came out 10. Next, he changed the arrangement by laying the pebbles out in a circle and counted in both directions. The answer? Still 10. Independent of the order, the sum was always 10. The child acted on both the pebbles and his concept of number using multiple one-to-one correspondences, but it was through the act of reflecting on what he observed that the child moved to a higher state of knowledge. Piaget termed this process reflective abstraction. If flipped instruction is to accomplish the goal of helping teachers guide student learning, then the design must contain ways for students to engage in reflective abstraction and for instructors to leverage the results of reflective abstraction to enhance students' learning.

One such leveraging of reflective abstraction is found in the work of Lev Vygotsky, who demonstrated that children's ability to speak serves both cognitive and communicative functions that form the basis for psychological processes (Vygotsky, 1986). For Vygotsky, humans develop higher states of knowledge through a psychological process carried out in and informed by both individual and social history. One way that Vygotsky's theory of human development informs flipped instructional design is through applying the notion that what students know can perhaps be better understood by observing what students can *do with the assistance of others* rather than what they can *do alone* (Vygotsky, 1978). Attending to this social nature of a student's construction of knowledge is vital for the design of in-class tasks and out-of-class activities during flipped instruction.

Lave and Wenger (1991) extend Vygotsky's work using the metaphor of *apprenticeship in a community of practice* to fully develop a social theory of learning. They argue that learning in a community occurs as both old-timers and newcomers negotiate what full (or fuller) participation in the practices of that community looks like. When we duly note the influence a learning community has on student learning, we understand that learning cannot be designed; it must be designed *for* (i.e., facilitated [Wenger, 1998]). By this, Wenger means that because individual students make countless decisions regarding their participation in and identification with classroom learning, instructional designers must design instructional experiences that provide maximal opportunities for students to engage in the learning process, but designers cannot prescribe exactly what that learning looks like for individual students.

According to Wenger, instructional designers hold four dualities in tension when designing for learning: participation/reification, designed/emergent, local/global, and identification/negotiability (Wenger, 1998). Wenger expresses *descriptive principles* for each of these dualities (see Table 12.1). First, instructional designers put certain artifacts in place that express the ideas in a lesson. This process is termed reification because the artifacts reify, or make more concrete, the ideas. Designers also ensure the right people are in the right place and given the opportunity to be in relation with each other and the artifacts so that learning can happen. This is termed participation. Students learn by organizing their future around the artifacts and the ideas they reify. This process leads to Wenger's first principle:

Design for practice is always distributed between participation and reification—and its realization depends on how these two sides fit together (Wenger, 1998, p. 232). Second, because practice is a response to design, we recognize that unanticipated adaptions of the design may emerge when it is implemented. A recognition that these unexpected adaptions can be a healthy response to the designed instruction leads to Wenger's second principle: *There is an inherent uncertainty between design and its realization in practice, since practice is not a result of design but rather a response to it* (Wenger, 1998, p. 233).

Third, although the response of individuals in the local learning community must be taken into account when designing instruction, this does not mean individuals are left to their own devices. Local communities find their place within broader global communities with which they share their defining practices. These complex relations are captured in Wenger's third principle: *No community can fully design the learning of another; no community can fully design its own learning* (Wenger, 1998, p. 234). Finally, the extent to which members of the learning community can define, interpret, and adapt the instruction is inherent in the design. It is unavoidable that certain perspectives may be privileged over others. This privileging impacts individuals' identification with and ownership of meaning and is at the heart of Wenger's fourth principle: *Design creates fields of identification and negotiability that orient the practices of those involved to various forms of participation and non-participation* (Wenger, 1998, p. 235).

Wenger's descriptive principles do not provide specific guidance for designing instruction that meets a given goal; therefore, instructional designers would not consider them "design principles" as such (Reigeluth, 1983). However, these principles describe with keen insight the complex space in which instructional designers operate, and I will draw on them as I develop instructional design principles for flipped instruction. Additionally, Wenger provides a framework for considering how individual learners interact with designed instruction. He asserts that individuals develop their identity as a member of a learning community through three distinct (yet interrelated) modes of belonging: engagement, imagination, and alignment. Through engagement, members participate in actively negotiating meaning. Through imagination, members extrapolate from their own experiences within the community to create images of what their involvement in the community means. Through alignment, members associate themselves with the broader structures of the community and act in ways that contribute to the broader enterprises of the community. Effective instructional design will work to support all three modes of belonging within the four dimensions of design addressed by Wenger's descriptive principles (Wenger, 1998, Chapters 10–12).

Flipped classroom instructional designers must be cognizant of Wenger's dualities and modes of belonging when designing instruction. Because flipped instruction relies so heavily on technology to convey information to students, designers can easily lose the balance in some of Wenger's dualities. For example, if flipped instruction exclusively uses video lectures to reify course content without requiring a meaningful response from students, then reification will outweigh participation and learning may suffer.

TABLE 12.1 Wenger's Descriptive Principles for Instructional Design

1. Design for practice is always distributed between participation and reification – and its realization depends on how these two sides fit together.
2. There is an inherent uncertainty between design and its realization in practice, since practice is not a result of design but rather a response to it.
3. No community can fully design the learning of another; no community can fully design its own learning.
4. Design creates fields of identification and negotiability that orient the practices of those involved to various forms of participation and non-participation.

Flipped Instruction's Place within Instructional Design Theory

The research base on the flipped classroom is just beginning to take shape (Goodwin & Miller, 2013). Most research to date has been conducted in individual classrooms or individual institutions and has focused on student learning preferences and student performance. While some studies have provided evidence that students prefer lecture-based settings to flipped settings (Jaster, 2013; Missildine, Fountain, Summers, & Gosselin, 2013; Strayer, 2007), most have concluded that students prefer the flipped classroom when compared to lecture-based classrooms (Butt, 2014; Chen, Wang, Kinshuk, & Chen, 2014; Findlay-Thompson & Mombourquette, 2014; Yeung & O'Malley, 2014; Kiviniemi, 2014; Lage et al., 2000; Love, Hodge, Grandgenett, & Swift, 2014; McGivney-Burelle & Xue, 2013; McLaughlin et al., 2013; Wilson, 2013). With regard to performance, studies have reported that when compared to students in lecture-based classrooms, flipped classroom students perform at either the same level (Findlay-Thompson & Mombourquette, 2014; McLaughlin et al., 2013; Strayer, 2007) or at a significantly higher level (Baepler, Walker, & Driessen, 2014; Kiviniemi, 2014; Love et al., 2014; Mason, Shuman, & Cook, 2013; McGivney-Burelle & Xue, 2013; Tune, Sturek, & Basile, 2013; Vaughan, 2014; Wilson, 2013).

One reason the current research base has a limited reach (Goodwin & Miller, 2013) is that many of the studies use different instructional designs for the flipped classrooms they study. Many studies provide descriptive models for flipped instruction (Chen et al., 2014; Hamdan, McKnight, McKnight, & Arfstrom, 2013; Zhou & Jiang, 2014), but most of the evidence reported in the research is comparative in nature. Because of this, the reported evidence often does not provide grounds on which to make decisions regarding the design of flipped instruction. One study, however, has used research results to support specific design principles for flipped instruction. Kim et al. (2014) used data collected in their study to extend Brame's key elements of flipped instruction (2013) and provide guidance for designers of flipped instruction. They assert that flipped instruction should be designed to:

1. Provide an opportunity for students to gain first exposure prior to class
2. Provide an incentive for students to prepare for class
3. Provide a mechanism to assess student understanding
4. Provide clear connections between in-class and out-of-class activities
5. Provide clearly defined and well-structured guidance
6. Provide enough time for students to carry out the assignments
7. Provide facilitation for building a learning community (Kim et al., 2014).

With these seven principles in mind, let us turn to the instructional design theory literature. During any instructional sequence, teachers employ *methods* in response to initial learning conditions with the goal of achieving desired instructional outcomes. Gibbons and Rogers (2009) note that we must attend to seven layers when designing instruction from the ground up, as an architect would design a building. These layers include content, strategy, message, control, representation, media-logic, and data management. The methods specific to flipped instruction (i.e., providing opportunities for students to be exposed to course content prior to class, incentives for preparing, mechanisms for assessment, connections between in-class and out-of-class activities, guidance, time, and facilitation [Kim et al., 2014]) focus on to the timing, goals, and organization of instructional interactions. In addition, flipped instructional methods determine the ways teachers and students interact and the means by which the interaction occurs. Therefore, within the broader instructional design literature, flipped instructional methods and the principles guiding their use fit in the strategy, message, control, and representation layers of design (Gibbons & Rogers, 2009; Reigeluth & Carr-Chellman, 2009b). For a more in-depth discussion of design layers and instructional design theory, see chapters 1–4, and 14 of Volume III in this series.

I hold the view that flipped instruction can be designed for use with a number of different instructional *approaches*. An instructional approach is guided by a broad theory for how the components (or methods) of instruction are related (Reigeluth & Keller, 2009). Volume III in this series presents five theories for approaches to instruction (direct, discussion, experiential, problem-based, and simulation) and describes *principles* for how those components are utilized during instruction. The universal and situational principles I describe in this chapter serve as a guide for developing instructional components (i.e., methods) *within* different approaches rather than as principles for a new approach called "flipped instruction." We will see that flipped methods are "selected in concert with other methods *as part of* [emphasis added] an instructional approach" (Reigeluth & Keller, 2009, p. 32). In fact, the selection of an instructional approach determines this chapter's situational principles for flipped instructional design. As such, even at the universal principle level, the flipped instructional model presented in this chapter is componential in nature (i.e., the model is methods-centric). This distinction sets the universal principles in this chapter apart from Kim and colleagues' (2014) principles—which present the flipped classroom as its own instructional approach. Both Kim and colleagues' principles and the principles in this chapter are useful for instructional designers. Taken together, they provide layers of guidance for designers who may utilize different theories of instruction.

II. Values of the Flipped Classroom Design

Some depictions of flipped classrooms portray the learning environment as one in which students watch lectures at home and complete traditional homework assignments during class. If students get stuck in class, they ask the teacher or other students for help (Thompson, 2011). However, this depiction of flipped instruction *is at odds with* the original vision for learner-centered flipped classrooms cast by Baker (2000) and Lage et al. (2000). In this section, I describe the values shared by flipped instructional designs that are faithful to that original vision (see Table 12.2).

The primary value that learner-centered flipped instructional designs share is the belief that students' thinking and reasoning should be the central focus of classroom instruction. Instructors in ideal flipped classrooms value solving *non-routine* problems (i.e., problems that require strategic thinking to solve [English, 1996]) rather than traditional homework problems in class. Flipped classroom adherents believe that this process is significantly aided when students have thought about some of the key concepts prior to class that they will use to solve problems during class (Bennett et al., 2011).

Teachers should prepare students for solving non-routine problems in class by communicating with students prior to class. More recent flipped instructional designs place a high value on efficiently conveying information to students using technology and eliciting some sort of response from the students. Teachers and students must value experiences that require exploring applications of course content, formulating solutions to non-routine problems, communicating one's thinking, and evaluating the reasoning of others. If students, instead, place a high value on the instructor doing all of the talking during class, they will not thrive in a flipped classroom (Strayer, 2007). In addition, teachers in flipped classrooms often find that conveying information that scaffolds students' developing understanding of course content using succinct, well-prepared videos can improve instructional efficiency when students complete learner-centered tasks in the classroom (Cargile, 2015; Fulton, 2012; Strayer, Hart, & Bleiler, 2015; Strayer, Hart, & Bleiler-Baxter, in press).

TABLE 12.2 Values of Flipped Instruction

1. Classroom instruction should focus on promotion of student thinking and reasoning through non-routine problems.
2. Student exploration of applications of course content, formulation of solutions to non-routine problems, communication of their thinking, and evaluation of the reasoning of others should be done during class.
3. Teachers should prepare students for the class activities with instruction outside of class to facilitate instructional efficiency during class.
4. Students should take responsibility for their learning both outside and inside the classroom.

Finally, teachers and students in flipped classrooms must value students taking responsibility for their learning both outside and inside the classroom (Kim, Kim, Khera, & Getman, 2014). In-class tasks are designed with the assumption that students have done their part to prepare by completing the out-of-class activities. It is difficult, if not impossible, for flipped classroom learning communities to thrive if students do not prepare outside of class or if they do not actively negotiate meaning during the in-class portion of the lessons (Strayer, 2012).

With these values in mind, the next section describes the theoretical framework I use to develop universal and situational principles for designing learner-centered flipped classroom instruction.

III. Universal Principles

The idea of interchanging traditional out-of-class and in-class activities is what began the flipped classroom model. The universal principles for designing flipped instruction presented in this chapter shift the focus away from traditional models of teaching towards a more integrated, learner-centered approach using the theoretical framework presented in the previous section. The universal principles are as follows*:

1. Use out-of-class tasks to encourage student reflection and elicit a response from students.
2. Use in-class tasks to build new knowledge as part of a learning community.
3. Connect out-of-class tasks and in-class tasks using the same instructional approach.

Principle 1. Use Out-of-Class Tasks to Encourage Student Reflection and Elicit a Response from Students

Teachers using the flipped classroom model must determine important information that can be used to scaffold students' developing understanding of course content, reify (concretize) that information in some way, and use technology to convey that reified information to students prior to class so they can complete tasks in class that help them make meaning.** This conveyance may occur with high-tech tools (e.g., interactive video with accompanying software), low-tech tools (e.g., assigned readings), or something in between (e.g., short, one-take teacher created instructional videos). We must bear in mind that whatever form the out-of-class tasks take, students construct their understanding of the reified information as they negotiate meaning by participating within the learning community that includes their fellow students and teacher (Wenger's first descriptive principle).* The design process of combining reification of information and an invitation to participate in the learning community is quite delicate. If teachers or instructional designers merely "dispense" information to students in a video during out-of-class tasks, they run the risk of marginalizing students from the community of practice, sending the message that ideas are generated by the instructor only.

Rather than treating the out-of-class tasks as places for conveyance of information only, the flipped designer should see these tasks as the beginning of a process.** They are the "launch" for the in-class tasks, if you will. Lobato, Clarke, and Ellis (2005) have shown that conveying information to students *can* be at odds with learner-centered learning. Conveyance of information is undesirable from a learner-centered instructional perspective if it:

1. does not provide opportunity for teachers to understand students' ideas, interpretations, or strategies;
2. focuses only on procedural information;
3. reinforces the notion that the teacher is the final arbiter of truth rather than developing the students' responsibility for making judgments;
4. minimizes student cognitive engagement;
5. reinforces the notion that there is only one solution path; or
6. prematurely concludes an educationally productive exploration (Lobato et al., 2005).

Lobato and colleagues go on to argue, however, that information conveyance *need not* be at odds with learner-centered learning. If teachers introduce new ideas in order to stimulate students' construction of knowledge, then they are supporting learner-centered learning. Lobato and colleagues (2005) term this type of conveyance *initiating* and describe examples of initiating actions as including, but not limited to, the following:

1. "Describing a new concept (which can include an idea, the meaning associated with a mathematical symbol, why something works, an image, a relationship, or connections among ideas or representations)
2. Summarizing student work in a manner that inserts new information into the conversation

3. Providing information that students need in order to test their ideas or generate a counterexample
4. Asking students what they think of a new strategy or idea (perhaps from a 'hypothetical' student)
5. Presenting a counterexample that the teacher has not seen any students introduce and thinks no one will." (Lobato et al., 2005, p. 110–111)

When designing learner-centered flipped instruction,[*] out-of-class tasks should use initiating actions that require students to make conceptual sense of course content. Teachers should follow these initiating actions by *eliciting* a response from students. This allows teachers to ascertain how students have interpreted conveyed information and use this assessment to guide subsequent in-class instructional tasks. Eliciting actions are those that ask students to "articulate, share, discuss, reflect upon, and refine their understanding" of course content (Lobato et al., 2005, p. 112). Depending on the instructional approach of the lesson (situationalities I will address later in this chapter), instructors may wish to elicit student responses in different ways. Regardless, if we design out-of-class tasks so that eliciting follows initiation, we acknowledge the uncertainty between instructional design and its realization in practice (Wenger's second descriptive principle) and value the notion that students should enter into the practices of the learning community as a response to design. Moreover, this principle acknowledges the importance of information conveyance[**] in its own right (Dewey, 1990) and the importance of reflective abstraction during the construction of knowledge (Piaget, 1970).

Principle 2. Use In-Class Tasks to Build New Knowledge as Part of a Learning Community

Learner-centered flipped instruction is designed to help students construct deeper understanding of content by having them complete tasks *during class* that ask them to reflect on and transform their understanding of the content under consideration (Piaget, 1970) as part of a learning community. Indeed, students should make meaning of content both individually and with the assistance of others (Vygotsky, 1978). During flipped instruction, teachers might design in-class tasks that begin with the student articulations of their understanding that were elicited during out-of-class tasks (Principle 1).[*] In-class tasks should require students to reflect on and critique their own initial reasoning and the reasoning of other community members. Tasks should enhance student reflection by asking students to draw on past experience and/or initiate a new experience for students to consider in the classroom (Dewey, 1990). The ensuing reflection and negotiation with other members of the learning community will require students to eventually refine and deepen their understanding of content. This process is aided by students' engagement (active negotiation of meaning), imagination (extrapolating from different learning experiences images of how to contribute to the negotiation of meaning in the community), and alignment (working within the structures of the classroom to contribute the broader meaning making in the classroom [Wenger, 1998]).

As an example of how teachers might connect out-of-class and in-class tasks as just described, let us consider five teacher practices that many teachers have found useful when leading productive in-class discussions (Smith & Stein, 2011). While identified in mathematics classrooms, these practices may position teachers to facilitate productive classroom discussions in other subject areas as well.[**]

1. First, before a task is given, the teacher *anticipates* different strategies and thinking students may use to complete the task (including misconceptions, gaps in prior knowledge, and confusions).
2. After the task is launched, the teacher *monitors* students' work to assess students' thinking as they are working.
3. While the teacher is monitoring, he or she also *selects* students to present and explain their work to the class.
4. In addition to selecting, the teacher *sequences* the order in which students will present their work.

These first four practices shape the ensuing class discussion. Three of these practices (monitoring, selecting, and sequencing) can be especially difficult for teachers in a traditional setting because they require teachers to examine student work quickly and carefully with an eye toward how the ensuing class discussion will progress (Smith & Stein, 2011). However, teachers who design flipped instruction beginning with an out-of-class task that uses a video, textbook, or other content resource to elicit student thinking are able to collect student responses, carefully read them, and select and sequence examples of student work prior to the beginning of class. Thus, the flipped instructional strategy allows teachers to enact these four practices in a way that eases the pressure for teachers to answer students' questions and address their misconceptions, gaps in reasoning, or confusions "on the spot."

5. The fifth and final of Smith and Stein's practices is enacted while the class engages in a discussion centered on the presented student work in class. During this discussion, the teacher works to *connect* students' thinking, strategies, and representations to the important course content that motivated the task.

Designers may have these or other teacher practices in mind while following Principle 2. In whatever way the instruction unfolds, this principle's focus is on designing in-class time so that students draw on their experiences to reflect on and transform their understanding of course content as part of a learning community (Dewey, 1990; Piaget, 1970; Vygotsky, 1986; Wenger, 1998). As students negotiate their way of belonging within that community, in-class learning opportunities may allow for students to push beyond the meanings brought to light by the local learning community to find ways that the broader, more global, community makes meaning of the content under study (Wenger's third descriptive principle). Designers can take advantage of the dynamic potential of in-class learning opportunities when they account for the ways that members of the community identify with the content they are learning, negotiate the meaning they are making regarding that content, and determine the extent to which they will participate in the practices of the community which rely on an understanding of that content (Wenger's fourth principle).

Principle 3. Connect Out-of-Class Tasks and In-Class Tasks Using the Same Instructional Approach

The instructional approach of a lesson (e.g., discussion, problem based, simulation) sets the direction for student learning (Reigeluth & Keller, 2009). In order for students to experience coherent instruction, the out-of-class and in-class portions of instruction should follow the same approach. As described above, flipped instruction employs different methods for different purposes during in-class and out-of-class tasks. However, all methods used during an instructional cycle should fit together to form a coherent instructional whole that supports students as they draw on their experiences to reflect on and transform objects of thought in a learning community. If these methods do not support one another within a unified instructional approach, students will have difficulty fully participating in the process of negotiating meaning of course content during classroom sessions (Strayer, 2007, 2012).

Learning difficulties that stem from a mismatch of in-class and out-of-class instructional approaches have been documented in flipped classroom settings (Jaster, 2013; Missildine et al., 2013). In one such study, students completed out-of-class tasks using an intelligent tutoring system designed with a mastery learning, direct instruction approach. During class, students completed tasks that used a problem-based learning approach that required them to analyze data, make statistical decisions, and defend their decisions to one another and the teacher (Strayer, 2007). Although the out-of-class activity content was carefully selected to correspond with the in-class task content, the instructional approaches for out-of-class and in-class were completely different.[*] Students experienced difficulty determining the practices that were most valued in the course—those fostered by the out-of-class tasks or those fostered by the in-class tasks. In this mixed-approach setting, the out-of-class tasks became something few students valued. Indeed, students in that flipped environment reported a noted dissatisfaction with how the learning environment oriented them toward the tasks they were asked to complete (Strayer, 2012).

While instructional design cannot determine student practice (Wenger, 1998), if designers create out-of-class tasks and corresponding in-class tasks so that they have a consistency of instructional approach, then students will be better positioned to more fully identify with and engage in the practices necessitated by those tasks. For example, in the flipped study mentioned above, if out-of-class tasks had asked students to articulate their understanding of the content of the lesson (be it mastery of a skill or understanding of a concept) and then used that articulation directly during a subsequent in-class task, then students may have placed greater value in those out-of-class tasks and used them as a tool to negotiate meaning during their participation in classroom activities.

Having identified the universal principles for flipped instruction, let us now consider situational principles that further guide the design of flipped instruction. These situational principles vary depending on the instructional approach employed during the instruction.

IV. Situational Principles

The situational principles for flipped instruction presented in this section provide guidance for designers who seek to implement flipped instruction within a given instructional approach. Each set of situational principles is contingent on the instructional approach the designer chooses and is therefore means-centric (Reigeluth & Carr-Chellman, 2009a). In this section, I describe a set of situational principles for two different instructional approaches: the discussion approach (DA) and problem-based instruction (PBI). Each set is determined by aligning the components (i.e., methods) of the approach with the universal principles for flipped instruction described earlier in this chapter. Space limitations make it impossible to provide situational principles for all of the foundational instructional approaches identified in Volume III of this series.[*] However, it is my hope that providing situational principles for DA and PBI will serve as a guide for how one might design flipped instruction while attending to the situationalities of other instructional approaches.

In both sets of situational principles, out-of-class tasks are aligned with those components of instruction where teachers reify course content, ideas, and skills to initiate contact with students. This contact also elicits a response from students, inviting them to participate in the practices of the classroom. In-class tasks are aligned with those components of instruction that require students to participate in the practices of the learning community. Other instructional components (e.g., formative and summative assessment, scaffolding, providing feedback) are distributed between in-class and out-of-class tasks so that students experience a unified instructional approach in the flipped design.

Discussion Approach

The discussion approach (DA) to instructional design includes seven primary components (Gibson, 2009).

A. First, the teacher must clearly lay the ground rules for how members of the learning community are to share responsibility for learning with, listen to, respond to, and show vulnerability to others in the community. Because the teacher shares responsibility for learning with the students, students must view themselves as full partners in the learning process.[**]
B. Second, the teacher must create a climate of collaboration and respect for multiple perspectives among members of the learning community. Teachers work to help students become independent thinkers[***] who can identify problems, propose and defend solutions, respectfully critique others' arguments, and draw conclusions supported by evidence.
C. Third, teachers must have strong content knowledge and strong discussion facilitation know-how. When facilitating productive classroom discussions, teachers must be able to listen carefully, think critically, and respond appropriately in the moment to accomplish the learning goals of the class session.
D. Fourth, teachers must build instruction from students' life experiences and prior knowledge.
E. Fifth, teachers must require students to listen to, reflect upon, respond to, and link together essential content that is discussed by members of the learning community.
F. Sixth, teachers must create a democratic learning community where students have a productive and

safe space to speak freely while discussing course content.

G. Seventh, the teacher must create a physical space in the classroom that provides the necessary environment for learning community members to easily communicate with one another.*

The situational principles for implementing flipped instruction using a DA approach align the components of DA with the universal principles for flipped instruction (Principle 1) and are given in Table 12.3. First, designers should use out-of-class activities to create opportunities for students to reflect upon course content and share their analysis of course content and their proposed solutions with the teacher and with others in the learning community (Principle 1; DA components A, B, D, E, and F). As students complete these activities, they are sharing responsibility for learning with others in the community (DA component A), so it is important for teachers to clearly articulate the ground rules for communicating with others in the course so that students have a productive, safe space to speak freely (DA components A and F). These out-of-class activities should encourage students to think independently to identify problems and propose solutions (DA component B) while drawing on their life experiences and prior knowledge (DA component D). This reflective abstraction (Piaget, 1970) will support student learning.

The second situational principle for flipped instruction with DA states that out-of-class activities should also provide students with the opportunity to reflect on information shared by others in the learning community with the goal of linking what was shared with the learning goals of the course (DA components E and F). Therefore, out-of-class activities should also require students to consider how they will, during subsequent class sessions, respond to and critique what others in the community have shared prior to class (Principle 3; DA components A, B, and E). Depending on the teacher's level of facility with technology, they can launch these out-of-class activities using existing videos of other teachers, or they can record themselves communicating the necessary information to students with video or screencast technology.

TABLE 12.3 Situational Principles for Flipped Instruction with a Discussion Approach

1. Out-of-class tasks should create opportunities for students to share what they have learned (e.g. analyses and solutions) with the teacher and with others in the learning community (DA components A, B, D, E, and F). UPFI 1
2. Out-of-class tasks should require students to consider what other students have shared prior to the class meeting and to prepare a response that will be shared during a subsequent class period (DA component A, B, E, and F). UPFI 3
3. In-class tasks should provide productive in-person opportunities for students to respectfully yet critically respond to arguments made by others prior to class. (DA components A–G). UPFI 2 and 3
4. In-class tasks should require students to draw conclusions supported by evidence, based on the information shared by members of the learning community during classroom discussion (DA components A, C, E, and G). UPFI 2

Third, because class discussion essentially began with the out-of-class activity, in-class tasks should focus on providing students with rich opportunities to substantively critique and respond to others' arguments by drawing on DA components A-G (UPFI 2 and 3). Flipped instructional designers believe that students and students' understandings should be at the center of classroom instruction (Bennett et al., 2011); however, creating a productive learning environment where this is the norm can be quite challenging for teachers (Hadjioannou, 2007; Smith & Stein, 2011). DA component C acknowledges the need for teachers to have strong content knowledge and facilitation know-how to meet this challenge. By utilizing a flipped classroom design and coordinating out-of-class activities and in-class tasks (Principle 3), teachers are afforded time to consider how they will further the in-class discussion in a way that both responds to what students have shared prior to class and connects to the learning goals of the class. The flipped classroom design relieves the teacher of the responsibility of having to make all of these discussion-based instructional decisions "in the moment" during class while the discussion is unfolding. Following this third situational principle will create a space for students to challenge and respond to others and will allow the teacher to better observe what students can do with the assistance of others (Vygotsky, 1978).

The fourth and final situational principle for flipped instruction with DA requires students to build knowledge as part of a learning community by drawing conclusions based on evidence that was presented during the classroom discussion (Principle 2). Having created the necessary space for students to productively engage others in a discussion of the course content (DA components A, C, and G), the teacher now encourages students to link together essential content (DA component E) as they a) negotiate their level of participation in the practices of the learning community and b) identify their place in the learning community by articulating the meaning they have made of the course content as a result of the class discussion (Wenger, 1998).

Problem-Based Instruction

The problem-based instruction (PBI) approach requires students to solve authentic problems that entail the kind of thinking that someone knowledgeable in specific fields of study would possess.[*] Instructional designers have identified four primary components of the PBI approach (Savery, 2009):

A. First, PBI poses authentic, meaningful problems that are holistic, practice-based, ill-structured, and contemporary. The problems presented to students are broader than any narrow disciplinary boundary, must mirror real problems in the field, must be somewhat messy (ill-structured) to help students make sense of ambiguous situations, and must suggest present-day value in the solution to the problem.
B. Second, during PBI students work together to solve problems, and the teacher functions as B. a facilitator of learning rather than a provider of information.[**] While it is true that the teacher must provide initial instructional and content materials, and perhaps model how the problem solving process should work, the teacher performs these functions to scaffold/support students' understandings as they negotiate meaning rather than to transfer knowledge to students. The teacher's ability to help students reflect on what they know and determine what information they still need to move forward (metacognition and self-regulation of learning) is critical to the success of problem-based learning.
C. Third, during PBI, as in all instructional approaches, it is essential for assessments of student knowledge to reflect the values underlying the approach. Yes, content knowledge in the domain of study will be assessed, but the teacher will also be interested in assessing students' problem solving skills and higher-order thinking skills they develop as a result of solving the problem.
D. Fourth, the teacher must consistently and thoroughly help students debrief their learning experiences during PBI lessons. Students can venture off into very deep water as they solve problems in a PBI classroom. Therefore, it is paramount that the teacher helps students articulate a clear solution to the problem, make connections between different solutions presented in the class, and make connections between the new knowledge they have built and their existing understanding of course concepts/content.

TABLE 12.4 Situational Principles for Flipped Instruction with a Problem-Based Instruction Approach

1. Out-of-class tasks should pose the problem under study (PBI component A) and provide supporting content materials and initial guidance/modeling for students (PBI component B). UPFI 1
2. In-class tasks should require students to find and present solutions to authentic, complex, ill-structured problems (PBI component A) while scaffolding student understanding and supporting student reflection on learning (PBI component B). UPFI 2
3. Additional out-of-class tasks should build off of in-class work to support students' metacognitive processing and problem solving skill (PBI component B) and support students' debriefing of the problem (PBI component D) . UPFI1, UPFI 3
4. Additional in-class tasks should assess students' content knowledge and problem solving skill (PBI component C) and connect to out-of-class tasks that support debriefing of the problem (PBI component D). UPFI 2, UPFI 3

The situational principles for implementing flipped instruction using a PBI approach align the components of PBI with the universal principles for flipped instruction and are given in Table 12.4.

First, out-of-class activities should pose the problem (PBI component A) and provide initial instructional materials, content materials, and resources to students (PBI component B). Out-of-class activities should also provide initial guidance and modeling for students regarding the problem solving process for the problem at hand (PBI component B). These out-of-class activities can be initiated using a video or screencast that teachers create. It may be difficult for teachers to piece together existing video resources to meet these goals, but instructional designers could develop their own out-of-class materials to accompany a given curriculum. Classroom teachers who use these kinds of materials could create their own videos as needed for out-of-class activities using a video camera or screencast technology.

Second, PBI flipped instruction should use in-class tasks to create space for students to find solutions for the authentic, holistic, practice-based, ill-structured problems under study (PBI component A). As students work on a problem in class, teachers must scaffold student understanding and serve as a metacognitive coach for students, helping them to determine what useful information they already know and what important information they still need to determine to solve the problem (PBI component B).[*] In-class tasks should also require students to present their findings to the class. As students in the learning community listen to, critique, and refine solutions to problems, they will have engaged in the type of reflective abstraction that effectively builds knowledge (Piaget, 1970).

Third, because PBI lessons span multiple class sessions, additional subsequent out-of-class activities (delivered via technology) should be used to support students' metacognitive processing and problem solving skill (PBI component B). This linking of in-class tasks and out-of-class activities with the overall PBI instructional approach of the lesson provides a way for students to identify with the practices of the learning community and negotiate meaning as they find solutions to multi-faceted, complex problems (Principle 3). Subsequent out-of-class activities should also help students debrief their PBI lesson (PBI component D). For example, a teacher can create an out-of-class activity that uses a video to provide a summary of multiple groups' work on the problem under study and begins to make connections between different groups' work. Teachers can then elicit a response from students, asking them to finish making connections a) between the solutions and b) between the new knowledge they build as they create their solutions and their previous understanding of the content under study.[*]

Fourth, additional in-class tasks should be used to assess students' content knowledge and problem solving skill (PBI component C).[1] These assessments can take the form of quizzes and exams or teacher observation of students collaborating in groups using an observation rubric (Elrod & Strayer, 2015) or assessments of students' formal presentations of their solutions. Toward the end of a PBI lesson, in-class tasks should also be used to facilitate students' debriefing the lesson. By initiating the debriefing using out-of-class tasks (as just mentioned in situational principle 3 above), teachers can make efficient use of class time while helping students deepen their understanding of the multiple solutions that student groups present during class.

V. Implementation Issues

Many educators share concerns that implementations of flipped instruction will devolve into all too familiar lecture/homework cycles of instruction, with students completing homework in isolation during class (Nielsen, 2012). In response to these concerns, flipped classroom advocates clarify that such an implementation is not consistent with the key tenants of flipped classroom instructional design (Bergmann, Overmyer, & Wilie, 2012; Cargile, 2015; Hamdan et al., 2013). Flipped instruction should increase *interaction*, not isolation, between students and teachers. It must create an environment where students negotiate meaning and construct their understanding of course content.

Introductory physics classes at Harvard University provide one example of such an environment. Instructors in these classes have implemented flipped instruction since the early 1990s, though not specifically using the term "flipped instruction." Physics instructors rely on low-tech out-of-class textbook reading for the conveyance of information (with quizzes to ensure students read the assigned content) and highly interactive peer instruction in-class tasks. Data has shown that students who learn with this type of flipped peer instruction approach have a stronger conceptual understanding of course content than their traditional class counterparts (Crouch & Mazur, 2001; Deslauriers, Schelew, &

Wieman, 2011). Another study documents increased retention of STEM majors in these flipped classrooms (Watkins & Mazur, 2013).

Despite these and other documented successes (Baepler et al., 2014; Kiviniemi, 2014; Love et al., 2014; Mason et al., 2013; McGivney-Burelle & Xue, 2013; Tune et al., 2013; Vaughan, 2014; Wilson, 2013), teachers implementing flipped instruction still encounter issues that raise concern. As reported by the chair of the Harvard physics department, faculty members who flip their classrooms often receive lower initial student evaluations of their courses (Berrett, 2012). In addition, some teachers find the approach time consuming. Others find it difficult to answer students' questions on the spot and address students' varied ways of thinking. Teachers in this position may find the strategies for conducting productive classroom discussions (Smith & Stein, 2011) discussed after UPFI 2 helpful.

VI. Closing Remarks

This chapter presents a theory for designing learner-centered flipped classroom instruction. I develop universal and situational principles for flipped instruction using a theoretical framework based on social theories of learning and instructional design theories that support learner-centered instruction. The universal principles reside in the component level of instructional design and are implemented within broader instructional approaches. The situational principles provide specific guidance as to how instructional designers may plan flipped instruction using the discussion and problem-based instructional approaches. The situational principles section also serves as a model for how designers might generate situational principles for other well-defined instructional approaches. The chapter ends with a discussion of concerns that may arise when flipped instruction is implemented and presents responses to those concerns.

The flipped classroom has garnered considerable interest among teachers, administrators, and political and educational leaders, during the last five years. Efficiently conveying information to students so that more time is available *during class* to support learner-centered instruction appeals to many. Yet when the flipped classroom is designed and implemented, we quickly see that this simple idea generates a complex and nuanced learning space with many variables that influence the ways students and teachers negotiate meaning. It is my hope that the principles in this chapter will provide a useful structure for those interested in investigating further the ways in which flipped instructional design can promote meaningful learning in learner-centered classrooms.

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Notes

* *Editors' note: See Chapter 3 in this volume for principles for task-centered instruction.*

* *Editors' note: This suggests that efficiency is highly valued in this instructional-design theory.*

* *Editor's note: The universal principles presented in this chapter are similar to those in Chapter 16 for Just-in-Time Teaching.*

** *Editor's note: This principle reflects a traditional teacher-centered approach in that the teacher selects content and controls the presentation of that content to students.*

* *Editor's note: This aspect reinforces a learner-centered perspective as it acknowledges that learners' understandings are uniquely their own, even when developed through social interaction.*

** *Editor's note: This approach to out-of-class tasks is similar to the pre-class JiTT learning tasks described in Chapter 16.*

* *Editor's note: Despite the use of the phrase "learner-centered flipped instruction", this approach does not necessarily implement all of the key principles identified in Chapter 1, especially Principle 1 (attainment-based instruction) and Principle 5 (changed curriculum).*

** *Editor's note: Indeed, information conveyance has long been considered a critical aspect of effective instruction, and was identified as one of the "First Principles of Instruction" by David Merrill in Chapter 3 in Volume III of this series.*

* *Editor's note: This approach requires that students choose to participate in the out-of-class activity, highlighting the importance of avoiding an overemphasis on reification as discussed earlier.*

** *Editor's note: These practices are similar to those developed for improved physics instruction as explained in Chapter 16.*

* *Editor's note: The issue in this example highlights the need for instructors and instructional designers to consider the entire instructional system during the design, development, and implementation process. The connections among system components are typically dependent on consistency – in this case, between two different learning contexts and their associated activities and tasks.*

* *Editor's note: Chapters 5–9 in Volume III of this series explain theories for five different approaches to*

instruction.

** *Editors' note: This is highly consistent with the changed roles of teachers and learners described in Chapter 1, as long as students play a major role in setting the ground rules.*

*** *Editors' note: This is closely related to the concept of self-regulated learning as described in Chapter 9.*

* *Editor's note: When learning community communication is desired (or required) out-of-class, instructors also need a virtual space that supports easy and effective communication. This might be very important when a consistent discussion approach is used for both out-of-class and in-class activities.*

* *Editors' note: As a kind of task-centered instruction, PBI typically follows the principles described in Chapter 3 of this volume as well as Chapter 8 by Savery in Volume III.*

** *Editors' note: This is an important aspect of the learner-centered paradigm of education, as reflected in Principle 4 in Chapter 1 and most of the other chapters in this volume.*

* *Editor's note: These teacher activities also reflect several principles of self-regulated learning as described in Chapter 9.*

* *Editor's note: When used this way, out-of-class activities are not just used to prepare students for subsequent in-class sessions, but also to bring closure to previous in-class sessions or perhaps to connect one in-class session to a following in-class session.*

1 Attainment-based assessment, formative and summative, is an important part of the learner-centered paradigm, but it should allow for each student to continue learning of mastery has not yet been reached.

13

GAMIFICATION DESIGNS FOR INSTRUCTION

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EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *Focus on problem solving with meaningful choices and gamification elements used to engage and motivate learners.*
- *For content gamification, the content must lend itself to incorporation of elements such as story, challenge, curiosity, mystery, and so forth.*

Learners

- *All learners.*

Learning environments

- *Appropriate for use both online and in classrooms.*
- *Learners should feel they are in a "safe" environment in which they can explore and make mistakes without dire consequences.*

Instructional development constraints

- *Gamification is easier to implement when technology can be used for support (e.g., automatic tracking of attainments and awarding of points).*

Values (opinions about what is important)

About ends (learning goals)

- *Fostering motivation and engagement is highly valued.*

About priorities (criteria for successful instruction)

- *Appeal and engagement are intended to increase effectiveness; efficiency is less important.*

About means (instructional methods)

- *Learning tasks should provide optimal challenge for the learner.*

About power (to make decisions about the previous three)

- *The teacher is primarily in control of ends, priorities, and means by providing course structure and reinforcement schedules. Learner choices are bounded by rules and parameters.*

Universal Principles

1. Engagement

- *Create and maintain student engagement.*

2. Choices

- *Encourage students to make meaningful and consequential choices within clearly defined rules and within a safe environment, allowing freedom to fail.*

3. Competence

- *Provide visible evidence of progress toward mastery to the student.*
- *Mastery. Organize instruction into discrete units, each of which must be mastered before moving on to the next unit.*
- *Scaffolding. Sequence units in increasing difficulty and scaffold learners toward mastery using various scaffolding techniques.*
- *Goal orientation. Foster a mastery orientation (rather than a performance orientation) in the learner by rewarding progress with points, badges, placement on a leaderboard, and/or other indicators of attainments.*
- *Feedback. Provide visual and/or aural feedback during instruction.*

Situational Principles

For determining structural or content gamification

- *Use content gamification when the content lends itself to the addition of a mystery or the inclusion of a story.*
- *Use content gamification when it is beneficial to immerse the students in the content and have them assume a role and interact with the content while learning.*
- *Use structural gamification when the content is part of a larger curriculum and it is otherwise difficult for students to remain motivated over time.*
- *Use both kinds of gamification when both situations prevail.*

For creating and maintaining student engagement

Principles for providing challenge

- *To initially engage students, provide challenge through uncertain outcomes due to the user's actions, multiple goals, hidden information, and randomness, but make sure the challenge is not so great that it overwhelms the student.*
- *When using structural gamification, adjust the goals, challenges, and reward structure to be difficult but achievable, and relate each challenge to learning complex ideas, concepts, and skills that lead to mastery.*
- *When using content gamification, use a progression of increasingly complex whole tasks, and provide assistance only when an obstacle proves too difficult for students to overcome on their own.*

Principles for using story/narrative

- *Use story/narrative when presenting content in a chronological or preferred sequence is beneficial.*
- *Use story/narrative when engaging students in the affective domain is important.*
- *Use story/narrative when it is important to demonstrate when specific content should be applied.*

Principles for using characters/avatars

- *Use avatars when it is important to foster student identification with a situation or particular person.*
- *Use characters when it is important to engage students more deeply in the learning experience.*

Principles for using mystery

- *Use mystery in content gamification when it is important to engage students' curiosity.*
- *Mystery can be created by evoking sensory curiosity or cognitive curiosity, such as by withholding information, providing novel and exciting situations, and providing surprising and constructive feedback.*

Principles for using competition

- *When students are initially intimidated by the amount of content, have a good social relationship with each other, or are hesitant to engage with the content, use competition by:*
    - *Rewarding performance and displaying results on a leaderboard (i.e., as part of structural gamification)*
    - *Awarding prizes that are of little importance or are symbolic to foster intrinsic rather than extrinsic motivation*
    - *Keeping the number of students competing directly with each other to a minimum, such as by dividing classes into smaller competitive teams*
    - *Making the competition last long enough to enable students to overcome bad initial results (i.e., as part of structural gamification)*
    - *Basing the goal on the process (learning and improving) rather than on the results (winning or losing).*

Principles for using cooperation

- *When students are able to learn content from peers, when the content is enriched through discussion, or when working together to achieve a common goal is desirable, use cooperation by requiring the students to work together to overcome a challenge or solve a mystery.*

Principles for using spaced retrieval

- *Use spaced retrieval to engage students with content over an extended period of time (i.e., as part of structural gamification).*
- *Use spaced retrieval to provide reinforcement and to foster retention of information.*

Principles for using retrieval practice

- *When students must memorize and recall information, use retrieval practice in the form of quiz show questions and reward performance.*

For encouraging students to make meaningful and consequential choices with clearly defined rules and within a safe environment

- *When the amount or complexity of the content may be overwhelming, give the student minimal control over content sequencing, pacing, and access to support.*
- *When the student has sufficient prior knowledge and metacognitive skills and when the content*

is of low complexity, give her or him greater control.

- *Unless personal mastery and individual learning are required, foster socialization by creating connectedness among students in a group.*
- *When using content gamification, have students assume roles and participate in activities that allow them to observe and imitate realistic actions.*
- *When using structural gamification, help students to share their accomplishments with others.*

For providing visible evidence of progress toward mastery

- *When using structural gamification and the activity is of little interest to the student, award points for level of effort, timeliness, correctness, or accuracy of student responses.*
- *When content has a clear progression in complexity and the activity is of little interest to the student, sequence units of instruction so that students progress through increasingly difficult levels and receive visual recognition for attaining each level.*
- *When the activity is of little interest to the student, provide recognition in the form of badges, trophies, or other visible signs of achievement for both measurement achievements and completion achievements.*

Implementation Issue

- *It can be difficult for teachers to know which game elements are appropriate for a particular context.*

– C.M.R., B.J.B., & R.D.M.

GAMIFICATION DESIGNS FOR INSTRUCTION

I. Introduction

What Is Gamification?

Gamification is an emergent approach to instruction that facilitates learning and encourages motivation through the use of game elements, game mechanics, and game-based thinking. In gamification, the students do not play an entire game from start to finish; rather they participate in activities that include elements from games such as earning points, overcoming a challenge, or receiving badges for accomplishing a task. The idea is to integrate game-based elements commonly seen in video or mobile games into instructional environments to motivate the learners and keep them engaged with the content. While not completely reliant on technology, the advent of certain software and technological advances has made the development and deployment of gamification more widespread.

Definition

The term "gamification" appears to have been coined in 2002 by Nick Pelling, with the first documented print appearance in 2008. However, the term did not gain widespread recognition until late 2010 (Deterding, Khaled, Nacke, & Dixon, 2011; Groh, 2012; Werbach & Hunter, 2012). While the term is relatively new, there seems to be general agreement about the basic tenets of gamification. Gamification has been defined as the "process of using game thinking and mechanics to engage audiences and solve problems" (Zichermann, 2013, p. 6), as "using game techniques to make activities more engaging and fun" (Kim, 2011, np), and as "the use of game design elements in non-game contexts" (Deterding et al., 2011, p. 1).

For an instructional context, the most relevant definition is one that combines elements from the above definitions and defines gamification as “using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems” (Kapp, 2012, p. 10).

Elements of gamification

While there is relative consensus around the definition of gamification, the complication arises when one tries to go beyond the surface definition and identify the elements, game-based mechanics, and game-based thinking that constitute games, which, in turn, are the elements of gamification. The difficult aspect of gamification is defining what constitutes a game. One place to start is to break the concept of “game” into its component pieces in an attempt to answer the question, “What elements make a game?”

There is no universal set of critical components that are definitive game elements.[*] Apostol, Zaharescu, and Alexe (2013) have identified eight items they believe constitute game elements, while others, such as Stott and Neustaedter (2013), have identified four critical game elements. Table 13.1 maps some of the more common game elements—those that have been identified by three or more researchers as key elements in the definition of a game.

Upon examining the various game elements, it appears that the most agreed upon are rules, goals/quantifiable outcome, a challenge or problem to solve, and a sense of control. Elements identified in two or fewer researchers’ definitions, and not represented in Table 13.1, include: storytelling, rapid feedback, abstraction of concepts and reality, adaptation, assessment, closure, attachment of the player to the outcome, negotiable consequences, time, aesthetics, sensory stimuli, player effort, reward structure, safety/freedom to fail, valorization of the outcome, and sense of mastery.

Categories of game elements

If one categorizes the various elements listed in Table 13.1 along with the elements that appear less than three times in the research, it is possible to identify three major categories under which most game elements can be classified: engagement, autonomy, and a sense of progression, as shown in Table 13.2. The concept of rules is under the category of autonomy because rules provide guidelines and boundaries under which a learner operates when engaging with a gamification learning experience.

The categories that emerge provide a foundation upon which the universal principles of gamification are aligned. The elements under each category are aligned with situational principles. For example, a universal principle is “create and maintain student engagement.” The engagement might be fostered through a mystery, a competition with others, or dropping the student into the middle of a compelling story. All of those methods lead to engagement, but different instructional situations call for different methods or combinations of methods.

Types of Gamification for Learning

Gamification is a broad term that can be further refined into two types: structural gamification and content gamification.

TABLE 13.1 Common Game Elements

	Goals/ Quantifiable Outcome	Rules	Fantasy/ Contrivance/ Mystery	Conflict, Competition, or Cooperation	Progression/ Levels	Challenge/ Problem Solving	Control
Apostol, Zaharescu & Alexe (2013)	x	x				x	
Garris, Ahlers, & Driskell (2002)	x	x	x			x	x
Gee (2004)						x	x
Juul (2003)		x					
Kapp (2012)	x	x		x	x		
Stott & Neustaedter (2013)					x		
Thiagarajan (1999)			x	x			x
Wilson et al. (2008)	x	x	x	x	x	x	x

TABLE 13.2 Categories of Game Elements

Engagement	*Autonomy*	*Progression*
Storytelling	Freedom to Fail	Levels
Fantasy	Rules	Rewards
Mystery	Control	Progress and surprise
Competition, conflict, cooperation	Safety	Provide a clear goal
Curiosity		Feedback
Challenge		

Structural gamification

"Structural gamification is the application of game-elements to propel a learner through content with no alteration or changes to the content" (Kapp, Blair, & Mesch, 2013, p. 224). The content does not become game-like, only the structure around the content. A common implementation of this type of gamification is to take the scoring elements of video games—such as points, levels, badges, leaderboards (listing names or nicknames of the players who have achieved the highest score or most points), and achievements—and apply them to an educational context (Nicholson, 2012).

An example of structural gamification in a learning context is when a student receives content to be learned through a quiz-type game on a daily basis for a two-week period via email or a mobile app. The student receives an email with a quiz question containing content to be learned. If they answer correctly, they earn points and progress toward earning a digital badge. If answered incorrectly, the student is immediately presented a short instructional piece designed specifically to address the topic covered in the initial question. Questions are repeated at various intervals until the student demonstrates mastery of the topic.[*] The entire process takes 30–90 seconds each day and is done at either the beginning or end of the day based on the choice of the student. As the students are progressing through the content, the number of questions they answer correctly is indicated on a leaderboard for the entire class to view, enabling students to assess their progress relative to others.

Structural gamification is based on behaviorism, the work of B.F. Skinner and the concept of operant conditioning. Skinner believed that an important event in changing behavior was the outcome produced by a specific behavior, and that he could reinforce the behavior to achieve a desired outcome. When a person performs a certain behavior, they are given a reward.

The rewards can come on different schedules. The concept of a variable ratio reinforcement schedule is one in which reinforcement for a behavior is provided at unpredictable intervals. The concept of a fixed ratio is that reinforcement is provided after a pre-selected number of times a behavior is exhibited. This activity/reward structure is at the center of many structural gamification learning events (Biehler & Snowman, 1986).

Structural gamification typically incorporates both variable- and fixed-ratio reward systems to keep the student interested and progressing through the content. The rewards can be in the form of tokens, points, coins or some other type of visible indication of success.

Content gamification

"Content gamification is the application of game elements, game mechanics and game thinking to alter content to make it more game-like" (Kapp et al., 2013, p. 237). A common implementation of this type of gamification would be to add elements such as story, challenge, curiosity, mystery, and characters to content to engage the learner. For example, adding story elements to a series of math problems to place the student in a fantasy context or starting a classroom dialogue with a challenge instead of a list of objectives are both simple methods of content gamification. The idea is not to create an entire game** but to add game elements to alter the instruction.

An example of content gamification in a learning context is when the student takes on a role and participates within the context of a story. In teaching the topic of accounting, a student could begin the instruction by being "dropped" into the middle of an audit where he or she has one hour to produce a series of requested documents using basic accounting procedures. Within the context of the gamified learning event, the student must complete the correct document request forms, retrieve filed information, and take it to the auditor's office for assessment. The student is scored on accuracy of documents, speed of responding to requests, and whether or not the right documents were provided to the "mock" auditor.

In content gamification, the underlying motivational theory is a macro-theory that explains human motivation to perform a task or activity as being internally driven, as opposed to the externally driven theory of operant conditioning. The theory is the self-determination theory (SDT; Ryan & Deci, 2000).

Self-determination theory has three component elements. One is *autonomy*, which is a person's feeling that they are in control and can determine the outcome of their actions. The next is *competence*, which is defined as a need for challenge and a feeling of mastery. Factors enhancing the experience of competence, such as the opportunity to acquire a new skill or the chance to be appropriately challenged, enhance perceived competence and, in turn, are motivating. The third component is *relatedness*, which is experienced when a person feels connected to others.

Researchers have found evidence that the psychological "pull" of games is largely due to their capacity to engender feelings of autonomy, competence, and relatedness, and that to the extent they do so, they not only motivate further play, but also can be experienced as enhancing physiological wellness (Ryan, Rigby, & Przybylski, 2006).

II. Values

The highest priority and value is given to fostering motivation and engagement through appropriate use of gamification elements in instruction. In structural gamification, the teacher is primarily in control and provides extrinsic motivation through the use of variable- and fixed-ratio reward systems. In content gamification, the instructional content is adapted to utilize various gamification elements intended to foster feelings of autonomy, competence, and relatedness.

The priority in a gamified learning environment is to increase the effectiveness of the instruction through the careful application of game elements. Efficiency or quick mastery of content is not as important as finding a method of engaging the students. In terms of motivation, extrinsic motivation is employed in structural gamification while intrinsic motivation is the focus of content gamification.

In the use of gamification within an instructional setting, the teacher or designer of the instruction is primarily in control of ends, priorities and means by providing course structure and reinforcement schedules. Student choices are bounded by the design of the gamification environment, and students must abide by the rules and parameters to achieve the desired learning outcomes.

III. Universal Principles

While structural and content gamification have different theoretical underpinnings in terms of motivation, they do share universal principles built on the categories of game elements found within the literature: engagement, autonomy, and progression (see Table 13.2). Stated as universal principles for structural and content gamification, they are:

1. Create and maintain student engagement.
2. Encourage students to make meaningful and consequential choices within clearly defined rules and within a safe environment.
3. Provide visible evidence of progress toward mastery to the student.

1. Create and Maintain Student Engagement

One fundamental element of gamification is engagement. The learner needs to be engaged with the learning process through activities, decision-making, and responding to stimuli. While this seems straightforward, most students are used to playing passive roles in the classroom and not being engaged during the teaching process (Gibson, 2009).

Sitzmann (2011) found individuals learned more, relative to a comparison group, when simulation games conveyed course material actively, rather than passively. Although Sitzmann was not looking at gamification specifically, the principle of engagement within games is a required element for learning within gamification design. Merrill (2009) describes how learning is enhanced when learners actively engage in interaction.

Creating and managing an environment of engagement requires the development of a structure that challenges students from the beginning and forces them to consciously make cognitive decisions and choices throughout the gamification experience.

2. Encourage Students to Make Meaningful and Consequential Choices within Clearly Defined Rules and within a Safe Environment

Rules are a critical element in gamification. Students need to know what is acceptable and what is not. The students can then make decisions within those rules. Rules are a form of "learner guidance" which helps focus learner attention on critical elements (Merrill, 2009). Within those rules, students are given latitude to make choices and to exert their autonomy.[*]

The concepts of student choice and autonomy are critical for successful gamification. Autonomy refers to the initiative and freedom a student experiences when engaged in an activity in the absence of external pressure with respect to his or her personal goals (Ryan & Deci, 2000). An environment that encourages autonomy is one where outside pressure is minimal, choices are offered, and the goals of the students are recognized (van Loon, Ros & Martens, 2012). Student control is a definite satisfier; it makes students feel more in control of their actions and is appealing to students (Clark & Mayer, 2011; Reeve, Nix, & Hamm, 2003).

A gamification experience has to incorporate not just explicit engagement, but meaningful choice. When a student makes a choice in a gamification environment, the system, teacher, or environment responds in some way. The relationship between a student's "choice and system's response is one way to characterize the depth and quality of interaction" (Salen & Zimmerman, 2004, p. 61).

This is not to say that the student should have absolute control of where to go, what to do, or what to learn. A large body of research has indicated that absolute learner control in an open instructional environment is both inefficient and ineffective (Clark & Mayer, 2011; Merrill, 2009). Rather, choices can (and should) be bounded by rules and parameters, but within those rules and parameters, the learner should have a degree of choice to determine specific actions and to set personal goals. In gamification, the students need to feel that the choices they are making are meaningful, have an impact on the eventual outcome, and are made autonomously.

While students are encouraged to make choices in a gamification environment, the choices cannot have dire consequences. The learning environment must feel “safe” for exploration, making mistakes, and examining ideas. The freedom to fail or “do over” is part of creating a safe environment. Incorporating “freedom to fail” into classroom design has been found to be an effective dynamic in increasing student engagement (Gee, 2008; Kapp, 2012; Lee & Hammer, 2011; Salen, 2008). If students are encouraged to take risks and experiment, the focus is taken away from final results and re-centered on the process of learning. The effectiveness of this change in focus is recognized in modern pedagogy as shown in the increased use of formative assessment (Stott & Neustaedter, 2013).

In gamification, failure is an option. And it is a good one. Allowing a player to fail with minimal consequences encourages exploration, curiosity, and discovery-based learning. When players know they can always restart the experience, it provides them with a sense of freedom, and players take advantage of that freedom by using multiple attempts to explore options (Kapp, 2012).

Failure adds an additional level of content to the gamification experience because it makes the student reconsider his or her approach or strategy. The necessity to approach the gamification differently than originally planned expands playability of the gamification experience.

Winning without failure or a do over is often a dissatisfying experience for the student. For a student to value the experience, he or she must feel that something was accomplished and achieved. Failing several times before success instills the feeling of accomplishment once a winning state is achieved (Kapp, 2012).

3. Provide Visible Evidence of Progress Toward Mastery to the Student

Demonstrating to the student that he or she is making progress toward mastery of the content and skills to be learned is a key element in gamification. The act of moving through content on the way to a clear endpoint, such as mastery of a particular terminal objective, motivates students, as does the feedback indicating how far they have progressed. Gamification should orient the students to where they are in the instructional process, where they are going, and how much further they have to go until the end. The concept is that the student is able to “see” progress. The progress might be in the form of a character moving up a mountain or an image of how close the learner is to the next level (Kapp et al., 2013).

Mastery learning[*]

Simultaneously the goal and the process of gamification are progression through content. The student masters an enabling objective on his or her way to eventual mastery of the terminal objective. Underlying this mastery learning approach is a philosophy asserting that under appropriate instructional conditions virtually all students can master what is taught (Block & Burns, 1976; Bloom, 1971). The basic concept of mastery learning is that instruction is organized into discrete units where complete mastery is required before moving to the next unit. The method of moving through the instruction is based on ungraded assignments with formative evaluation as a tool for identifying what is learned and what is yet to be learned and then providing additional support for concepts that have not been mastered (Bloom, 1971; Melton, 2008).

Mastery learning provides an approach that recognizes that learning may be more closely linked to time and perseverance than to ability (Bloom, 1971; Melton, 2008). This is similar to the idea underlying the concept of criterion-referenced tests, which is to assess the performance of each test-taker without regard to the performance of others (Shrock & Coscarelli, 2007). There is no limit to the number of students who can succeed on a criterion-referenced test, as opposed to a norm-referenced test, which strives for a bell-shaped distribution curve, meaning some students pass and others fail regardless of mastery on the test. Gamification uses criteria and levels of mastery to advance the learner from one element of the instruction to the next.

Scaffolding

In instructional games, collecting rewards, awarding points, moving from one level to another with increasing difficultly, and the need to apply more skills to master the new level are similar to the educational concept of “scaffolding.”

Scaffolding is a concept built upon the idea of the zone of proximal development, which is the distance between the actual developmental level of the student and the level of potential development of the student (Vygotsky, 1978). Vygotsky (1978) wrote that the distance between the current level of development and the desired level could be closed by having the student engage in problem solving under adult guidance or in collaboration with more capable peers Scaffolding is the application of educational strategies and techniques which help move a student from his or her current level of knowledge to the next logical level. Scaffolding techniques can include, but are not limited to, hints, checklists, cues, prompting, role-plays, group activities, and even parsing content into small units to aid learning. Another form of scaffolding is illustrated in Merrill’s application principle that “instruction should provide coaching, which should be gradually withdrawn to enhance application” (Merrill, 2009, p. 42). In gamification, the coaching can be in the form of a live peer, instructor, or mentor, or it could be in the form of computer-generated and -mediated prompts, cues, and hints. Scaffolding provides support, functions as a learning tool, extends the range of the learner, and permits the accomplishment of tasks not otherwise possible (Vygotsky, 1978).

The use of scaffolding and levels or rewards in the form of achievements provides visual progress to the student and maintains interest in the instruction as the student moves from level to level, achieving success as he or she progresses and, eventually, achieves mastery. In gamification, the levels usually become more challenging as the student moves toward the end, and the skills they exhibit at the final level would not be developed without the experience of playing the preceding levels.

Goal orientation

In applying gamification, there are two types of goal orientation: performance orientation and mastery orientation (Blair, 2012). Each of these two types of goal orientation has an impact on how achievements awarded to students should be constructed. Students who favor a performance orientation are concerned with other people’s assessment of their competence. Students who have a mastery orientation are concerned more with improving their proficiency. Poorly designed gamification environments tend to push students toward a performance orientation.

To balance student predisposition towards performance orientation, effective gamification environments instill a mastery orientation in the goals and feedback they create.[*] Creating a mastery orientation means that students will more readily accept errors and seek challenging tasks, providing them with the opportunity to develop their competencies. When given mastery goals, students will have higher self-efficacy and utilize more effective strategies. Students given mastery-oriented goals perform better on complex tasks (Winters & Latham, 1996). To foster mastery orientation, students should be required to earn achievements that acknowledge effort put forth and support them during challenges. Errors and mistakes should be treated as opportunities to provide diagnostic feedback and encouragement.

Feedback

Feedback and feedback loops are an integral part of gamification and adhere to Merrill’s (2009) application principle that instruction should provide intrinsic or corrective feedback. A feedback loop in gamification is designed to evoke appropriate behavior, thoughts, or actions. When receiving feedback in a gamification environment, the student will receive different levels of feedback (from detailed correction of incorrect action to simple acknowledgement of a correct action), feedback related to the timing of his or her actions, and feedback delivered via different channels (Kapp et al., 2013).

Feedback delivery can come in the form of a visual change on the screen. It can be an animation of coins disappearing if an answer is incorrect or the image of a badge appearing if the student answers five questions correctly in a row. The visual cues are an element of gamification designed to draw attention to actions and activities. Feedback can also be delivered through an audio channel, which might include buzzes for an incorrect answer and applause for a correct answer.

IV. Situational Principles

The situational elements described below are each linked to one of the three universal principles. Indicated for each situational element is the type of gamification for which it is most appropriate. If the element is appropriate for both types of gamification, it is indicated. However, it is important to note that, often, situational elements will be combined within either a structural or content gamification delivery, since the research is relatively new, and determining the best combination of situational elements to foster learning is still in its infancy for gamification.

Because gamification is composed of a set of game elements not universally agreed upon, it is implemented in many different ways. In some implementations of gamification, four or five game elements and mechanics are utilized, and in others only one or two. Additionally, the complexity of having both structural gamification and content gamification elements causes many different implementations. The situations described below will help educators to determine how to best implement gamification within their particular context.

Determine Structural or Content Gamification

The decision to utilize structural or content gamification depends on a number of elements. If the content can be changed to be more game-like with the addition of a mystery or the inclusion of a story, then content gamification would make sense. If an element of the instruction is to immerse the student into the content and have them interact, engage, and assume a role while learning, content gamification is appropriate.

On the other hand, if the content is part of a larger curriculum that unfolds over time and an instructor is looking to motivate the students to continually return to the content, then the use of structural gamification where points, badges, and leaderboards propel students through the content would be an appropriate approach to the instruction.

Additionally, the option exists to combine both content gamification and structural gamification. The two types together can provide an effective method of motivating and engaging students. One caveat in combining both content and structural gamification is that, at some point, the combination evolves into a learning game and can no longer be considered gamification, although that point is most likely of more interest to an academic researcher than to an educational practitioner.

Situational Principles Related to Creating and Maintaining Student Engagement

To engage students through gamification, there are several methods that can be used individually or in conjunction to both create and maintain student engagement. The best combinations seem to be the use of three to four of the separate items to create an engaging instructional environment for the student.

Challenge *

Challenge is a strong motivator in learning (Jones, Valdez, Norakowski, & Rasmussen, 1994; Malone, 1981; Schlechty, 1997). A challenge is a call to engage in a difficult but achievable task. Uncertain outcomes are challenging because of the variability resultant from the user’s actions, multiple goals, hidden information, and randomness (Wilson et al., 2009). Challenge is correlated with both intrinsic motivation and motivation related to fostering competence and student efficacy (White, 1959).

Challenges should be used in gamification to initially engage students to start learning a task. Often students who are reluctant to learn content can be persuaded to begin the process by being challenged. This requires a careful balance as, in cases where a student or students are overwhelmed with the content or feel that it is too difficult to even begin to learn, other methods need to be employed to engage the students. These methods could include the use of story or employing spaced practice, both of which are described below.

Structural gamification. If the structural gamification platform is too easy, the students will not care. The goals, challenges, and reward structure all must convey a sense of difficulty and high, but achievable, stakes. If a person does not think the experience will be challenging or interesting or result in a large enough payoff, he or she will not engage. The challenge could be related to the number of points that need to be achieved, finding hidden badges, or getting to the final level. Each of the challenges not only needs to be related to structural gamification items, but also needs to be tied to learning complex ideas, concepts, and skills. Achieving the final level within the gamification environment must equate with having mastery and above average competencies in the actual work or learning environment. There needs to be alignment between the two.

Content gamification. In content gamification, challenge plays a big role in engaging learners. For example, a lesson might start by telling the student, “You are a manager, and an employee has informed you that a co-worker has been leaving work early for the past month. What do you do?”

As the students try to figure out what to do, the teacher should provide guidance and assistance. The idea is that the instruction should use a progression of increasingly complex whole tasks (Merrill, 2009).** The teacher should be supportive of the students but only provide information when the students encounter an obstacle to solving their problem. Furthermore, the teacher should create the need for students to seek or require the information that he or she wants them to learn. This creates motivation and aids retention because people like a challenge and will remember how they solved the challenge more easily than remembering an abstract bulleted list such as “Five things to do if an employee is suspected of leaving work early.”

Story/narrative

Using story or narrative to engage the learner can work well under several circumstances. First, content can be presented in a chronological fashion or a preferred sequence. Second, stories are good vehicles for engaging students in the affective domain. Third, narrative is useful if one wants to add story context to the learning to help students know when specific content should be applied.

Storytelling can be an integral element of both structural and content gamification. The construct of story is a frequent element in many games (Kapp, 2012). Stories add meaning, provide context, and guide action (Martin, 1982; Martin & Powers, 1983). Stories evoke emotions, provide a context for placing information, and are the way humans have handed down information for centuries. Students tend to use narrative to inform views of themselves and others (McAdams, 2006). The convention of narrative is often used for framing experiences and providing meaning to actions and activities (McAdams, 2006).

Creating a story as the context for instruction provides the students with an engaging way to learn the content that is being taught. It answers the question students often ask, “Why are we learning this?” Using a story-based approach is similar to using a case study or a scenario, but the focus should be on building a story that is meaningful and has elements from the affective domain so the student becomes engaged. Involving the student within a story context can make the learning more meaningful to the student and can focus the student on solving problems and learning new content and skills.

Characters/avatars

Characters and avatars are an important element in many video games and can be an important motivational element in gamification. If one wants a student to closely identify with a situation or a particular person, then using an avatar allows the learner to become invested in the learning environment. Additionally, when a person interacts through an avatar, they can improve performance. Even if one does not create a fully fledged story with plot and tension, simply adding a character can help to more deeply engage the learner. For example, on e-learning tests involving different word problems, the group who had a character explain the problems generated 30% more correct answers than the group with just on-screen text (Clark & Mayer, 2011).

Having an avatar appear on the screen can be motivating to learners because they somehow feel more accountable to a "person" than to a computer (Clark & Mayer, 2011). However, interestingly, it has been found that a "realistic" character does not facilitate learning any better than a "cartoon-like" character (Baylor & Kim, 2005).

Mystery

Mystery is primarily used in content gamification, as the designer of the instruction can modify the instructional content to create a sense of mystery. Mystery exists when the student is aware that unknown information needs to be discovered (Wilson et al., 2009). Mystery can be used to engage a student's curiosity and unveil information gradually to encourage students to start and continue with a task. Another use is when revealing too much information all at once might interfere with or impede the student's learning.

To evoke a sense of curiosity that accompanies a presented mystery, instructional environments can create an optimal level of informational complexity and a novel and exciting situation using both sensory and cognitive curiosity (Malone, 1981). Sensory curiosity involves the attention-attracting value of changes in the light, sound, or other sensory stimuli of an environment. Cognitive curiosity is evoked by the prospect of modifying higher-level cognitive structures, and Malone suggests that cognitive curiosity can be aroused by making learners believe their knowledge structures are incomplete, inconsistent, or unparsimonious. The learners are then motivated to learn more, in order to make their cognitive structures better formed (Malone, 1981).

To further engage the student's curiosity and perpetuate the sense of mystery, feedback should be surprising and constructive. For surprising feedback, randomization and hiding information within the learning environment are two effective techniques (Malone, 1981).

Competition

Competition is often associated with structural gamification. Competition is when students are "constrained from impeding each other and instead devote the entirety of their attentions to optimizing their own performance" (Crawford, 2003, p.8). In structural gamification, this is exemplified by students accumulating points and appearing on a leaderboard. Competition can be used if the students are initially intimidated by the amount of content they must learn, have a good social relationship with each other, or are initially hesitant to engage with the subject matter they are being requested to learn.

To be most effective, the competitive environment created with structural gamification needs to have the following elements:

- Prizes for winners should be of little importance, or even symbolic, to help ensure that the student efforts are intrinsic and not driven solely by an external prize such as money or a trophy (Cantador & Conde, 2010).
- The number of students directly competing against one another should be kept to a minimum. Increasing the number of competitors can decrease student motivation (Garcia & Tor, 2009). In larger classrooms, this can be done by breaking students into smaller competitive teams.
- Competition has to be long enough to avoid learner demotivation because of bad initial results, and to assure that all participants have a good chance of winning until the end of the activity (Cantador & Conde, 2010).
- The goal of the competition must be clearly set into the process instead of into the results, making it

clear that ultimately winning or losing is very low in importance in comparison to learning and improving while competing (Cantador & Conde, 2010).

Cooperation

Cooperation is the act of working with others to achieve a mutually desirable and beneficial outcome. Primarily used in content gamification, working together to overcome a challenge or solve a mystery is a method of adding game elements to instruction. This is the social aspect of gamification that many students enjoy. The more individuals work together, the more they are able to achieve. It has been found that serious games are more effective when played in groups for learning. Therefore, one can suppose that with gamification, group cooperation would be more effective than solo gamification, but more research is needed on this specific aspect (Wouters, van Nimwegen, van Oostendorp, & van der Spek, 2013).

Cooperation is a viable option for engagement when working with groups of students, especially if working together to achieve a common goal is desirable. It is also helpful when students are able to learn content from peers and the subject matter is enriched through discussion and working together.

In gamification that employs characters or roles, sometimes two or more students who are assigned different roles team together to overcome an obstacle or accomplish a goal. Working together and achieving a goal is the winning state of cooperative gamification.

Spaced retrieval

Web and mobile technologies have allowed gamification to be provided to students using the concept of spaced retrieval. This concept involves providing students with course content spaced over time and is an effective tool for aiding student retention[*] (Carpenter & DeLosh, 2005). Spaced retrieval can also be employed in a face-to-face classroom environment if the teacher instructs the students to engage with small bits of content for a few minutes a day. This is in contrast to mass practice where a student attempts to learn a large amount of content all at one time. The problem with mass practice is that the succeeding and preceding content can interfere with the learning of the new content and fatigue can set in. Spaced retrieval is effective when engaging students with content over an extended period of time and when reinforcement of the content is important for learning and application. The use of spaced retrieval appears to be growing in popularity with the advent of such computer adaptive instructional models as ALEKS (Doignon & Falmagne, 1985) and LearnSmart (McGraw-Hill, 2013).

The greater the amount of spacing between retrieval events, the greater the potential benefit to retention. Spaced retrieval helps learners retain access to memorized information over long periods of time because the spacing promotes deeper processing of the learned material. Ideally, the time between the learning events is greater than 24 hours, but shorter times have also been found to be effective. As long as eight years after an original training, learners whose practices were spaced showed better retention than those who practiced in a more concentrated time period (Clark & Mayer, 2011).

Within an instructional setting or context, the student could log onto a website or open a mobile application and be presented with content that they need to learn. The student may earn points for reviewing the content. The next day, the student would log back into the application or website and be presented with a review of the content and new related content. This would continue until all the required content was covered.

Retrieval practice

Retrieval practice requires students to recall information rather than simply reread or re-listen to it. Retrieval practice primarily uses tests or quiz questions as a means of requiring students to recall previously learned information. In gamification, the student could be provided a quiz question, asked to answer it, and given points, badges, or some other type of reward for correctly doing so. This is primarily used in structural gamification where students' learning is measured through performance on quiz questions, and they are rewarded as the content is correctly recalled and eventually mastered. This process does involve repeating missed questions until the student gains mastery of all the content. Retrieval practice within the context of gamification works best when content is required to be memorized and recalled.

A review of the pertinent scientific literature reveals that the benefits of retrieval practice have been known for at least 100 years and have been demonstrated with many diverse groups (Larsen, Butler, & Roediger, 2009). Gamification, with its ability to record student answers and keep track of performance,[*] allows the student to engage in the process and answer questions as they are presented in an engaging and fun manner.

Retrieval practice improves student recall performance (Dobson, 2013). Using quizzing as a technique for gamification forces the learner to recall content learned previously, and the act of retrieving information from memory actually alters the retrieved memory by strengthening the existing memory trace and/or creating additional retrieval routes. One consequence of these changes is that the probability of successful retrieval in the future is increased, making testing a potent mechanism for enhancing long-term retention (Roediger & Butler, 2013). In essence, the quiz is the game element the student encounters, and answering the questions triggers additional game elements like points or badges.

As an example of a gamification experience using retrieval practice, a student receives a quiz question on a daily basis and he or she answers the question. If the student answers incorrectly, he or she is provided with immediate corrective feedback based on the answer. The question is then placed back into the pool of questions and will be given randomly to the student in the future.

Situational Principles Related to Encouraging Students to Make Meaningful and Consequential Choices within Clearly Defined Rules and a Safe Environment

Gamification that provides the student with the opportunity to decide when to bypass some lesson elements and to control the sequence in which they receive content themselves is considered high in learner control. In contrast, a course or lesson that offers few control options to the student is considered to be program control (Clark & Mayer, 2011). Content sequencing, pacing, and access to learner support are forms of control that can be more or less in the hands of the student depending on the design of the instruction.

Allow the student minimal control

In some cases, it is appropriate to allow the student to have minimal control over the gamification elements. Examples of minimal control include limiting the number of attempts on a trivia-type question or only giving one opportunity to guess the solution to a mystery. Minimal student control is best when working with students who are new to a topic. It is also important when the amount of content to be covered could be overwhelming and it makes sense to provide the student with a little bit of content at a time (Clark & Mayer, 2011).

The idea of allowing minimal control works in both structural and content gamification. In structural gamification, for example, the design may be such that the student must progress through content in a linear fashion to obtain the most points or to be able to answer questions that appear periodically within the gamified instruction.

In content gamification, additional content and information may be revealed after students have hit a certain milestone within the instruction, such as uncovering a clue about a historical event or discovering a message related to solving an algebra problem. Providing instruction in a prescribed format with limited student control can be appropriate for content that requires a prescribed sequence to be learned and content that needs to be memorized.

Allow the student maximum control

The more experienced a student is with the subject matter, the more control he or she should be allowed in the pacing, sequencing, and access to assistance with gamification (Clark & Mayer, 2011).

Allowing more learner control within gamification is most likely to be successful when the students have prior knowledge of the content and skills involved, the subject is a more advanced lesson in a course or more advanced course in a curriculum, students have a high level of metacognitive skills, and the content is of low complexity (Clark & Mayer, 2011).

Allowing students, as described above, to have more control in gamification applies to both structural and content gamification. In structural gamification, an experienced student could decide to answer trivia-type questions to earn points first, rather than being forced to go through content before being allowed access to the question. The experienced learner may decide to go after content with the highest point values and ignore content with lower point values.

In content gamification, providing a student with control means he or she can approach a challenge, mystery, or even a role as a character with some degree of freedom. The student can choose how he or she wants to approach the content and determine the sequence in which to proceed.

Socialization

If students must demonstrate personal mastery and are required to learn content individually, then socialization would not be appropriate. However, if content is best learned as a group through constructing meaning by comparing ideas and concepts with others and constructing group knowledge, then socialization is appropriate. The social element, called "relatedness" in the self-determination theory (SDT), is when a person feels connected to others. This connectedness can motivate students and can encourage them to work harder to achieve goals within the context of gamification.

Content gamification. In content gamification, students can assume roles and participate in activities that allow them to observe and imitate realistic actions and activities. Albert Bandura in the late 1970s articulated the concept of social learning theory as a method in which individuals learn from one another in the context of a social situation through observation. Gamification can provide this social situation. Social learning theory is based on the premise that observation and imitation by an individual leads to learned behavior. Research in this area indicates that, indeed, human social models can be effective in influencing another person to change behaviors, beliefs or attitudes, as well as social and cognitive functioning (Gredler, 1997). Reshaping content into a game-like approach reinforces the adoption of content to be learned.

Structural gamification. In structural gamification there are many social aspects. A student showing off badges or other earned achievements is a way to share accomplishments of non-linear goals and to indicate progress to others. The idea of competition is a social construct, and a leaderboard allows the sharing of progress and success. A leaderboard does not have to be individual; it is possible to create leaderboards with team members to encourage social interactions (Kapp et al., 2013).

Situational Principles Related to Providing Visible Evidence of Progress Toward Mastery

Reward and motivational structures provide visible feedback to the student and help him or her gauge progress toward mastery. Rewards come in several different forms. They can be points earned for an action or activity; they can be moving from one level to another; and they can be earning achievements such as a trophy or a badge. The elements of earning points, leveling up, and earning achievements are best used in learning "when the activity is one that students do not find of inherent interest or value" (Lepper, 1988, p. 299). These elements are least likely to promote learning when the points, levels, and achievements are functionally superfluous (not needed to engage the learner) and/or are not informative about the student's level of ability, progress, or knowledge level regarding the task (Lepper, 1988). If the student is intrinsically motivated to learn the material, these elements are not necessary.

Earning points

Points are feedback related to the level of effort, timeliness, correctness, or accuracy of student responses to a question, scenario, or other instructional event. Points are an effective tool for providing a means of measuring student progress against him or herself (as a measure of personal improvement), against a standard, against the maximum amount of points attainable, or against peers.*

Earning points is primarily used with structural gamification. In some cases, students can earn points for something as simple as logging into a course. Other times, points are earned for more complex tasks, such as solving a difficult calculus problem.

Leveling up

When content has a clear progression from basic knowledge to advanced knowledge, it is important to sequence the units of instruction into levels so that students' progress through increasingly difficult levels.* This is called "leveling up." In gamification, a level is a defined phase that requires certain actions for one to move to the next phase. To help students recognize progress and mastery of each level and to help them understand where they are in the learning process, provide visual recognition for attaining each new level.

Levels serve several purposes within gamification. One purpose is to keep the learning space manageable. Developing gamified instruction with one vast level with all the content and dozens of learning objectives would be daunting for the student. A well-designed progression of levels accomplishes three elements of gamification. One element is that each level helps the student progress. The students learn new information or insights at each level, which keeps them engaged and focused on a relatively small enabling objective.

The second element is that skills are built and reinforced at each level. At the earliest level of gamification, students learn skills and knowledge they can apply in later levels. As students progress and the levels become more difficult, they are required to recall and use skills learned in previous levels to advance. However, at this point, the students usually have to perform the skills more quickly or under greater pressure to make the application of the skill more challenging. Toward the end, students typically must combine skills learned from previous levels in unique combinations.

The third element is that levels serve as motivation. When a student masters a level, he or she wants to progress to the next level and then the next level and so on until successful completion of the terminal learning objective. The different levels provide small, achievable goals that lead to the students wanting to engage in more and more activities so they can eventually get to the next level.

Earning achievements

Achievements are badges, trophies, or other visible signs of having accomplished a task or performed a specific behavior or series of behaviors. Recognition of learning achievements can indicate that the student has learned content and was able to progress from one level to the next, or that the student has learned valuable content but has not yet progressed, as is sometimes the case with the awarding of a badge. For example, a student may win the "Divide by Zero Award" but may not have finished the "Division Level" because she needs to still learn how to divide by other numbers such as 2 or 5 in a gamified version of learning division.

Often, it is appropriate to allow the student the option of sharing an achievement with others, either through a virtual "trophy case" or by allowing them to post the earned badge on some sort of social media account.

Achievements in gamification are effective in encouraging students to perform a specific behavior and for providing students with items to visibly show to others (usually virtual items in the case of gamification). Achievements should provide challenging goals for students to fulfill, as moderate difficulty leads to superior gains in performance and a greater sense of accomplishment upon completion (Campbell, 1982). Achievements can also provide encouragement to the students for moving across different levels.

Gamification has two primary categories of achievements: measurement achievements and completion achievements. Measurement achievements are given for completing a task to a certain degree. This is when performance is measured against another student's performance, the student's own performance, or some standard.* An example of this would be the three-star rating used in many games, which gives the player one-to-three stars based upon how well he or she performed on a level. One star indicates adequate performance on a level, three stars means the top level of performance.

Completion achievements do not tell the players how well they have performed the task; instead they are offered as an award once a task is completed. Completion achievements can be split into two subcategories: performance-contingent achievements and non-performance-contingent achievements. Performance-contingent achievements require skill to complete, while non-performance-contingent achievements are awarded for simply being present.

The best practice from a gamification perspective is to use measurement achievements instead of completion achievements to increase intrinsic motivation.**

A student's self-efficacy for the learning task(s) associated with earning an achievement must be high enough that he or she feels confident in attempting it (Blair, 2012). Student self-efficacy (which refers to an individual's perception about their own ability to produce a desired result for a specific task) is another important factor that must be considered in gamification. Increasing student self-efficacy is important because it has been linked to increased goal commitment, increased strategy creation and use, and a more positive response to negative feedback.

There are four factors that designers can address in order to affect a student's self-efficacy (Bandura, 1999). The first is related to their level of expertise on the subject matter. The designer should make sure that achievements are available for students at all skill levels in gamification. Students seeing people around them succeed is the second factor that influences self-efficacy. This effect is likely to be particularly powerful if the person succeeding appears to be at the same ability level as the observer. Designers can use leaderboards to influence this. Social persuasion (giving someone a verbal encouragement) is the third method of influencing self-efficacy. This can be as simple as telling someone "good job" after a performance or "Great job! You've earned a trophy." How a person feels is the fourth factor, which includes stress level, emotional condition, and perceived physical state.

V. Conclusion

With the popularity and ubiquity of video games within modern culture and the growing use of game elements in everything from websites to electric cars, it seems reasonable to assume that the interest in educational gamification will continue and the usage within school systems at all levels will grow.

Proponents of gamification argue that it is an effective method for propelling students through content and motivating them to learn. A recent meta-analysis of 24 studies concluded that "gamification provides positive effects," but with some caveats related to the context being gamified and the actual participants in the gamification (Hamari, Koivisto, & Sarsa, 2014, p. 1).

The difficulty and the struggle for educators in using gamification is to know when to use which game elements to increase motivation and learning. This chapter is an attempt to begin that dialogue and to frame the current thinking in this emerging field. Certainly, as time passes, concepts and ideas around gamification will shift.

Table 13.3 provides a summary of the three universal principles of gamification and associated situational principles. It is expected that, as more research is undertaken in this subject area, changes will be made to this framework and to our understanding of gamification.

TABLE 13.3 Universal and Situational Design Principles for Gamification

Universal Principle: *Create and maintain student engagement.*			
Situational Principle	*Description*	*When To Use*	*Most Often Used In Content or Structural Gamification*
Challenge	Have students engage with a difficult task.	If students are reluctant to learn content. To initially engage students to start a learning task.	Both

TABLE 13.3 *(continued)*

Universal Principle: *Create and maintain student engagement.*			
Situational Principle	*Description*	*When To Use*	*Most Often Used In Content or Structural Gamification*
Storytelling	Use the vehicles of plot, character, tension, and resolution to convey an instructional message.	If content needs to be presented sequentially. If context is critical to the learning process.	Content
Character/ Avatar	Allow the student to assume a persona.	If students need to more closely identify with the content. If the instructor wants the student to feel more accountable. If the instructor wants to include the affective domain in instruction.	Both
Mystery	Provide unknown elements that can evoke curiosity.	To initially engage students to start a task. If revealing too much information at once will interfere or impede learning.	Content
Competition	Have students work toward a goal but constrain them from impeding each other and instead have them devote their effort to optimizing their own performance.	If students are reluctant to learn content. To initially engage students to start a learning task.	Structural
Cooperation	Have students work together to achieve a mutually desirable and beneficial outcome.	If working with groups of students. If working together to achieve a goal is desirable. If	Content

		students are able to learn content from peers. If subject matter is enriched through discussion and working together.	
Spaced Retrieval	Provide students with a quiz or course content spaced over time to aid student retention.	If students are able to engage with the content over an extended period of time. If reinforcement of content is required.	Structural
Retrieval Practice	Require students to recall information rather than simply reread or re-listen to it. Use quizzes, a test, or quiz questions as a means of measuring student knowledge.	If content needs to be memorized and recalled.	Structural
Universal Principle: *Encourage students to make meaningful and consequential choices within clearly defined rules and a safe environment.*			
Minimal Control	Limit student choices to only a few options.	If students are novices. If instructional content requires a prescribed sequence. For content that is to be memorized.	Structural
Maximum Control	Give students freedom to explore and to make many different types of choices.	For experienced students. If the instruction is in areas which provide for opportunities for discussion or alternative approaches, such as problem solving.	Content

TABLE 13.3 *(continued)*

Universal Principle: Provide visible evidence of progress toward mastery to the student.			
Situational Principle	*Description*	*When To Use*	*Most Often Used In Content or Structural Gamification*
Earning Points	Give points as feedback related to the level of effort, timeliness, correctness, or accuracy of student responses.	To provide a means of measuring student progress against a standard. If you want to provide feedback related to the effort, timeliness, correctness, or accuracy of a student response to a question, scenario, or other instructional event.	Structural
Leveling Up	Provide graduated levels for students to progress from the simplest to more complex levels in a process called "leveling up."	If there is a great deal of content and there is the need to keep the content manageable for the student. To visibly indicate to the student the progress being made toward a terminal objective. To motivate the student to continually move through the content.	Both
Earning Achievements	Offer students badges, trophies, or other visible signs of having accomplished a task or performed a specific behavior or series of behaviors.	To encourage students to perform a specific behavior. To provide students with items to visibly show to others. To provide encouragement that moves across multiple levels.	Both

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Notes

* *Editors' note: See Principle 2 in Chapter 8, Designing Games for Learning, for further discussion of game elements.*

* *Editor's note: This notion of repeating until mastery is a foundational aspect of the learner-centered paradigm.*

** *Editors' note: this is what distinguishes this chapter from Chapter 8, which describes principles for designing games for instruction.*

* *Editors' note: Student choice and autonomy are key aspects of self-regulated learning, discussed in Chapter 9.*

* *Editors' note: The principles for competency-based education discussed in Chapter 2 are relevant here, particularly with regard to stating competencies, scaffolding learning, and assessing mastery.*

* *Editors' note: A mastery orientation is an important aspect of self-regulated learning (see Chapter 9)—assessing one's own learning rather than comparing self to others.*

* *Editors' note: Many of these methods are also discussed as elements of the game space in Chapter 8.*

** *Editors' note: This shows the role of gamification in task-centered instruction, which is central to the learner-centered paradigm of education (see Principle 2 in Chapter 1, all of Chapter 3, and Principle 2 in Chapter 4).*

* *Editors' note: This is also called review.*

* *Editors' Note: This would be handled by the recordkeeping function of a Personalized Integrated Educational System as described in Chapter 12.*

* *Editors' note: This last option is more in line with the sorting-focused Industrial-Age paradigm of education. The other three are good options for the learner-centered paradigm.*

* *Editors' note: For guidance on defining the levels, you may find the Elaboration Theory's Simplifying Conditions Method useful (see Chapter 18 in Volume II).*

* *Editors' note: A standard tends to be preferable for the learner-focused paradigm of education, though the student's own performance is also common, especially as an indicator of progress toward the standard.*

** *Editors' note: We suggest that perhaps visible completion achievements are useful for summative evaluations (certifying mastery), whereas measurement achievements are useful for encouragement within formative evaluation (indicating progress).*

14

DESIGN CONSIDERATIONS FOR MOBILE LEARNING

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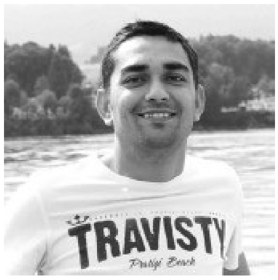

EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *Subject areas in which digital communication and collaboration skills are necessary for producing artifacts for eportfolios.*
- *Learners create, curate, and share content.*

Learners

- *All students.*

Learning environments

- *Bridging formal and informal learning contexts.*

Instructional development constraints

- *Learners must have access to mobile devices and networks.*
- *Teachers must develop an ecology of resources to support learning.*

Values (opinions about what is important)

About ends (learning goals)

- *Developing communication and collaboration skills.*
- *Developing multimedia production skills.*

About priorities (criteria for successful instruction)

- *Efficiency and appeal are highly valued, but effectiveness is also important.*

About means (instructional methods)

- *Mobile devices should be used to bridge classroom-based instruction and more situated authentic learning experiences.*
- *Contextual sensors in mobile devices should be utilized to design learning experiences that are responsive to location and environmental contexts.*
- *Learners should generate their own contexts and content in the process of creating meaning.*

About power (to make decisions about the previous three)

- *Learners should have significant control over what, when, where, and how they learn.*

Universal Principles

1. Enable student-generated content

- *Promote student use of built-in, mobile, multimedia production tools.*
- *Promote student and teacher use of mobile social media for communication and collaboration.*

2. Enable student-generated contexts

- *Facilitate student-directed projects and negotiation of assessment activities.*
- *Facilitate student creativity and reconceptualization of role from passive reproducer of knowledge to active participant in learning communities.*
- *Promote use of built-in contextual sensors.*
- *Promote use of eportfolio spaces to personalize and customize learning environments.*

3. Enable authentic learning experiences

- *Promote use of mobile social media for participation in professional global networks and communities.*
- *Design an ecology of resources to support authentic learning, and design triggering events to enable student-generated content and contexts.*
- *Use social media to foster the development of teamwork skills in team-based projects.*

Situational Principles

For enabling learner-generated content

- *Content creation: When a learning goal is for students to create a portfolio of their work, require them to use the content-generation and multimedia recording capabilities of their mobile devices to capture work in progress and capture moments of inspiration.*
- *Content curation: When a learning goal is to capture an experience outside the classroom, such as a field trip or an interview, require students to use their mobile devices to upload these into a curated collection (e.g., a YouTube playlist or ScoopIt collection) for later critique and analysis.*
- *Content sharing: When a learning goal is to facilitate student reflection and peer review on their work, require the use of mobile social media such as Twitter, Wordpress, and Google Plus comments to share these reflections.*

For enabling learner-generated contexts

- *When a learning goal is to foster communication and collaboration skills, require students to use social media on team-based projects.*
- *When a learning goal is to foster communication and collaboration skills, require students to select and use collaborative mobile multimedia tools appropriate for their context.*
- *When a learning goal is to share or situate an authentic experience located outside the classroom, leverage the geolocation, image recognition, and augmented reality capabilities of mobile devices.*
- *When a learning goal is to enable multimodal communication or for visual disability access, use the voice recognition capabilities of mobile devices.*

For enabling authentic learning experiences

- *When there is a need to establish communication and collaboration channels among learners, teachers, and the community in which the experience is located, provide an ecology of resources, such as a project hub, communication channels, hashtags for curating project*

content, and eportfolio platforms.
- *When introducing students to the appropriate choice of tools to use in a situation, provide triggering events, such as a series of short, quick production and sharing exercises using mobile social media.*
- *When the expense (and safety) of real-world scenarios and environments is prohibitive, provide virtual reality experiences.*

Case Study

- *A Global Mobile Collaborative Project #moco360*

– C.M.R., B.J.B., & R.D.M.

DESIGN CONSIDERATIONS FOR MOBILE LEARNING

I. Introduction

In this section we introduce the key theoretical foundations of mobile learning that support learner-centered instruction.

What Is Mobile Learning?

Sharples (2010) and Cook (2009) identify three distinct phases that have characterized the development of mobile learning research and practice:

1. A focus upon devices
2. A focus upon learning outside the classroom
3. A focus upon the mobility of the learner.

As the field of mobile learning research and practice has matured it has moved away from a techno-centric focus towards the mobility of the learner.

Definition

Definitions of mobile learning tend to be very broad and inclusive. One of the most popular definitions is "the processes of coming to know through conversations across multiple contexts amongst people and personal interactive technologies" (Sharples, Milrad, Arnedillo-Sanchez, & Vavoula, 2009, p. 5). However, we believe that a definition of mobile learning should capture the unique affordances of mobile devices that enable new pedagogies. The following is our attempt at a definition of mobile learning that encapsulates the affordances of ubiquitous connectivity, collaboration, and serendipitous content sharing:

> It is the potential for mobile learning to bridge pedagogically designed learning contexts, facilitate learner generated contexts, and [learner generated] content (both personal and collaborative), while providing personalisation and ubiquitous social connectedness, that sets it apart from more traditional learning environments. (Cochrane, 2010, p. 134)

While much of the literature around mobile learning emphasizes the informal nature of mobile learning beyond instructionally designed learning environments, we believe the role of the teacher is fundamental in designing both formal and informal mobile learning experiences (Laurillard, 2007). Within the context of activity theory, mobile devices are the tools that mediate learner-centered activities and facilitate collaborative learning environments (Uden, 2007).

Unique affordances of mobile learning

Many mobile learning projects attempt to replicate teacher-directed activities and practice on a small screen mobile device, focusing upon reformatted content delivery and use of prior pedagogical practice. We think this is a mistake that leads to the almost inevitable comparative research study that results in “no significant difference” (Reeves, 2005). Mobile learning provides a range of tools that can enhance learning and teaching via new contexts, communication, and collaboration, and allows a refocus on student-generated content and student-generated contexts (Cook, 2007, 2010; Pachler, Bachmair, & Cook, 2010). Bannan, Cook, and Pachler (2015) categorize a range of mobile device affordances, to which we offer some examples of current tools available:

- collaborative and communicative potential; for example Twitter, Skype
- interactivity and nonlinearity; for example Google Now, Virtual Reality
- distributed knowledge construction; for example Google Plus, Google Docs
- multimodal knowledge representation; for example YouTube, Jumpcam, Vyclone
- authentic/contextualized/situated material, interaction, tasks and settings; for example Augmented Reality
- multi-functionality and convergence; for example voice recognition systems such as Siri
- portability, ubiquity, and personal ownership: for example Smartphones
- user-generated content and contexts: for example ePortfolios such as Behance.

In our view the concepts of user-generated content, user-generated contexts, and authentic learning encapsulate the above list of mobile device affordances.

Underlying theories for mobile learning

Much work has been done on attempting to define new learning theories suitable for mobile devices (Sharples, Taylor, & Vavoula, 2007). However, we feel the best approach is to leverage learning theories and frameworks that support the unique affordances of mobile devices, such as social constructivism, the conversation framework, and new concepts such as connectivism (Siemens, 2004) and rhizomatic learning (Cormier, 2008), where the emphasis is upon authentic student learning experiences. Within this context the role of the teacher changes from designer and deliverer of content or mobile apps, to designing student learning experiences that are triggered by an appropriate ecology of resources (Pachler, et al., 2010).

Types of Mobile Learning

We are particularly interested in the ability of mobile devices to bridge and connect informal and formal learning experiences, enabling the design of authentic learning experiences (J. Herrington, Herrington, Mantei, Olney, & Ferry, 2009; Laurillard, 2007).

Informal

Informal learning is characterized by learning experiences that happen outside the classroom setting. Typically these include serendipitous events that can be captured and shared via a student’s smartphone equipped with a quality camera, microphone, and the recording of contextual metadata via the built in GPS, compass, and proximity sensors, then shared immediately via either 3G or WiFi networks.

Formal

Formal learning is generally characterized by learning activities designed by a teacher and carried out in a classroom setting, with direct formative or summative assessment associated. This can be achieved in a variety of ways, including: live Twitter conversations, curation and sharing of student-generated mobile multimedia, eportfolios, and projects, for example YouTube videos, Blog posts, Soundcloud recordings, and Flickr photo streams.

II. Values Underlying a Theory for Mobile Learning

A design theory for mobile learning needs to leverage the unique affordances of mobile devices to enable new pedagogies, in particular the mobility of the learner and the centrality of communication and collaboration to learner-centered instruction. New technologies do not automatically of their own accord change pedagogy; "If we want students to become smarter than a smartphone, we need to think harder about the pedagogies we are using to teach them. Technology can amplify great teaching but great technology cannot replace poor teaching" (OECD, 2015, p. 4).

A theory for mobile learning must also acknowledge the dynamic and rapidly changing nature of mobile technologies and their impact upon society as a whole. "The nature of learning is being augmented and accelerated by new digital tools and media, particularly by mobile devices and the networks and structures to which they connect people" (Bannan, et al., 2015, p. 1). Mobile learning can bridge classroom-based instruction and more situated authentic learning experiences outside of the classroom: "it can be an opportunity to bridge the gulf between formal and experiential learning, opening new possibilities for personal fulfillment and lifelong learning" (Sharples, Taylor, & Vavoula, 2005).

As mobile devices are inherently personal and personalizable devices, they also provide opportunities for designing learning experiences that are customized for learners. Mobile learning provides an opportunity to democratize learning by enabling student-determined learning or heutagogy (Blaschke & Hase, 2015; Hase & Kenyon, 2001). Finally, the contextual sensors built into mobile devices provide opportunities for designing learning experiences that are responsive to location and environmental contexts to a level that was previously prohibitively expensive, difficult, or even impossible. What we need to avoid is merely replicating learning activities or simply reformatting pre-existing content on/for mobile devices producing comparative learning experiences that have not been redesigned for the unique affordances of mobile learning (Rushby, 2012).

III. Universal Principles

The unique affordances of mobile devices provide the basis for a set of universal principles for designing mobile learning conceptualizing what can be achieved via the integration of mobile learning within the curriculum. These include: enabling student-generated content, enabling student-generated contexts, and enabling authentic learning experiences. These three mobile learning principles support guidelines for using the affordances of mobile devices in the design of instructional methods, and guidelines for using instructional methods on mobile devices. The three universal principles are discussed in the following sections, however they overlap and build a basis for designing authentic learning environments. Thus, rather than designing mobile learning around teacher-directed content delivery to small screen devices, our mobile learning principles focus upon learner-generated content, and learner-generated contexts, enabling learners to become active participants within authentic learning communities and preparing them to become active participants of professional networks and communities (Cochrane et al., 2013; Cochrane, Sissons, Mulrennan, & Pamatatau, 2013).[*]

Principle 1: Enable Student-Generated Content[**]

Mobile social media provide a powerful suite of personalizable tools for enabling student as worker, self-directed learner, and teacher (Bruns, 2008). Bruns coins the term 'produser' to indicate that social media enable the dual roles of producer and consumer for the user.[***] In our framework, mobile social media are reconceptualized from a purely social domain to an educational domain (Kukulska-Hulme, 2010; McLoughlin & Lee, 2008). This represents a significant conceptual change for both teachers and learners who typically use mobile social media predominantly in a social context (Beetham & White, 2014).[†]

1.1 Promote student use of built-in, mobile, multimedia production tools

Today's mobile devices, and in particular smartphones, provide students with ubiquitous access to a built-in suite of multimedia production tools such as: high definition still and video camera, audio recording, a GPS for navigation and geotagging of recorded/captured content, 2D bar code scanner, augmented reality, touch screens for sketching and image manipulation, and an extensive range of powerful multimedia creation and editing apps, including audio (for example Garageband on iOS), video (for example iMovie on iOS), and collaborative media production tools such as Vyclone or Mixbit. Therefore, students have powerful multimedia production tools in their pockets wherever they are and can carry larger-screen mobile devices such as touch screen tablets with long battery life that are significantly lighter than even the most modern laptop computers.[*] Mobile learning should encourage and provide opportunities for serendipity or allowing space for non pre-determined learning experiences (Buchem, 2011), as mobile devices uniquely enable capturing and sharing moments of inspiration or critical learning events.

1.2 Promote student and teacher use of mobile social media for communication and collaboration

Mobile devices are designed predominantly as communication devices, and, combined with the social sharing properties of social media, their potential is realized in enabling a bridge between students' informal (out of class) learning[**] and a more collaborative formal learning experience in class (Cook, Pachler, & Bradley, 2008; Kearney, Schuck, Burden, & Aubusson, 2012; Vavoula, 2007). Similarly Kukulska-Hulme (Kukulska-Hulme, 2010) argues that mobile learning is a catalyst for pedagogical change as it focuses upon the learner rather than the teacher:

> mobile technologies can be used very effectively as learning and communication tools by a surprisingly broad range of learners in a variety of settings. With its strong emphasis on learning rather than teaching, mobile learning challenges educators to try to understand learners' needs, circumstances and abilities even better than before. This extends to understanding how learning takes place beyond the classroom, in the course of daily routines, commuting and travel, and in the intersection of education, life, work and leisure. (Kukulska-Hulme, 2010, p. 181)

This emphasizes the mobility and connectedness of the learner.

Principle 2: Enable Student-Generated Contexts

Mobile learning enables pedagogies that focus upon student-generated contexts, moving from teacher-directed content delivery towards student-determined learning[***] as defined by the pedagogy-andragogy-heutagogy (PAH) continuum (Luckin et al., 2010). In this context the PAH continuum encompasses a range of learning approaches, where pedagogy refers to teacher-directed learning, andragogy as student-centered learning, and heutagogy as student-determined learning (involving student-directed projects and negotiation of assessment activities).[*] The goal of student-centered pedagogies is to enable transformative learning experiences and produce creative,[**] self-directed graduates. Design of mobile learning experiences should focus upon facilitating student creativity within a variety of contexts in and beyond the classroom (Sternberg, Kaufman, & Pretz, 2002).

2.1 Facilitate student-directed projects and negotiation of assessment activities

We have found that designing learning experiences that include students in the negotiation of assessment outcomes and the brokering of student-generated project plans leads to higher levels of student engagement that go beyond simply doing what is required to pass a course (Cochrane & Rhodes, 2013). The integration of geolocation and image recognition capabilities with a variety of multimedia content production, editing, and sharing capabilities of mobile social media provides students with a wide choice of platforms and tools for linking student-generated content to student-generated contexts. While students will often need guidance on the appropriate choice of tools suitable for a particular project, allowing them to optionally explore new and emerging mobile social media tools can enrich the learning environment and lead to new assessment strategies and activities.

2.2 Facilitate student creativity and reconceptualization of role from passive reproducer of knowledge to active participant in learning communities

Creating a supportive learning environment where students feel encouraged and safe to try new ideas is key to enabling or unleashing student creativity (Cochrane, 2014). Danvers argues that "Creativity thrives in an atmosphere that is supportive, dynamic, and receptive to new ideas and activities. The learning environment has to encourage interactions between learners" (Danvers, 2003, p. 52). Mobile social media provide avenues for teacher and peer feedback and formative critique upon student work, and facilitate a reconceptualization of the teaching/learning environment as a form of intentional community of practice (Brown, 2006; Surry & Baker, 2016; Wenger, White, Smith, & Rowe, 2005). In this approach the learning environment is designed to draw students from being passive, peripheral participants within a teacher-directed learning environment into becoming active participants within a supportive learning community.

2.3 Promote use of built-in contextual sensors

The concept of context adds a layer of rich information to student-generated content, adding the variables of time, location, and spatial interaction and awareness. The unique affordances of mobile devices include a variety of built-in contextual sensors, including location data via GPS and compass, spatial awareness via gyroscope and proximity sensors, and communication and collaboration tools for crossing geographic boundaries. These tools provide a potentially dynamic and active link between the learner and the environment in which a learning activity takes place. The combination of the unique contextual sensors and the personal mobility of these devices provides opportunities for the educational use of both augmented reality and virtual reality in particular.

2.4 Promote use of eportfolio spaces to personalize and customize learning environments

A focus upon student-owned mobile devices (Bring Your Own Device, or BYOD) and student-owned eportfolio spaces enables more personalized and customizable learning environments (Cristol & Gimbert, 2013; Parsons, 2013) than the traditional institutional learning management system (LMS). While not inherent in the use of LMSs themselves, the default implementation of an institutional LMS tends to focus upon creating a teacher-directed learning environment and teacher-delivered content. The communication and collaboration tools built into most LMSs also tend to be teacher-control focused and different from the teamwork and collaborative tools generally used in professional environments beyond educational institutions.[*] We also believe that student eportfolios should be professional, customizable, and transferable beyond the end of their courses.

Principle 3: Enable Authentic Learning Experiences

An authentic mobile learning experience will focus upon the development of student-generated portfolios and authentic projects rather than mobile access to online examinations or teacher-generated content (Chan, 2007; Mann & McKewen, 2013).[**] Herrington, Herrington, and Mantei (2009) argue that mobile learning requires new pedagogies that are learner-centered and project-based. Mobile learning by its very nature provides a powerful catalyst for enabling authentic situated learning,

> because of the ability to design social constructivist learning environments using social media, and the ubiquitous nature of mobile device ownership provides a democratizing technology that can be used beyond the confines of the classroom and beyond the myopic constraints of institutional learning management systems (J. Herrington, Reeves, & Oliver, 2005). (Cochrane, Narayan, & Oldfield, 2015, p. 127)

Authentic learning creates a direct link between theory and practice for the learner.

3.1 Promote use of mobile social media for participation in professional global networks and communities

Mobile social media enable students to form and become active members of professional global networks and communities, preparing them for real-world roles within their chosen industries or professions after graduation. Traditional student work experience is limited to local contexts as international travel is very expensive and may even involve issues of student safety. In comparison, virtual professional community participation can be facilitated via the emergence of a variety of discipline-specific professional networks (Villar-Onrubia & Rajpal, 2015). Virtual global communities can be nurtured and sustained (Wenger, White, & Smith, 2009; Wenger, et al., 2005) via the critical use of networks formed around the use of tools such as Twitter, Google Plus, and Behance. Cook et al., argue: "A key evolving pedagogical affordance of mobile devices is the ability to use social media and apps to enable new patterns of connected social, learning and work-based practices" (Cook & Santos, 2016, p. 316).

3.2 Design an ecology of resources to support authentic learning, and design triggering events to enable student-generated content and contexts

The concept of the digital native (Prensky, 2001) has led many educators to believe that the Millennial Generation is naturally proficient in all aspects of digital technologies. However, several researchers have found that that is not necessarily the case (Sheely, 2008; White & Le Cornu, 2011). We have found that students' use of mobile social media is predominantly limited to Facebook, maintaining their social networks, and media consumption, rather than utilized as critical educational tools or for the production and sharing of multimedia content. Thus, the roles of the teacher as designer, facilitator, and mentor within the context of mobile social media are critically relevant. The role of the teacher thus becomes one of designing an ecology of resources to support authentic learning experiences and designing triggering events to enable student-generated content and student-generated contexts beyond their prior social use (Cochrane & Antonczak, 2015). An ecology of resources for mobile learning should encompass a set of negotiated platforms to support a learning community, including: a community hub for administration and discussion, both synchronous and asynchronous communication networks, student-generated content sharing channels, and an agreed method of curating the various reified activities of the learning community—such as a project hashtag or a project management platform. Triggering events can be designed to introduce the educational affordances of these mobile social media networks and platforms to students and to facilitate student interaction and discussion via these platforms.

3.3 Use social media to foster the development of teamwork skills in team-based projects

A key graduate capability for most professions is the ability to work as effective members of teams. The communication and collaboration affordances of mobile social media enable the design of team projects that foster the development of teamwork skills.[*] There is a variety of mobile social media project management tools and platforms that can facilitate team projects. While students generally are adept at using mobile devices for social activities, they are inexperienced at using their devices in critical thinking and educational environments (Beetham & White, 2014; Helsper & Eynon, 2010; Wang, Hsu, Campbell, Coster, & Longhurst, 2014).

A Framework for Applying the Universal Principles of Mobile Learning

Our framework (Cochrane & Antonczak, 2015; Cochrane, Antonczak, Guinibert, & Mulrennan, 2014) is essentially a mashup of creative pedagogies and frameworks that focus upon transformational pedagogies that enable students to become active participants of global professional communities based upon the implementation of our three universal principles of mobile learning. These include Puentedura's (Puentedura, 2006) SAMR framework (Substitution, Augmentation, Modification and Redefinition) that maps a continuum from substitution of pre existing pedagogical practice with new technologies towards enabling redefined learning objectives and activities, Sternberg et al's., (Sternberg, et al., 2002) notion of three levels of creativity, and the PAH continuum (Luckin, et al., 2010). The framework thus forms a simple guideline to link mobile learning theory and practice along a continuum from teacher-directed pedagogy towards student-determined heutagogy, summarized in Table 14.1.

The overlap of the underpinning frameworks is illustrated in Figure 14.1. According to Narayan & Herrington (2014):

> The central **Learning and Teaching** element in Figure 14.1 represents both aspects as interchangeable, meaning the 'learner as teacher' and 'the teacher as learner' and helps to indicate the change in both learning style for the students (from passive to active) and the teaching style for the teachers (from transmission to social constructivist) (Hase & Kenyon, 2007). (Narayan & Herrington, 2014, p. 154)

We have previously argued that mobile learning provides a powerful catalyst for enabling authentic learning (Cochrane, et al., 2015), and in this chapter we argue that mobile learning, therefore, provides a powerful catalyst for the post-industrial paradigm of instruction.

TABLE 14.1 A Framework for Using Mobile Social Media to Design Creative Pedagogies

	Pedagogy	*Andragogy*	*Heutagogy*
Activity Types	Teacher-delivered content	Student-generated content	Student-generated contexts
Locus of control	Teacher	Student	Student
Cognition	Cognitive	Meta-cognitive	Epistemic
SAMR	Substitution & Augmentation	Modification	Redefinition
Creativity	Reproduction	Incrementation	Reinitiation
Knowledge production	Subject understanding	Process negotiation	Context shaping
Ontological shift	Reconceptualising mobile social media: from a social to an educational domain	Reconceptualising the role of the teacher	Reconceptualising the role of the learner
Self perception	Learning about	Learning to become	Active participation within a professional community

(modified from Luckin et al, 2010)

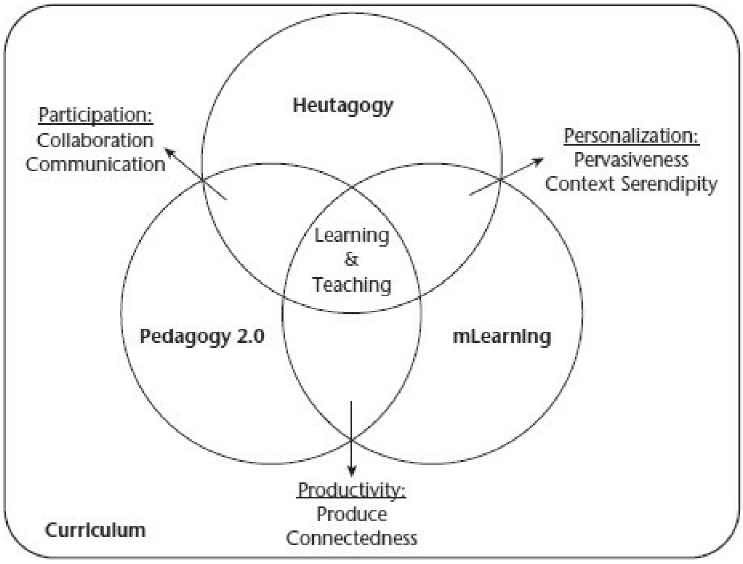

FIGURE 14.1 A Heutagogical Framework for Mobile Learning

(Narayan & Herrington, 2014)

IV. Situational Principles

Situational Principles for Enabling Learner-Generated Content

Learner-generated content has three main elements: content creation, content curation, and content sharing.

Content creation

When a learning goal is for students to create a portfolio of their work, require them to use the content-generation and multimedia recording capabilities of their mobile devices to capture work in progress and capture moments of inspiration. This can be achieved via a variety of multimedia content creation affordances, editing applications, and social media portfolio hosts such as Wordpress, Mahara, or Behance.

Mobile content creation is useful when you require students to create their own copyright-free multimedia content for projects, such as creating original audio tracks for their YouTube videos rather than infringing copyright by using a pre-recorded commercial soundtrack. However, mobile content creation should not be used when it is easier to use a laptop or desktop computer—for example writing a long-form essay or thesis is much easier on a laptop or desktop, whereas making quick notes on a mobile device is simple and convenient and easier to do while not in a formal learning environment than having to carry a laptop everywhere.

Content curation

When a learning goal is to capture an experience such as a field trip, an interview with an expert, or an event outside the classroom, require students to use their mobile devices to upload these into a curated collection (for example, a YouTube playlist or ScoopIt collection) for later critique and analysis. A variety of social media curation platforms are available with either mobile web access or mobile application interfaces that enable curation of learner-generated content using mobile devices. These tools facilitate critical analysis and selection of either learner-generated content or third-party content. Some platforms serve a generic audience while others focus upon specific communities of professionals or communities of practice.

These tools can be used to enable students to create eportfolios of experiences beyond the classroom, and also enable channels for peer and teacher feedback on their work. Examples of generic curation tools that can be used in almost any curriculum context include: ScoopIt, Wordpress, and LinkedIn. Examples of more specific curriculum context curation tools include: Behance (targeting graphic designers), Vimeo (targeting video professionals and independent movie creators), Mendeley (targeting researchers), and Flickr (targeting photographers). These mobile social media content curation tools include annotation and commenting features that can enable different levels of critical reflection and analysis of the curated content, although mobile content curation is most suitable to quick and serendipitous events.

Content sharing

When a learning goal is to facilitate student reflection and peer review on their work, require the use of mobile social media such as Twitter, Wordpress, and Google Plus comments to share these reflections. Content curation tools also provide options for content sharing, and they link directly with the most popular mobile communication and networking platforms such as Twitter, Google Plus, Facebook, and LinkedIn. The mobile apps for these social network platforms provide tools for students to share content and update their communities of practice on the go and immediately.

Mobile content sharing tools enable students to immediately update their community of followers as they upload and publish new work via social networks such as Twitter and Facebook. However, mobile content sharing may not be appropriate in all situations, particularly when there are ethical, confidential, and safety issues such as those involving young children, patients, and uninformed consent of participants. In confidential or ethical situations, a more closed-access content sharing platform should be used, such as Mahara or the institution's learning management system (LMS).

Situational Principles for Enabling Learner-Generated Contexts

Learner-generated contexts encompass the affordances of mobile devices that enable communication, collaboration, and interaction with the environment via contextual sensors adding digital metadata to the learning environment.

Communication

When a learning goal is to foster communication and collaboration skills, require students to work on team-based projects facilitated by mobile social media. In student teamwork situations that involve students being geographically disperse from their team members, the communication affordances of mobile devices can facilitate virtual student team meetings and discussion on a project via social networks such as Skype or a group Google Plus Hangout. Situations where student team projects cross time zones, with team members in other countries, can be facilitated by asynchronous communication tools such as Twitter. Situations involving inviting a guest international lecturer to provide an interview or discussion live during class can also be live streamed to students who are in disperse locations via a mobile live-streaming app such as Hangouts on air that can also be archived on YouTube for later viewing by students who could not be available at the live event time.

Collaboration[*]

When a learning goal is to foster communication and collaboration skills, require students to select and use collaborative mobile multimedia tools that are appropriate for their context. Mobile devices provide a variety of tools for collaboration to enable student group work or team projects. There is a lot of overlap between mobile communication and collaboration tools. Student group work is one of the more difficult learning environments to make authentic and assess equitably. However there is a variety of collaborative mobile social media tools that can help engage students in group work.

Collaborative activities are defined by specific contexts for which different choices of collaborative tools will be appropriate. Learning to choose appropriate mobile collaboration tools to suit a specific context is a key skill for students to acquire. In situations that require structured project stages and outcomes, a mobile project management tool such as Basecamp can be effective. In situations where student teams are required to link and associate concepts, a mind mapping tool such as Mindmeister can be useful. In direct face-to-face team meetings, students can use their mobile devices to take notes and capture team brainstorms.

Geolocation, image recognition and augmented reality

When a learning goal is to share or situate an authentic experience located outside of the classroom, leverage the geolocation, image recognition, and augmented reality capabilities of mobile devices. These contextual affordances of mobile devices enable learning experiences that directly link a real-world experience or physical artifacts with digital metadata and knowledge bases that are traditionally accessed in environments separated from the actual experiential context (for example libraries). Thus, leverage these affordances in situations where accessing learning information on the job leads to higher productivity. In situations where a physical field trip is too expensive or safety is an issue, then a virtual experience can be facilitated by these affordances. However, in situations where there may be concerns over student privacy and safety from location-based tracking, geolocation services should be disabled.

Voice recognition

When a learning goal is to enable multimodal communication or for visual disability access, use the voice recognition capabilities of mobile devices. Most mobile devices include a built-in microphone and speaker, and there is a wide variety of mobile apps and system integration with voice recognition capabilities built-in, for example Google Search, Siri, and Cortana. In situations where students are required to explore alternative forms of interacting with technology, voice recognition can be a useful option. In learning situations involving sight-impaired students, voice recognition, text-to-speech, and voice search capabilities of mobile devices can be powerful enablers of learning. In learning situations involving second language students, voice recognition and translation tools can be used on mobile devices. However, in learning situations that have high background noise or where silence is required, voice recognition may be inappropriate.

Situational Principles for Enabling Authentic Learning Experiences

Designing authentic learning experiences involves a change in role for the teacher and for learners. Teachers become designers of an ecology of resources and triggering events, and students become active participants and creators of interactive learning environments utilizing the unique affordances of mobile devices.

An ecology of resources

Provide an ecology of resources when establishing communication and collaboration channels and protocols between learners, teachers, and the community in which the experience is located. Teachers play a key role in designing and negotiating an appropriate ecology of resources to enable authentic student learning experiences. This ecology of resources needs to work across the range of mobile devices that the students use/own and leverage the unique affordances of mobile devices, rather than simply provide a limited mobile portal to the institutional learning management system. Defining an agreed set of tools for communication, feedback, and collaboration at the start of individual and team-based projects is essential.

Key elements of such an ecology of resources include: a project hub (traditionally the role of the institutional learning management system), asynchronous and synchronous communication channels, hashtags for curating project content and social media, and student eportfolio platforms.* In situations where you want to create a project hub, utilize collaborative social media tools such as Google Plus Communities. In situations where you want to focus student use of their mobile devices upon a classroom learning environment, use a mobile short messaging service to facilitate discussion and make the back channel visible via tools such as Todaysmeet and Twitter. In situations in which you want to enable students to create a transferable professional eportfolio, use an appropriate social media portfolio platform rather than the institutional LMS. In situations that focus upon administration purposes, course documentation sharing, and access to copyright protected resources such as library subscription resources, it may be more appropriate to use the institutional LMS.

Triggering events

Provide triggering events when introducing students to the appropriate choice of tools to use in a situation. To enable an authentic learning environment that scaffolds learners into negotiating learning outcomes and learner-directed experiences, the teacher takes on the role of designing triggering events rather than the role of producing teacher-generated content. Triggering events are designed to facilitate student creativity and collaboration within specific contexts while introducing students to some of the unique affordances of mobile devices. Teacher-directed triggering events are most appropriate at the start of a project to establish a culture of trust and sharing within the learning environment. A series of short, quick production and sharing exercises using mobile social media is effective in establishing a negotiated learning culture. As projects progress, triggering events should focus more upon inspiring student creativity and discussion and allow for student choice of mobile social media tools and negotiation of learning outcomes.

Virtual reality

Provide virtual reality experiences when the expense (and safety) of real-world scenarios and environments is prohibitive. While augmented reality adds contextual information to real-world experiences, virtual reality enables real-world scenarios and immersive environments that are physically impossible or prohibitive. Situations beyond the reach of affordable student travel costs can be virtually experienced via mobile virtual reality, bringing these experiences into the classroom for critique and discussion. Previously time consuming and costly to produce, mobile virtual reality creation and interaction tools are now available via a range of mobile apps and low-cost viewers such as Google Cardboard and 360-degree video support via YouTube. These low-cost mobile virtual reality tools allow students to create and interact with immersive virtual environments, take virtual science tours, and create and share their own virtual reality scenarios.

V. Case Study

In this section we illustrate the implementation of our mobile learning design principles for utilizing mobile social media to enable creative student-centered pedagogies by evaluating a case study (Cochrane, Antonczak, Keegan, & Narayan, 2014; Cochrane, et al., 2015). These principles have been implemented in various contexts to guide the design and curriculum integration of several mobile learning projects, illustrated in the following case study.

A Global Mobile Collaborative Project #moco360

Enabling an authentic learning experience

The MoCo360 project (Cochrane, Antonczak, Keegan, et al., 2014) involved a global community of practice (COP) of lecturers participating in collaborative curriculum design to develop and implement student-directed collaborative mobile filmmaking projects. The goal of the project was to design an authentic international collaborative learning experience for our students. A group of six lecturers from New Zealand, UK, France, and Colombia used a range of mobile social media tools (Google Plus Community, Google Plus Hangouts, Google Docs, Twitter, and Wordpress) to brainstorm and design a global collaborative experience for their student cohorts. The course contexts included: graphic design, filmmaking, and audio engineering.

The lecturers collaboratively defined an ecology of resources to support the project. A Google Plus Community was created as a project hub, facilitating access from all of the six institutions globally. A common social media hashtag (#moco360) was defined to facilitate curation and sharing of project content and to facilitate an asynchronous communication and collaboration channel via Twitter.

Student-generated content

The project began with the lecturers introducing three triggering events designed to introduce students to the unique affordances of mobile devices for content creation and sharing. These involved the production of student-generated short mobile film activities for their students to engage in and share with the global MoCo360 COP. These three triggering events introduced some of the unique affordances of mobile filmmaking: short-form animation (Vine), collaborative video production (Vyclone), and geolocation of mobile media (Google Maps and Wikitude). Following these short exercises the students were asked to brainstorm collaborative mobile filmmaking project ideas and form global teams based upon their own selection of projects to pursue, and using their own mobile devices. Thus the second phase of the project enabled student-generated content and student-generated contexts.

Student-generated contexts

A group Facebook page was created as a space for the students to form teams and share their projects, with their final project videos linked or embedded into the MoCo360 Google Plus Community. Students were also encouraged to maintain a personal reflective journal or portfolio throughout the project—students chose either Wordpress or Behance as the platforms for these eportfolios. Participation within the global MoCO360 COP was brokered by the lecturers inviting one another into each other's classes as guest lecturers via Google Plus Hangouts, and by posting formative feedback on students' Twitter streams, Vine videos, and Vyclone videos curated via the hashtag #moco360. Each cohort also hosted a mobile film-viewing event as well. The MoCo360 project was limited to a span of six weeks defined by the overlap of the educational timeframes of the northern and southern hemispheres. The spanning of several different global time zones also necessitated the use of both negotiated synchronous and asynchronous collaborative tools. Table 14.2 provides an outline of the MoCo360 project design with respect to our three universal principles of mobile learning and the implementation of the project via situational principles.

Student-generated content and contexts

One example of a student collaborative project resulting from the MoCo360 project involved the production and collation of examples of forced perspective videos filmed on smartphones (http://theforcedperspectiveproject.wordpress.com). The project progress was recorded as a series of Facebook page and Wordpress blog posts:

TABLE 14.2 Overview of the #Moco360 Project

Topic	*Triggering event*	*Activity design*	*Universal Principle*	*Situational Principles*
Week 1: Introduction to the MoCo360 community	All students invited to become members of a G+ Community	A G+ community was established as the support and announcement channel for the class	Enabling an authentic learning experience	Design an ecology of resources to support authentic learning at the start of a project
Week 2: Personal introduction	Students create and share a 6-second Vine video, and an eportfolio profile (Behance or Wordpress)	Students establish an online digital identity using a range of mobile social media	Enable student-generated content	Introduction of content creation and sharing
Week 3: Global Hangout	Synchronous video conference of all project teams	Lecturers invite their students to participate in a global G+ Hangout	Participation within a global community as an authentic learning experience	Provide triggering events
Week 4: Collaborative content creation	All participants record content for a shared Vyclone video	Collaboration in a global team-based project as content creators	Promote student and teacher use of mobile social media for communication and collaboration	Triggering events that foster communication and collaboration skills
Week 5: Negotiate student-directed projects via a Facebook page	Students invite peer participation into an original mobile video production project, shared via Twitter	Establishment of international student team projects	Student-generated content and contexts	Content creation and sharing within a team-based project
Week 6: Collaborative video production	Student-directed collaborative mobile video production project	Active participation within a global professional community	Student-directed learning experience	Facilitating an authentic global learning community

> We have an idea! The idea is to collaborate . . . . .
>
> #MoCo360 will take part in [sic] in a video sequence of students (and lectures!) filming reveals of forced perspective shots. These shots have been used creatively for years but the idea of people around the world exposing the shots in a collective video has never been done. We need you to start your film at the initial perspective point and then either move the camera, people or objects in your shot to uncover the trick of you have filmed. If you can fit it into a Vine or Instagram video that would be perfect but using any app will give a different effect to each video. The crazier the better but it must be filmed on a mobile and be submitted portrait instead of landscape. Anyone who submits and is put in the film will be notified and credited either during the video or at the end depending on the editing.
>
> If you have and questions tweet us @TheFPProject
>
> The hashtags will be #Moco360 #ForcedPerspective #TFPP
>
> We will submit an example to YouTube for people to view for ideas. (Student team Wordpress post, 2014)

Wordpress, Twitter, and Facebook were all used to promote the project idea, recruit participants, and share the mobile created content.

> Some amazing ideas for forced perspective http://bzfd.it/1eqi3rn. Any ideas let us know at http:/theforcedperspectiveproject.wordpress.com/ or on twitter @TheFPProject (Student Facebook post, 2014)

The student team posted a tutorial on their team Wordpress blog on how to create a forced perspective video.

> Hey guys! By the end of the day we will have an instructional video on how to film forced perspective. It will be uploaded here, on Twitter and on our site: http://theforcedperspectiveproject.wordpress.com/ Watch this space!!
>
> Here it is guys! We said we would. The instructional video is here if you guys want to know how its done. The more people who help us the better and it only takes 2 minutes to make and upload a video. Cheers! (Student Facebook post, 2014)

The final compilation video was hosted on YouTube and embedded in the team's Wordpress blog.

> 300 views on http://theforcedperspectiveproject.wordpress.com/Thank you to everyone who's had a peek and remember there's still time to upload your own vids! Thanks again from everyone on The Forced Perspective Project team and we hope to here from you all soon!! # TFPP # moco360 (Student Facebook post, 2014)

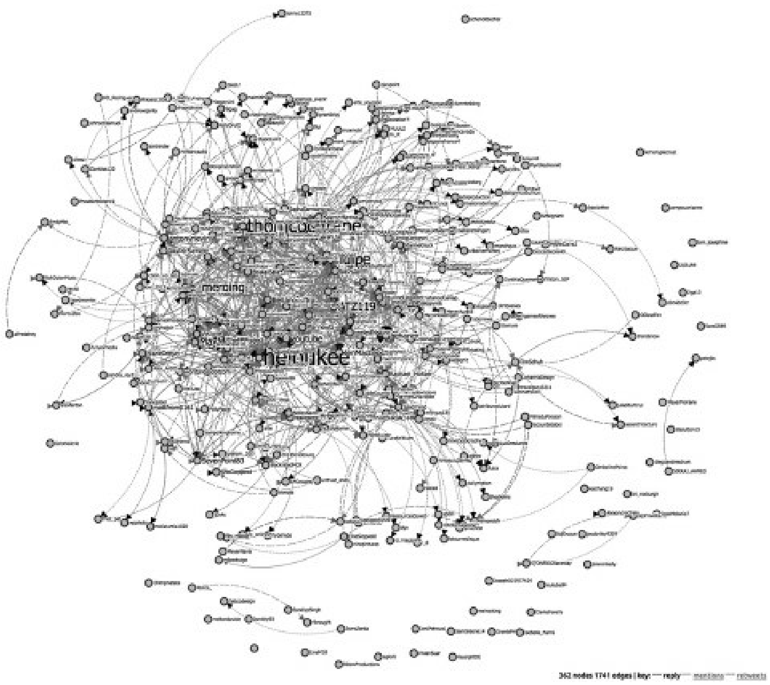

FIGURE 14.2 Twitter Activity as Represented by Tagsexplorer

The team of lecturers involved in the MoCo360 project were very pleased with the level of student engagement and creativity evidenced throughout the project. One measure of the project participation was the use of TAGSExplorer for the analysis of Twitter activity around the project #moco360 hashtag, graphically representing 362 #moco360 hashtag users with a total of 1,741 tweets throughout the project as shown in Figure 14.2. While the lecturers represent the most significant conversational nodes, TAGSExplorer also identified several students as core conversationalists and a host of peripheral participation by interested parties beyond the project participants, illustrating the global reach of this project via mobile social media.

In the MoCo360 project, the lecturers actively modeled the types of collaborative practice and critical mobile social media engagement that we expected of our students. The use of mobile social media as both evidence of student collaboration and eportfolio generation were formal assessment requirements of the project. We chose appropriate cross-platform tools as an ecology of resources for the project and worked with each institution's Information Technology service departments to ensure adequate WiFi connectivity on campus and mobile presentation systems (Cochrane, Munn, & Antonczak, 2013). The project has been critically informed and redesigned based upon peer-reviewed reflective publications (Cochrane & Antonczak, 2014; Cochrane, Antonczak, & Guinibert, 2014; Cochrane, Antonczak, Keegan, et al., 2014).

VI. Conclusion

In this chapter we have identified three universal principles for transformative mobile learning that represent a rethinking of instructional theory for the post-industrial age enabled via mobile learning. The three principles focus upon the unique affordances of mobile learning that enable new pedagogies and include: user-generated content, user-generated contexts, and designing authentic learning experiences. These principles have implications specifically for reconceptualizing the roles of teachers, students, and technology within teaching and learning environments defined by collaborative learning communities. These principles resonate with Reigeluth's (2012) post-industrial paradigm of instruction and are illustrated by an implementation case study. This approach leads to authentic learning environments that facilitate creative student graduate outcomes. We have also outlined a variety of situational learning principles for mobile learning illustrating the transferability of these principles across various learning contexts and scenarios. We argue that rather than replicating traditional learning and assessment activities or repurposing content for small screens, mobile learning provides the opportunities for a refocus upon learner-centered pedagogies. Therefore mobile learning provides a powerful platform for enabling new educational paradigms.

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Notes

* *Editors' note: The main focus here is on self-regulated learning (Chapter 9) rather than teacher-directed learning.*

** *Editors' note: This is especially consistent with aspects of universal principles regarding task-centered instruction, personalized instruction, and the changed roles of teachers, learners, and technology described in Chapter 1.*

*** *Editors' note: This new role for students is described in Principle 4, changed roles, in Chapter 1.*

† *Editors' note: This is a different role from the four roles described in Principle 4 of Chapter 1 and in all of Chapter 11, Designing Technology for the Learner-Centered Paradigm of Education.*

* *Editors' note: While not explicitly stated as a principle, this implies the use of task-centered instruction (which includes project-based instruction, problem-based instruction, inquiry-based instruction, maker-based instruction, and so forth. It also implies student design or at least selection of tasks based on learning goals and student-directed performance of those tasks (see Chapter 9 on self-regulated learning).*

** *Editors' note: Learning by doing is a form of task-centered instruction (Chapter 3) rather than content-centered instruction (using "instruction" in the broad sense of anything that is intended to foster learning.*

*** *Editors' note: This is an important part of self-regulated learning (see Chapter 9), but only one part.*

* *Editors' note: This is highly consistent with Principle 3, personalized instruction, described in Chapter 1, and all of Chapter 4, Principles for Personalized Instruction.*

** *Editors' note: The development of creativity is an issue for curriculum theory and is addressed by Chapter 5.*

* *Editors' note: For more on this, see Chapter 11, Designing Technology for the Learner-Centered Paradigm of Education.*

** *Editors' note: This is consistent with the learner-centered paradigm's use of task-centered instruction, which includes project-based instruction (see Chapter 1, Principle 2, and all of Chapter 3 for details).*

* *Editors' note: Collaboration is a key feature of the learner-centered paradigm of education, both as an outcome (collaboration skills) and a method (collaborative learning).*

* *Editors' note: The development of collaboration skills is highly valued in the learner-centered paradigm, and so is collaboration as a tool for learning.*

* *Editors' note: As discussed in Chapter 1, well-designed resources for instructional support are a critical component in the learner-centered paradigm.*

15

DESIGNING JUST-IN-TIME INSTRUCTION

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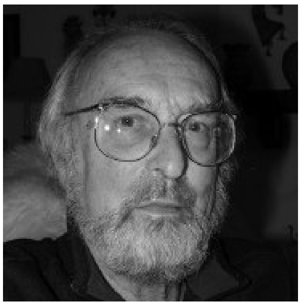

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EDITORS' FOREWORD

Preconditions (when to use the theory)

Content

- *All content, especially when conceptual understanding is important and conceptual misunderstandings are common.*

Learners

- *All levels of students who are capable of accessing and completing pre-class online activities; requires moderate independent learning skills.*

Learning environments

- *Classroom instruction, supplemented with online resources and activities*
- *Students must meet regularly in a face-to-face setting.*
- *Students must have access to technology for communicating outside of class via a learning management system.*

Instructional development constraints

- *Requires instructor ability to use a provided learning management system to present content and facilitate pre-class activity.*
- *Moderately more development time may be required to create pre-class content and activities, review student performance, and adjust in-class instruction.*

Values (opinions about what is important)

In this chapter, instructional values have not been explicitly addressed; however, based on a careful reading of the introduction and theoretical foundations sections, the following values are supported:

About ends (learning goals)

- *Metacognition: JiTT instructors collaborate with students to evaluate the class climate, the affective aspects of the student-teacher interaction, and the cognitive gains that the class is making in the subject area. Students are encouraged and supported to develop self-assessment skills.*

About priorities (criteria for successful instruction)

- *Active learning: Learning is more effective when learners are actively engaged in applying information and concepts.*

About means (instructional methods)

- *Assessment: Student understanding is assessed (and self-assessed) frequently and regularly; often before and during every lesson.*

About power (to make decisions about the previous three)

- *Learners influence the instructional content: JiTT relies on the use of student responses to pre-class activities to adjust lesson content to fit the specific understanding level of participating students.*

Universal Principles

General (associated with pre-class and in-class tasks)

1. The continual assessment principle

- *Instructors continually assess learners' understanding of key concepts through pre-class assignments and in-class activities.*

2. The assessment of thinking principle

- *Instructor assessment and feedback to students takes into account students' thinking and understanding processes, in addition to content acquisition.*

Associated with pre-class assignments

3. The sequencing principle

- *Learning tasks are sequenced from simple to complex.*

4. The fidelity principle

- *Learning tasks are based on real-life tasks.*

5. The variability principle

- *Versions of a learning task are sufficiently different from each other to allow for the construction of general, abstract schemata.*

6. The training-wheels principle

- *Whole learning tasks require the coordination of many different constituent skills.*

7. The completion strategy principle

- *Support is implied by the learning task description.*

Associated with in-class tasks

8. Develop an interactive lesson

- *In-class sessions should be highly interactive and integrate specific student responses to the pre-class activities.*

9. Use unique student responses to explicitly shape the lesson

- *Instructors should use student responses to modify the content and lesson flow.*
- *Modifications to the lesson should take into account the differences between learners.*

10. Use student-centered discussions to extend understanding further

- *Instructors should use student-proposed extensions to the questions posed in the pre-class activities as a basis for further class discussion, either in a whole group or in smaller groups.*

Situational Principles

Variations in JiTT methods due to discipline

- *Pre-class exercises reflect discipline-dependent thought processes. JiTT questions and activities address not only content, concepts, and ideas of the discipline but also the process of learning these (e.g., physics, economics, history). Therefore, JiTT methods should vary based on the ways that learning occurs (and is valued) in specific disciplines.*

Variations in JiTT methods due to pedagogy

- *The pedagogical strategy influences the specific nature of the JiTT methods (e.g., inquiry-based learning, problem-based learning, project-based learning, peer-led instruction, peer instruction). Therefore, JiTT methods should vary based on the overarching pedagogical strategy implemented in a class.*

Variations based on course, lesson, and activity characteristics

- *JiTT assignments can be fine-tuned by deconstructing the structure of the upcoming lesson and carefully considering the student audience and student abilities.*
- *Specific JiTT methods may be implemented at the course, lesson, and activity levels; specific methods vary based on the target level.*

Implementation Considerations

- *Flexible and adaptive: Prepare for a trial and error period while adapting existing JiTT materials and creating one's own.*
- *Student-learning-centered: Work to become sensitive to students' ideas, attitudes, and state of knowledge and constantly monitor the progress of their learning.*
- *Deep understanding of content: Knowledge about the content includes having a diverse repertory of conceptual pathways for the subject matter at hand to be able to appreciate and respond to students' ideas.*
- *Creative design: Use a variety of new approaches to develop learning tasks that support this kind of learning.*
- *Safe learning environment: Maintain a classroom climate where everybody is free and encouraged to participate and make mistakes.*

– C.M.R., B.J.B., & R.D.M.

DESIGNING JUST-IN-TIME INSTRUCTION

I. Introduction

What is JiTT?

Just-in-Time Teaching (JiTT) is an inductive pedagogy (Prince & Felder, 2007), blending active in-class learning with web-based preparatory work. Evidence of student understandings generated in the pre-class assignments is used to inform and shape the subsequent class content and activities. In a JiTT class, students complete a considerable amount of online work in preparation for an interactive, in-person session with an instructor. Students submit work on JiTT assignments electronically just before the live lesson, normally using a class website hosted by an institutional learning management system. The instructor scans the student responses and incorporates insight gleaned from them into the subsequent classroom experience (presentation content and interactive activities).

For example, Kathy Marrs teaches a large-enrollment introductory Biology class (Marrs & Novak, 2004). In preparation for the first introductory lesson on genetics, she posts a pre-class assignment on the course Web page and asks the students to submit responses electronically just before class time. One of the questions in the pre-class assignment goes like this:

> Allison is driving with her parents when they get in a serious car accident. In the emergency room her doctor tells Allison that her mother is fine, but her father, Bob, has lost a lot of blood and will need a blood transfusion. Allison volunteers to donate blood, and finds out that her blood type is AB. Bob is type O.

a. Can Allison donate blood to Bob? Why or why not?
b. Allison, who is a biology student, begins to wonder if she is adopted. What would you tell her and why?

These are typical pre-class "warm-up" questions, a key feature of JiTT pedagogy to prepare students for an interactive, engaging in-class lesson.

Note some of the interesting features of this kind of assignment. Each question:

- requires an answer that cannot easily just be looked up,
- encourages the student to examine his/her prior knowledge and experience,
- requires that the student formulate the response, including the underlying concepts, in his/her own words, and
- contains enough ambiguity to require the student to supply some additional information not explicitly given in the question. (This feature enriches the subsequent classroom discussion.)

Before going to class, Kathy retrieves the student responses from the class website. Most of the time, student responses fall into a well-defined set of categories. She selects representative examples, including the free-form comments. She then adjusts the prepared lesson flow in light of the students' responses to the warm-up. The fact that the wording actually comes from the class she is meeting makes the lesson fresh and interesting to the students. The specific lesson flow is pretty much predetermined, but the examples used in class will flow from the student responses and, most importantly, will be influenced by the feedback from students in the live class.

The pre-class responses and the subsequent in-class discussion always suggest questions for subsequent assignments, thus forming the JiTT feedback loop (see Figure 15.1).

JiTT incorporates concepts and practices of active learning, learner-centered instruction, and ongoing assessment. Students construct knowledge through gathering and synthesizing information and integrating it with the general skills of inquiry, communication, critical thinking, problem solving, and so on. Emphasis is on using and communicating knowledge effectively to address enduring and emerging issues and problems in real-life contexts. A major aspect of the instructor's role is to coach and facilitate, assessing learning and evaluating instruction in collaboration with students.

Why JiTT?

JiTT has its origins in classrooms where instructors were looking for more effective ways to engage a particular audience—non-traditional students. Eventually, it found its way into virtually all higher education environments, regardless of the audience demographics. The pedagogy evolved mostly through an iterative design approach (aka "trial and error"), although many JiTT practitioners were paying attention to the relevant education research literature. JiTT started in the physics community, which has a rich and much appreciated tradition of education research (Arons, 1996; Scott, Asoko, & Driver, 1991). Over the years, JiTT practitioners' attention shifted to broader questions, such as "Which aspects of the technique work well, which not so well, and why?"[*] To answer those questions, one has to examine the rich trove of knowledge about teaching and learning that has accumulated over the past half century.

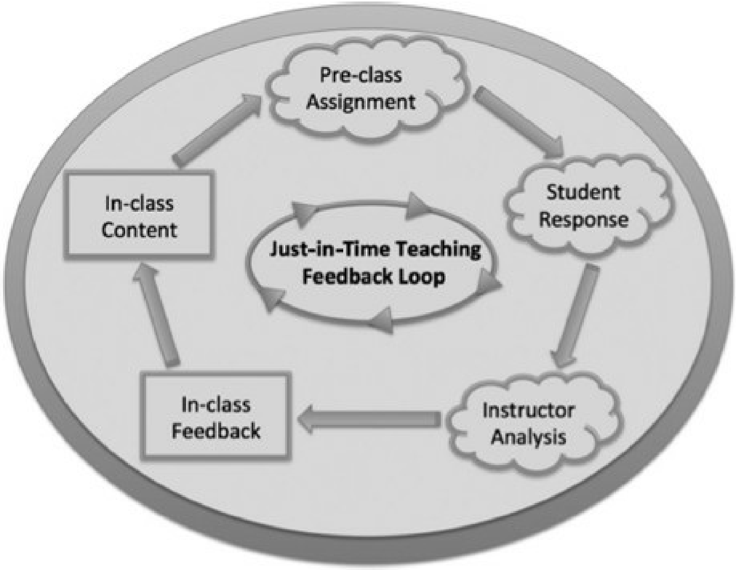

FIGURE 15.1 Just-in-Time Teaching Feedback Loop

To put JiTT into a broader teaching and learning perspective, consider two broad JiTT goals: 1) to encourage the students to construct and monitor their own learning experience,[**] and 2) to create a learning environment where students are actually motivated to do just that, both in the classroom and away from the classroom. JiTT assignments and classroom activities are designed to motivate the students to examine their present knowledge and get ready to modify it, add to it, and apply it. To take full advantage of the JiTT technique, the instructor must make use of a web-based course (or learning) management system, and the students must have access to the Internet via a web browser. In the 21st century, this technology is widely available in practically all education institutions. In many institutions, recent developments in mobile learning enable student and instructor access to the assignments via assorted mobile devices as well.[*]

There is little doubt that learner-centered instruction, facilitated by information technology, is here to stay in one form or another. The question commonly debated in the educational research community is: How does one optimize the many benefits of the new paradigm: easy access to course materials, improved student motivation and participation (Kulik & Kulik, 1991), differential instruction serving different learning styles, and so on? Resource availability and cost issues aside, and there are many, the intellectual challenge is to find the proper balance between technology tools and live human interactions. The pedagogical strategies must follow from evidence-based sciences of learning and instruction. The past several decades have seen the emergence of discipline-based education research, such as Physics Education Researchers (PER) in physics (McDermott, 2001), and a deeper understanding of the learning process through cognitive science research (Bransford, Brown, & Cocking, 2000).

For learning to be effective, the learning activities must be designed to work in harmony with the human cognitive system. Cognitive science (Anderson, 1990) can help optimize the delivery of information to the learner by determining what is critical, what is salient, and what is most directly valuable to the cognitive system (Dror, 2008). Cognitive science studies, combined with discipline-based pedagogical research, can help instructors tailor the pre-class assignments to the needs of the students he/she is currently working with. Classroom discussions, based on the students' on-line responses, inform the content of subsequent assignments, thus forming the JiTT feedback loop (see Figure 15.1).

JiTT: Proven in Practice

In the May 13, 2011, issue of *Science*, Louis Deslauriers and colleagues report the results of an interesting experiment conducted at the University of British Columbia (Deslauriers, Schelew, & Wieman, 2011). In the words of the authors:

> We compared the amounts of learning achieved using two different instructional approaches under controlled conditions. We measured the learning of a specific set of topics and objectives when taught by 3 hours of traditional lecture given by an experienced highly rated instructor and 3 hours of instruction given by a trained but inexperienced instructor using instruction based on research in cognitive psychology and physics education. The comparison was made between two large sections (N = 267 and N = 271) of an introductory undergraduate physics course. We found increased student attendance, higher engagement, and more than twice the learning in the section taught using research-based instruction . . .
>
> The instructional approach used in the experimental section included elements promoted by CWSEI (Carl Wieman Science Education Initiative, parentheses added) and its partner initiative at the University of Colorado: pre-class reading assignments, pre-class reading quizzes, in-class clicker questions with student-student discussion (CQ), small-group active learning tasks (GT), and targeted in-class instructor feedback (IF). Before each of the three 50-min classes, students were assigned a three- or four-page reading, and they completed a short true-false online quiz on the reading. (pp. 862–863)

The rather striking results of this experiment highlight two important trends that research into teaching and learning has spawned during the past three decades (Bransford, Brown, & Cocking, 2000; Bransford, Vye, Adams, & Perfetto, 1989). The first is the realization that replacing passive environments—even if presided over by charismatic, knowledgeable and engaging presenters—with active student-centered pedagogies leads to superior learning outcomes. The second trend, without which the first would be much less effective, is the growing use of technology, inside and outside the classroom. JiTT (Novak & Patterson, 1997; Simkins, 2009), an evolving instructional strategy and active learning pedagogy, incorporates both of these research-based trends. The key features of the Deslauriers experiment are: pre-class assignments; in-class clicker questions with student-student discussion; small-group active learning tasks; targeted, in-class instructor feedback; and supporting on-line material. Learning tasks are activities completed by students in class that target specific learning objectives and expand upon the concepts and skills introduced in the pre-class assignments, deepening understanding and extending learning through further topic exploration and application exercises.[1*] All of these parts were carefully aligned with one another, and all of them were informed by education research. The students were actively involved in carefully planned activities at all times. Technology that supports the experience of students both in and out of class was brought in as needed by the pedagogy involved.

An experiment similar to the one above, but more narrowly focused on JiTT, was recently conducted at North Georgia College & State University (Formica, Easley, & Spraker, 2010). This study found that students in courses that were taught using the JiTT strategy better understood Newton's third law after instruction than did students in traditional lecture courses. Formica et al. speculate that improvement in learning may have been due to the JiTT process: students reading their textbooks, thinking critically about the concepts, and then reflectively writing on the concepts—all before the concepts were discussed in class.

Next, several learning and instructional design theories are reviewed. These theories provide a conceptual foundation for JiTT design.

II. Theoretical Foundations

JiTT instructional design has been developed on the foundation laid by a variety of learning and instructional design theories, including active and learner-centered instruction, constructivism, neuroscience (e.g., brain-based learning), Gagné's nine events of instruction, and van Merriënboer's 4C-ID model.

Active and Learner-Centered Instruction

Over the past several decades the education research community has been emphasizing the benefits of "active learning." The National Teaching and Learning Forum defines active learning in the following way:

> To be actively involved, students must engage in such higher-order thinking tasks as analysis, synthesis, and evaluation. Within this context, it is proposed that strategies promoting active learning be defined as instructional activities involving students in doing things and thinking about what they are doing. (Bonwell & Eison, 1991)

The influential *How People Learn: Brain, Mind, Experience, and School* (Bransford et al., 2000) is more explicit. To benefit the learner most, instruction has to be learner-centered, assessment-centered and knowledge-centered.

Learner-centered teachers present students with "just manageable difficulties"—that is, challenging enough to maintain engagement, but not so difficult as to lead to discouragement.[2] They must, therefore, have an understanding of their students' knowledge, skill levels, and interests.

For instruction to be knowledge-centered, the content knowledge necessary for expertise in a discipline must be differentiated from the pedagogical content knowledge that underlies effective teaching. The latter includes information about typical difficulties that students encounter as they attempt to learn about a set of topics; typical paths students must traverse in order to achieve understanding; and sets of potential strategies for helping students overcome the difficulties that they encounter. Pedagogical content knowledge is not equivalent to knowledge of a content domain plus a generic set of teaching strategies; instead, effective teaching strategies differ across disciplines.[*] (JiTT applied to various disciplines is explained in the Situational Principles section of this chapter.)

Constructivism

Constructivism (Phillips & Soltis, 2003) requires that teachers understand the mental models students bring to the learning task and guide them in the construction of their knowledge. JiTT instructors construct the pre-class assignments and subsequent classroom activities in accord with the feedback they get as the students struggle to analyze and interpret the information in their responses to the pre-class assignments.

Piaget's theory of learning (2001) was developed primarily to understand how children learn. It proposes the idea that the developing child builds cognitive structures—mental maps, schemes, or networked concepts for understanding and responding to physical experiences within his or her environment. Piaget further attested that a child's cognitive structure increases in sophistication with development, moving from a few innate reflexes such as crying and sucking to highly complex mental activities. JiTT places substantial emphasis on the notion that the pre-class assignments must be appropriate for the specific cognitive developmental level of the students at the moment. This can vary from semester to semester, even in the same course,[**] and is particularly the case if the curriculum calls for a course sequence that spans varying developmental capabilities.

Neuroscience and Brain-Based Learning

Neuroscience holds that learning changes the physical structure of the brain, making possible increasingly more complex mental patterns (Caine & Caine, 1994). Several decades of research have shown us that the brain changes throughout our lifetime, as we use it constantly, and it changes even more as we focus our efforts on learning. We know that mental concentration and effort alter the physical structure of the brain in observable and measurable ways. Human memory develops as patterns of neuron firing emerge (through sensory experience and subsequent thinking) and are reused. The brain strengthens these patterns of connection, making each connection easier to create next time.

A curriculum that makes use of this fact would occasionally present to the students the "big picture," relating the subject-matter material to the real-world experience. In a JiTT classroom this can be accomplished by having the students examine relevant webpages (with real-world examples) and respond to appropriate question prompts and then making use of the responses in the subsequent classroom discussion.

Brain-based learning theory (Jensen, 2008) suggests that learning environments should be fully challenging, fully immersive, involving the student in active participation. JiTT assignments attempt to pique the students' interest by contextualizing the content. The classroom activities involve real-world scenarios. Much emphasis is on non-threatening formative assessment with students getting rewarded for monitoring their own learning.

The social cognition learning model (Schiering, Bogner, & Buli-Holmberg, 2011) suggests that cognitive development grows out of shared problem-solving experiences. The JiTT feedback loop accomplishes that with the in-class sharing of student responses and instructor input (see Figure 15.1).

Gagné's Nine Events of Instruction

The JiTT pre-class-in-class feedback loop creates a teaching-learning pattern reminiscent of the nine events of instruction, identified by Gagné (1985). Table 15.1 presents a comparison of Gagné's nine events of instruction and the JiTT feedback loop.

TABLE 15.1 Comparison Of Gagné'S Nine Events of Instruction and Jitt Feedback Loop

Gagne's Nine Events of Instruction	*JiTT Feedback Loop*
1. Gaining attention	Pre-class assignment
2. Informing the learner of the lesson objective	
3. Stimulating recall of prior learning	
4. Presenting the stimulus material with distinctive features	In-class content
5. Providing learning guidance	
6. Eliciting performance	Pre-class assignment
7. Providing informative feedback	In-class feedback
8. Assessing performance	
9. Enhancing retention and learning transfer	Next pre-class assignment

4C-ID Instruction

The instructional design that most completely implements the spirit of JiTT is the four-component instructional design model (4C/ID, van Merriënboer, Clark, & de Croock, 2002). The 4C/ID assumes that all human knowledge is stored in cognitive schemata. It also assumes a cognitive architecture that distinguishes the very limited-capacity working memory from effectively unlimited long-term memory. Learning processes are either related to the construction of schemata (new schemata and embellishments of existing schemata) or to the automation of schemata.

In a learning environment developed according to the 4C/ID model, students work on learning tasks and study supportive material that helps them construct and automate cognitive schemata. In schema construction, learners generalize and abstract knowledge by leaving out the details so that the schemata apply to a wider range of events or to less tangible events (induction), and they use what they already know about a topic to structure and understand the new information (elaboration). Schema automation has two components: knowledge compilation, where procedural information is embedded in automated schemata; and strengthening, the learning mechanism leading to a speedy performance of routine aspects of a complex task.

The 4C/ID model has four interrelated components: *learning tasks, supportive information, procedural information,* and *part-task practice*.

1. Learning tasks[*] consist of meaningful whole-task experiences that are based on real-life tasks; whole-task in the sense that the activity mimics a real-life task in its entirety, before it is broken down into parts to facilitate analysis and plan of attack. The sequence of learning tasks forms the backbone of the learning process. Each new task is more difficult than the preceding task.

2. Supportive information builds a bridge between what the learner already knows and what may be helpful to know to fruitfully work on the learning task. Some examples of supportive information are: task description (e.g., a fully worked-out-example), guidance (worksheets or guidelines leading the learner through the problem-solving process), and conventional tasks without guidance (which also serve as assessments).[**] Typically, supporting information addresses three questions: "What is this?" (domain models), "How is this organized?" (conceptual models), and "How does this work?" (structural, causal models).

3. Procedural information consists of algorithmic specification of how to perform routine aspects of a task. Procedural information may pertain to prerequisite information (i.e., what the learner must know to correctly accomplish the task) and corrective feedback (given on the quality of performance on routine aspects).

4. Part-task practice presents exercises for routine aspects of learning tasks.[*] Drill and practice on a vast set of practice items leads to a high level of automaticity.

The four components of the 4C/ID model have clear implications for the construction of JiTT pre-class exercises, the selection of suitable educational media and relevant principles, and the structure and content of the follow-up in-class activity. The JiTT pedagogical approach is based on a feedback loop between a sequence of pre-class tasks students perform on their own, just before the in-class lesson, the in-class follow-up conducted by a live instructor, informed by the student submissions of the pre-class work, all leading up to the next pre-class/in-class activity. The 4C/ID model provides useful design principles on which to base the lesson designs. These design principles are reflected in the JiTT design principles, which are explained next in the Universal Principles section of this chapter.

III. Universal Principles

There are two key stages to JiTT implementation in any given situation. They include 1) giving students a set of questions that probe for student understanding as a pre-class assignment and 2) using the anticipated student responses to guide the lesson flow in class. Design principles that apply to all JiTT implementations include those associated with pre-class assignments and those associated with adapting content, lesson flow, and instructional activities in the following class session.[3] In addition to implementation-specific principles, we think it is useful to begin with two general principles associated with the role of assessment in JiTT classrooms.

General Principles Associated with Assessment and Metacognition

1. The continual assessment principle

Instructors should continually assess learners' understanding of key concepts through pre-class assignments and in-class activities. In an effective teaching and learning environment, students and instructors constantly monitor the learning outcomes. Assessment-centered instruction leverages ongoing assessments designed to make students' thinking visible to both teachers and students. An important feature of assessments in JiTT classrooms is that they be learner-friendly: they are not the "Friday quiz" for which information is memorized the night before and for which the student is given a grade that ranks him or her with respect to classmates.[*] Assessment in JiTT connotes many ideas. JiTT assignments themselves are a form of assessment. Ideally, they provide a sightline into the progress the student-teacher team is making towards deeper student learning.

JiTT assessments should:

- provide students with opportunities to clarify, revise, and improve their thinking,
- help students see their own progress over the course of weeks or months, and
- help teachers identify learning and understanding problems that need to be remedied (problems that may not be visible without the assessments).

2. The assessment of thinking principle

Instructor assessment and feedback to students should take into account students' thinking and understanding processes, in addition to content acquisition. For successful application of the JiTT strategy, it is also necessary to evaluate the class climate, the affective aspects of the student-teacher interaction, and the cognitive gains that the class is making in the subject area. Bransford et al. (2000) put it this way:

> Opportunities for feedback should occur continuously, but not intrusively, as a part of instruction. Effective teachers continually attempt to learn about their students' thinking and understanding. They do a great deal of on-line monitoring of both group work and individual performances, and they attempt to assess students' abilities to link their current activities to other parts of the curriculum and their lives. The feedback they give to students can be formal or informal. Effective teachers also help students build skills of self-assessment. Students learn to assess their own work, as well as the work of their peers, in order to help everyone learn more effectively. (p. 140)

Principles Associated with Pre-Class Assignments (JiTT Learning Tasks[4])

The pre-class assignments that students complete are a critical component of every JiTT implementation. Effective pre-class assignments implement six important design principles: sequencing, fidelity, variability, individualization, "training wheels", and completion strategy.

3. The sequencing principle

JiTT learning tasks should be sequenced from simple to complex and from conceptual model (which components make up a system) to functional model (how the system works). Start with a pre-class assignment where the JiTT learning task can be solved on the basis of a simple domain model. Subsequent assignments should involve learning tasks where the supportive information pertains to increasingly more complex and elaborated domain models. The complete task would be complex, such as solving a complex physics problem or writing a historical essay analyzing original sources. Before a student can accomplish the complete, complex task (hopefully by the end of the course), he/she would practice on simpler whole tasks (JiTT learning tasks).

4. The fidelity principle

JiTT learning tasks should be based on real-life tasks. The emphasis on the real-world context is important. Effective JiTT practitioners relate even the simplest tasks, such as rephrasing a definition, to the real world. An important feature in the genesis of the JiTT approach in physics was the attempt to counter the common perception by many students that physics is esoteric and only remotely related to the student's everyday life. This occurs despite the fact that the student is immersed in a world full of complex technologies, which in many cases are only a small step away from basic physics. Similarly, in a discipline such as history JiTT practitioners must confront the perspective held by many students that history is comprised solely of irrelevant dates and names from the past.

Learning should start in a low-fidelity environment, which only represents those aspects of the real environment that are necessary to perform the task. There is a high level of psychological fidelity; the JiTT learning task is representative of a real-life task (or just a basic part of a real-life task in many cases) but there is minimal physical correspondence with the real-life environment. Later JiTT learning tasks in subsequent lessons (though typically within the same instructional unit) move to higher fidelity (i.e., closer to a real-world environment). The extent to which high-fidelity tasks can be assigned and assessed may be limited by the restraints and constraints of the broader instructional context, since not all high-fidelity (real-world) tasks are possible or practical for students.

5. The variability principle

Versions of a JiTT learning task should be sufficiently different from each other to allow for the construction of general, abstract schemata that make transfer of learning possible. Ideally, versions of a JiTT learning task differ on all dimensions that also vary in the real world. Each set of JiTT learning tasks addressing a particular learning outcome (or set of learning outcomes) should exhibit high variability and high contextual interference.[5] JiTT learning tasks vary from one or two paragraph responses or a multiple-choice selection to a complete lab report in physics, a document analysis in history (Pace & Middendorf, 2009), or an artwork critique in photography (Cookman, 2009). In mathematics and most science courses, such as physics, theoretical concepts and principles are discussed in abstract. Beginning students find this difficult because the connection to the real world, the application, is missing. JiTT assignments attempt to remedy this by providing a familiar context.[6] Further explanation of the variability principle due to discipline variations is explained in the Situational Principles section of this chapter.

6. The training-wheels principle

Whole learning tasks require the coordination of many different constituent skills. For example, in a physics course students may be required to apply concepts and skills from a variety of disciplines.[*] To discuss the results of an experiment, the student must draw on his/her understanding and abilities in mathematics, physics, data analysis, and writing. These are different skills that may or not already be mastered by a particular student. The instructor must pay attention to all of these to structure JiTT learning tasks that allow the student to work on individual deficiencies.[**] In a traditional instructional setting it is not practical to consistently accomplish this with individual students, but it is possible and not unusual to prepare a set of versions of a JiTT learning task that focuses on one or more of these skills and offer these to students who have demonstrated deficiencies.

Learners should be provided process-oriented worked examples and process worksheets that ask leading questions.[***] It is customary in the traditional lecture-based environment to focus on the content, physics theory, literary text analysis, or mathematical techniques, and more or less neglect the "how do I study all this" aspect. With the advent of interactive engagement techniques, JiTT included, we now have the means to model to the students how they should approach learning. The training-wheels approach explicitly guides the student through the learning process, pointing out the steps taken, explaining the motivation behind these steps, and asking the student metacognitive questions that, we hope, will lead to the learning schema becoming automatic.[*]

7. The completion strategy principle

Support is implied by the JiTT learning task description. Learners should start with worked examples, continue with completion tasks, and finish with conventional tasks for which they must generate complete solutions.[7] Worked examples (Chi & Bassok, 1989) pedagogy, a recent extension of JiTT (Simkins & Maier, 2009), attempts to teach procedural skills (process) in tandem with conceptual content. Before being presented with a formal theory, students analyze an application of the theory, presented as an example of an expert's solution of a real-world problem. Students are prompted to explain to themselves the steps taken by the expert. This self-explanation metacognitive approach has a long research history and boasts many success stories. Over the course of an entire term, the prompts are gradually withdrawn and students are expected to generate their own explanations. As Chi has shown, the best students do this on their own. Weaker students need the "training wheels" prompts until they catch on to the process.

Universal principles associated with pre-class activities may be summed up as: Design a set of questions that probe for student understanding, or misunderstanding, of the concepts, and ask students to connect new concepts to previous knowledge.

A good JiTT question:

- yields a rich set of student responses for classroom discussion,
- requires an answer that cannot easily just be looked up,
- encourages the student to examine his/her prior knowledge and experience,
- requires that the student formulate an original response, including explaining the underlying concepts in his/her own words,
- contains enough ambiguity to require the student to supply some additional information not explicitly given in the question. (This feature enriches the subsequent classroom discussion.)

Principles Associated with In-Class Activities

Just as important to the JiTT approach as the carefully chosen pre-class activities is the instructor's use of the student responses to the activities to prepare for the following class session and to develop an interactive lesson that relies on the student responses to shape the content and the lesson flow. We've identified three principles that should be part of the in-class element of every JiTT implementation.

8. Develop an interactive lesson

Design an interactive lesson that incorporates student feedback (responses to pre-class activities) to engage students in learning class content. It is important that the in-class session be highly interactive with as much student participation as possible. Even though some of the specifics of the lesson content and flow will be shaped by specific student responses (see the next principle), an instructor should prepare the interactive framework ahead of class. A critical change for many instructors new to JiTT is that student responses must constitute an integral part of the lesson, not merely provide an add-on to predetermined (and often repeated) lesson content and flow. This may be especially challenging to instructors used to teaching in traditional lecture (telling) mode.

To help shape the interactive lesson with student responses, begin by anticipating the mental processes in students' minds and the responses they are likely to come up with. This may be a bit of a challenge unless you are used to running highly interactive classes. Anticipating student reactions gets easier with practice, particularly after several iterations of a JiTT-based course. It is a rewarding exercise, paying dividends as the lessons become richer, more learner-centered and better received by the students. As Scott Simkins remarked about adopting JiTT pedagogy: " . . . we think that the most profound effect comes in changing the way the instructors think about their own teaching, and more important, the learning of their students" (Simkins & Maier, 2009, p. 135).

Use the anticipated responses as a guide to develop the initial outline of the content and lesson flow. Once student responses have been gathered (often a day or less prior to the next in-class session), revise the lesson flow based on actual student responses. These responses are an important form of feedback to the instructor about what students understand and misunderstand about the content and skills being targeted.

Specific recommendations for using common phrases and approaches to incorporating student responses to shape the lesson flow are listed in Table 15.2, thanks to Andy Gavrin of IUPUI (A. Gavrin, personal communication, PKAL workshop, June 2004).

9. Use unique student responses to explicitly shape the lesson

TABLE 15.2 Shaping Lesson Flow with Student Responses

Category	*Sample Approaches for Interactive Lesson*
General guidelines for sharing student responses	• Always show some good answers, not just weak ones • Always be positive, never be critical
Common formats for specific comments about student responses	• "This makes sense, but it is missing something. . . . " • "This is all true, but what if something else occurs simultaneously. . . . " • "This is correct, but for the reason isn't quite right. . . . " • "This is a great response. . . . "
Useful phrases when sharing examples of student misunderstanding	• "This has a great beginning, but there is more that could be added. . . . " • "This is a great answer, but to a different question. . . . " • "This is the right idea, but I think the person meant something slightly different here. . . . "
Extension: Use the student responses to extend discussion further; an instructor might ask the students in class	• to extend or respond to one another's responses • "What part of this is completely correct." • "Under what circumstances would these be correct?" • "What word or two could be changed to fix this completely?" • "What is particularly good about this response?"
Expansion: Use the student responses to expand the discussion conceptually; an instructor might ask the students in class:	• to expand the scope of the question • "Is this true for other cases? Which?" • "When is this statement false? What happens then?" • "Is this similar to something we have done before? What?"
Comparison: In many cases, an instructor can ask students to compare similar or contrasting responses to engage students in thinking more deeply about a concept.	• When student responses include two very different answers, not obviously exclusive: Ask if they are exclusive. • When student responses include two obviously exclusive answers: Ask for a vote on which is correct.

For each JiTT learning task, performance should be analyzed in order to give cognitive feedback to the learner in the subsequent in-class session. In a sense this is formative assessment, but not of learning. It is an attempt to gauge the student's mental status to adjust the complexity of the assignment to fit the learner, or rather a group of learners. To adjust for each individual student is obviously an impossible task.[8] JiTT, however, can approximate some of the features of one-to-one individualization. For starters, data from JiTT assignments are coming in at a regular pace and, if the assignments are properly designed, are exploring areas where students have problems. Unlike a traditional lecturer, a JiTT instructor has a sightline into the status of the class and is thereby encouraged to act on these data. The JiTT communication channel also enables the instructor to adjust (individualize) the lesson content and style and to provide ancillary material to remediate and enrich. In a typical JiTT environment the adjustments occur at several levels.

- The target of the individualized adjustment can be the entire class, a group of students in the class, all the way down to single individuals.
- Based on the JiTT feedback, the instructor can change the pace of a lesson, insert a clarifying lesson,

provide extra instruction online or as handouts or extra readings, and suggest or mandate additional practice exercises.

- If specific groups of students display lack of understanding, lack of background skills, or lack of motivation, the instructor can suggest, or require, that the group complete additional targeted assignments. These may be prepared in advance or generated in response to a previously unknown issue. Even more flexibility is available if practice sessions are supervised by teaching assistants. Breakout sessions can deal with specific difficulties, with students assigned to these as needed.

From the JiTT assignments the instructor and/or the TA can follow the progress of each individual student. Any particular student may be having problems with some of the material or may exhibit exceptional talent and interest. There are many ways such students can be given extra attention, ranging from extra instruction online or with handouts, to suggestions to join a group of students with similar problems/interests, to an invitation to an office hour visit.[9]

During the lesson, it is important to repeatedly connect the purpose of pre-class activities with the content presented in the class session. In the JiTT classroom, each in-class session is unique to the extent it is shaped by student responses from that specific class. Using direct student responses (often word for word) makes the lesson fresh and more interesting to students. Throughout a class and over the course of a term, it is important to reiterate the important role each student plays in shaping the lesson content and flow through their feedback to the instructor (in their responses to the pre-class activities). Using direct quotes from student responses on multiple occasions and for many discussion purposes is an effective technique to provide evidence that their responses do, in fact, shape the lesson.

Many instructors keep track of their own use of each student's responses, so that throughout a given course each student "sees" their own response being used with the entire class at least once. Though challenging with a very large class, this is an important method to use to more meaningfully connect each student to their learning experience.

10. Use student-centered discussions to extend understanding further

Interaction techniques which engage students in interactive discussions with the entire class, small groups of peers, or even in pairs are especially effective in a JiTT classroom, since all students have already started to think about the lesson content beyond simply reading ahead of time. JiTT pre-class activities prepare students for discussions and activities that build on their prior understandings and allow them to benefit from their preparation efforts by already answering questions targeting key learning objectives.

Where possible, instructors should use student-proposed extensions to the questions posed in the pre-class activities as a basis for further class discussion, either in a whole group or in smaller groups. These extensions are often meaningful to students as they are drawn from their own experience or the experiences of their immediate peers. Extensions may be forward-looking (how will this connect to upcoming topics) or backward-looking (how does this connect to what we've already learned), or even sideways-looking if students become interested in tangentially-related topics. Though these discussions should be student-centered and -directed as much as possible, the instructor remains an important player to facilitate and guide the process and to draw students back to core learning objectives as needed. Table 15.3 provides a summary of the Universal Principles.

IV. Situational Principles

In this section we briefly discuss the discipline- and educational-level-dependent aspects of JiTT, described here as situational principles. JiTT is a fairly loose technique that allows for variations in different instructional environments. The most basic structure calls for timely pre-instruction assignments that inform the upcoming lesson and encourage the students to examine their prior knowledge and to get informed about the upcoming topic before coming to class. There is much flexibility as long as two crucial criteria are met. The assignments must be thoughtfully constructed, and they must constitute an integral part of the lesson. Design aspects that vary the most among JiTT implementations are variations in discipline, pedagogy (apart from discipline), and aligning JiTT methods to other course, lesson, and activity characteristics.

Variations in Discipline: Pre-Class Exercises Reflect Discipline-Dependent Thought Processes

The applicability of JiTT teaching strategies, originally developed for the STEM disciplines, is not immediately obvious in other disciplines. David Pace (in Simkins & Maier, 2009) quotes a participant in one of his JiTT workshops: "If only, I told myself, there were 'answers' in the humanities—if only the kinds of discrete and specific solutions that exist in physics were part of disciplines like history—the JiTT 'warm-up' exercises would solve so many problems" (Pace & Middendorf, 2009, p. 153).

TABLE 15.3 Summary of Universal Principles

Phase of JiTT	*Universal Principle*
Both Pre-Class and In-Class Activity	1. Instructors continually assess learners understanding of key concepts through pre-class assignments and in-class activities. 2. Instructor assessment and feedback to students takes into account students' thinking and understanding processes, in addition to content acquisition.
Pre-Class Activity Students begin to develop deeper understanding as the respond to pre-class activities and tasks.	3. The sequencing principle. 4. The fidelity principle. 5. The variability principle. 6. The training-wheels principle. 7. The completion strategy principle.
In-Class Activity Student responses to pre-class activities are used to shape interactive, student-centered lessons.	8. Develop an interactive lesson. 9. Use unique student responses to explicitly shape the lesson. 10. Use student-centered discussions to extend understanding further.

This quote reveals in equal amounts a somewhat superficial understanding of the teaching of science and the real and important difference between teaching and learning in the two cultures. Teaching and learning in the sciences involves both the internalization of the concepts and principles as well as the process of scientific thinking and reasoning. In most introductory science courses the emphasis is on the former, largely because it is easier. Many active learning pedagogies, JiTT included, are paying attention to the latter where the challenges they face overlap with the difficulties that the above quote alludes to. It turns out that the thought processes in scholarly work are discipline dependent (Donald, 2002) and pre-class exercises ought to reflect that. The following paragraphs explain how JiTT is implemented differently in several common disciplines other than science.[10]

Economics (Simkins & Maier, 2009)

JiTT questions and activities address not only content, concepts, and ideas of the discipline, but also the process of learning these. For example, economics course content may not be what the student expects. The pre-class exercises, by providing the everyday context of the upcoming content, help mitigate the clash between expectation and the actual content of the lesson.

As in the sciences, the terms used in economics are borrowed from everyday language but are given specific technical meanings. Students are less likely to be misled if they are prepared for this before the lesson. Everyday experiences may or may not be relevant, and immediate application is not always possible. For example, economic modeling may involve initial assumptions that may make it difficult to apply the concept to personal experience. The JiTT exercises can help students understand when it is appropriate to apply economic concepts to personal experiences.

Diagrammatic techniques used in economics require repeated practice in varying contexts. For example, a supply and demand diagram looks deceptively simple but contains sophisticated assumptions about the dynamics of the market. JiTT exercises can identify novice-level thinking patterns and allow students to practice their way towards expert-like thinking. JiTT exercises in an economics course do not ask students to demonstrate the final learning outcomes; rather they reveal skills, observations, and reflections that are steps leading up to these ultimate goals.

History (Pace & Middendorf, 2009)

In addition to factual information, students in a humanities course, such as history, are presented with conflicting interpretations of ambiguous phenomena. Students must learn how to marshal evidence to support sophisticated interpretations of complex phenomena, rather than memorize lists of facts about the past. Thus, more than anything else, the JiTT exercises in a history class have to be designed to focus on the process by which a student reaches an answer, rather than an answer itself. Before JiTT can be applied in the humanities, instructors have to break apart the reasoning processes that dominate their discipline and define the specific operations that students must master.

As an example, David Pace lists the critical distinction between the concept of "fact" and the concept of "evidence" as used in historical arguments. Evidence is always relative to a particular argument, whereas facts are independent statements of truth. Evidence is critical to "thinking like a historian." He uses JiTT exercises throughout the semester to model the process and to give students multiple opportunities to practice, make mistakes, and get feedback. Following is an example of Pace's JiTT exercise.

Imagine that you are preparing to write an essay on the ways that Christians in various ages reinterpreted the Book of Revelation and other biblical prophesies of the end of the world in terms of the issues of their own time.

1. Find a short passage in the excerpts from Klaassen's *Living at the End of the Ages* that might be useful as evidence.
2. Briefly explain how this passage might be used in the essay.
3. Find a short passage of apocalyptic writing on the web that might be useful as evidence.
4. Briefly explain how this passage might be used in your essay.

The student responses to this assignment revealed a learning gap. Most students were good at selecting the passages but did not make a good case for how this evidence might be used. The instructor addressed this issue in the upcoming class and in subsequent JiTT exercises, each time with a different historical context and increased sophistication.

Another "evidence"-related assignment goes as follows:

1. Summarize the argument in this particular primary source,
2. Identify one assumption made by the author,
3. Quote a specific passage in which the assumption was present, and
4. Explain what about this passage convinced you that it was good evidence for the particular assumption.

Thus the students get an opportunity to practice the development of historical arguments in a low-stakes environment where they are allowed to make creative mistakes.

History of Photography (Cookman, 2009)

Our final discipline-variant example of JiTT comes from a History of Photography course. Prof. Claude Cookman's audience consists of fine arts students for whom the course is required and journalism students for whom the course is a research elective. This is an interesting mix of students, which gives

Prof. Cookman an opportunity to expand the course content into a serious venture into critical thinking, which he defines, in part, as practicing a variety of mental operations that are crucial to study visual art and practicing art history, including observing, describing, comparing and contrasting, summarizing, classifying, analyzing, synthesizing, interpreting, sourcing, periodizing, contextualizing, and formulating and testing a thesis.

Instead of calling the pre-class JiTT exercises warm-ups, he calls them "Thinking about the Readings," or TARs for short. More than in any other course I am aware of, these exercises are a crucial component of the course; crucial in the sense that without them the course would be very different. All the features of JiTT are in play here: the immediacy of the assignment, the free-form response with a metacognitive component, the tight integration of the responses with the live lesson, and the sequence of feedback loops with ever increasing sophistication. The underlying structure of the TARs is Bloom's taxonomy. The early questions emphasize comprehension while later in the semester the emphasis shifts to analysis and creativity.

As an example, consider a TAR involving the famous photograph from the Spanish Civil War entitled "Falling Soldier" (Metropolitan Museum of Art, n.d.). It depicts a loyalist soldier as he is struck by a bullet. Since 1936 a debate has been raging in the journalism circle whether the photo was staged or not. The TAR directs students to two short readings, taking opposite sides of the debate and then asks them a series of questions:

1. Summarize in your own words the argument that the photo was staged, then summarize in your own words the argument that the photo is authentic.
2. Which argument do you find more convincing? Why?
3. In your opinion, does it matter whether or not this photograph was staged? Why or why not? This is chance to explore and articulate your ideas about the truth value of photography.

This assignment goes beyond the course topic. It touches on the intellectual and ethical development of the students and teaches them to recognize competing arguments and to make a reasoned commitment to a position. Without the immediacy of the JiTT assignment, while the thinking is still fresh in the student's mind and the instructor gets the response as he/she is preparing the lesson, this feature would be very difficult to implement.

Variations in Pedagogy: Pre-Class Exercises Support the Overall Pedagogical Approach

JiTT has been successfully incorporated with many pedagogical approaches, including inquiry-based learning, problem-based learning, project-based learning, peer-led instruction, and peer instruction, among others.

Inquiry-based learning (Olson & Loucks-Horsley, 2000)

In an inquiry-based learning context, students are presented with a challenge – a question, an observation, a data set, or a hypothesis to be tested. They accomplish learning goals by responding to the challenge. JiTT gives students ample time, before the lesson, to ponder the challenge, adding value to the experience.

Problem-based learning (PBL) (Barell, 2007)

In problem-based learning, students work in teams, to solve an ill-structured open-ended real-world problem. They formulate and evaluate alternative solutions, select the best one and make a case for it. Instructor acts as a guide. JiTT chatting can provide out-of-class preparation and practice.

Project-based learning (Bender, 2012)

In project-based learning, students work together on an assignment to produce a product: a process or product design, a computer code, or a simulation. The outcome is a report. JiTT exercises remove the classroom walls and generate an environment that simulates the real world work experience.

Peer-led instruction (pioneered at Dickenson College as Workshop Physics) (Laws, 2004)

In peer-led instruction, students work in small groups on very structured assignments. The groups are led by specially trained undergraduates from previous semester classes. Adding JiTT assignments extends the workspace and time.

Peer instruction (pioneered at Harvard by Eric Mazur) (Mazur, 1997; Watkins & Mazur, 2009)

In peer instruction, students vote on answers to a question, discuss in small groups, and re-vote. This can get very sophisticated with clicker software and clever pre-class and in-class questions.

Variations in Course, Lesson, and Activity Characteristics

JiTT assignments can be fine tuned by deconstructing the structure of the upcoming lesson and carefully considering the student audience and student abilities. When designing an upcoming JiTT lesson, it helps to ask (and answer) the following four types of questions. Answers to these questions will help the instructor design effective pre-class JiTT tasks and activities to better fit the instructional context.

Course level. What is the course level? Is this an undergraduate or a graduate course? Is it a survey course or an introductory course? Is it part of a sequence? JiTT tasks designed for an introductory undergraduate course will be less complex (and may be shorter) than those used for an advanced undergraduate or graduate course.

Lesson type. What type of lesson is being prepared? Is the lesson introducing a new topic or is it a continuation? Will the lesson present and explore conceptual issues, or will it develop and practice procedural skills? Does the lesson involve laboratory or field work? Does proper preparation for the lesson require a comprehensive review? JiTT tasks designed to introduce a new topic will be less complex (and may be shorter) than those used to extend student understanding that has already been established in previous class sessions. JiTT tasks should fit the type of learning desired, such as conceptual tasks for concept learning and procedural tasks for skill learning.

Lesson component. What are the lesson parts? Is it a single concept or a multiple concept lesson? Will there be demos that might benefit from advance preparation? Similarly, ask and answer these questions for any hands-on activities. How are the lesson parts to be sequenced? Incorporating student responses into a seamless lesson flow requires preparing a pacing blueprint to avoid choppiness and lack of cohesion.

Lesson prerequisites. Does the lesson introduce new concepts (words, definitions, examples)? Does the lesson require prerequisite skills? Does the mathematical part of the lesson call for advanced preparation or review? When a lesson requires prerequisite skills or conceptual understanding, the JiTT tasks should focus on developing and evaluating specified prerequisite understandings.

V. Implementing JiTT

We have identified several important implementation considerations to help an instructor get started with JiTT more effectively. To make the JiTT aspect of the course meaningful, useful and effective in supporting student learning, designers and instructors should:

1. Let the students know that JiTT will be used, why it will be used, and how it works.
2. Use JiTT regularly.
3. Include JiTT assignments in the overall learning assessment contributing to the student's final grade.
4. Include class climate questions in JiTT assignments.
5. Write questions with the learning sciences in mind.
6. When reviewing student responses, look for patterns that reveal common [mis]understandings.
7. Link student responses to subsequent in-class activity.
8. Reuse JITT questions on exams, and use selected student responses as distractors in multiple-choice exams.
9. Keep JiTT assignments short and manageable.
10. As part of the JiTT question set, ask students how they reached their answers.
11. Ensure that student responses easy to submit, manage, and review.
12. Grade primarily for student effort, and make it clear to students what a quality response looks like.
13. Provide personal feedback to students as much as possible.

Implementing JiTT differs substantially from delivering a set of lectures. Instructors transitioning to JiTT from a traditional lecture format will benefit from a shift in teaching perspective as well. Several high level perspectives that will help instructors implement JiTT successfully include:

- Flexible and adaptive: Prepare for a trial and error period while adapting existing JiTT materials and creating one's own.
- Student-learning-centered: Work to become sensitive to students' ideas, attitudes, and state of knowledge and constantly monitor the progress of their learning.
- Deep understanding of content: Knowledge about the content includes having a diverse repertory of conceptual pathways for the subject matter at hand to be able to appreciate and respond to students' ideas.
- Creative design: Use a variety of new approaches to develop learning tasks that support this kind of learning.
- Safe learning environment: Maintain a classroom climate where everybody is free and encouraged to participate and make mistakes.

An Illustrative Case

When Kathy Marrs at IUPUI prepares her lesson on cloning, she sends her students to the course website and invites them to ponder three warm-up questions. After some thought, students post their answers on the course site from where Kathy retrieves them just before class. She carefully weaves the student responses into her subsequent lesson.

Here is a sampling of questions used in Kathy's class:

> QUESTION 1: Dolly the sheep is a genetic twin, or clone, of a sheep that was born 6 years earlier than Dolly. Read the material for today. Does Dolly have parents? If so, who were her genetic parents? Is Dolly a "virgin birth"?
>
> QUESTION 2: What is wrong with the thinking that if we were ever to clone a person, like Einstein, a brilliant physicist, we would end up with another brilliant physicist?
>
> QUESTION 3: Can you think of a way that a person's genetic information might be used to discriminate against them for employment or insurance coverage? Give an example. How might employers or insurance companies obtain this knowledge?

Here is a sampling of student responses. These are actual, unedited, student responses.

Q1_A1: That's a hard question. She was cloned from the cell of a 6 year old sheep. Dolly doesn't have what we would commonly think of as parents, but genetically her parents would be the same parents of the six year old sheep. So her parents would be the parents of the sheep she was cloned after.

Q2_A1: We can't assume that a clone of Einstein would turn out just as brilliant and come up with as many, if not more brilliant theories because who and what a person is depends on the environment in which they live as well as the people they are surrounded with, influences in their lives as well as their genetics. Although it would be possible to recreate the genetic Einstein it would be impossible to recreate his entire childhood and all the influences in his life.

Q3_A1: I would say that if they knew they were carrying a genetic disease or had a genetic disease the insurance companies could hold something against them on coverage. They could obtain this information, possibly by having a physical done and having a blood test during the physical. Which I think would be illegal unless they were telling you what they were doing.

In the following class session, Kathy presents a subset of the student responses to the class. To make the lesson as interactive as possible, students are asked to comment on the responses presented and on the follow-up extensions suggested by Kathy or by students in the class. Some of the thoughts that emerge during the class activities become the grist for subsequent warm-up assignments. This is the important feedback loop feature of the JiTT instructional design. The fundamental result is that students and the instructor collectively guide the construction of new student knowledge.

VI. Closing Remarks

JiTT assignments differ from discipline to discipline (Simkins & Maier, 2009) but they share the common feedback loop features described above (and shown in Figure 15.1.). As such, the JiTT instructional design promotes the three factors identified by Alexander Astin as the most important for success in college: time on task, student-instructor interaction, and student-student interaction (Astin, 1997). In trying to assess the efficacy of any pedagogical strategy it is important to appreciate that the choice and implementation of a particular teaching method will impact student and faculty attitudes and motivation as well as learning outcomes.

Teachers using JiTT report a large spectrum of results, ranging from significant affective and cognitive gains to very negative student reactions, disillusionment and even regression in learning gains. We have much anecdotal evidence that in the best of cases, after adopting student-centered teaching approaches such as JiTT, many faculty change their teaching philosophies, sometimes in significant ways. The editors of the *JiTT Across the Disciplines* book comment that " . . . the most profound effect comes in changing the way the instructors think about their own teaching, and more important, the learning of their students." (Simkins & Maier, 2009, p. 135) Faculty members who once viewed their role as being "conveyors of knowledge" shift to becoming "facilitators of student learning." This developmental shift increases the efficacy of their subsequent teaching, and ultimately increases the levels of "deep learning" experienced by their students.

It has become clear, however, that successful implementation of the JiTT strategy depends critically on total buy-in on the part of the students as well as on the part of the faculty. If the on-line assignments are seen as an add-on to the course, to be completed perfunctorily in the shortest time possible, and then discussed briefly at the beginning of class, before the "real" lecture, the results will be disappointing. Students will resent the extra work and, in comparison with passive teaching and learning, no gains will be reported.

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Notes

* *Editors' note: These are the classic questions for Formative Research, described in Chapter 26 in Volume II and Chapter 17 in Volume III.*

** *Editor's note: Principles for achieving this goal are discussed in more detail in Chapter 9 on self-regulated learning.*

* *Editors' note: Principles for designing instruction for mobile learning are discussed in Chapter 14.*

1 JiTT learning task examples from physics include: paraphrasing a definition or a principle, describing the outcome of an experiment, applying a physics principle to solve a specific problem, explaining a problem solution strategy to a peer or a group of peers, selecting a choice from a multiple choice question, and conducting a hands-on experiment. The range of choices is vast, the only requirements being that the task has a well-defined learning target and is performed by the student. Typically, as in the Deslauriers experiment, there is an immediate feedback from a live instructor or, less effectively, software-generated feedback.

* *Editors' note: The term, "task," as used here, has a somewhat different meaning from that used elsewhere in this volume, including Principle 2 in Chapter 1 and all of Chapter 3, Principles for Task-Centered Instruction. Here, instead of being "whole, complex, ill-defined, and real-world," the term includes fairly small and well-defined tasks.*

2 The reader may recognize the similarity between the concept of "just manageable difficulties" with the "zone of proximal development" concept proposed by Vygotsky (1978).

* *Editors' note: Actually, there are many effective instructional strategies that are useful across disciplines, but there are also some that are particular to a given discipline. The more precise a strategy, the more local and particular to a discipline it is likely to be, as described in Chapter 1 of Volume III, pp. 21–22.*

** *Editors' note: JiTT can be even more powerful when such aspects of the Industrial-Age paradigm as courses and semesters are replaced with tasks and freed from the shackles of time, as described in Chapter 1.*

* *Editors' note: This meaning is consistent with the use of "tasks" elsewhere in this volume (see Principle 3 in Chapter 1, and all of Chapter 3, Principles for Task-Centered Instruction.*

** *Editors' note: For more about supportive information, see Principle 2 in Chapter 1, Principles 3 and 4 in Chapter 3, Principle 3 in Chapter 4.*

* *Editors' note: Part-task practice may also be helpful for non-routine parts of a task – that is, for learning heuristic as well as procedural elements of a task – as described in Volume II, Chapter 18, The Elaboration Theory.*

3 We labeled the pedagogy JiTT because the student responses reach the instructor very close to the beginning of the live lesson, just in time to be fresh to the instructor and to the student.

* *Editors' note: This advocates the change in paradigm of student assessment from norm-referenced to criterion-referenced, as described in Chapter 1's Principle 1: attainment-based learner assessment.*

4 JiTT learning tasks are defined as the pre-class assignments described throughout this chapter.

5 A JiTT learning task with high contextual interference (Shea, 1990) varies the contextual factors among versions of the task so that not all versions are alike. The contextual differences require the learner to learn more deeply and apply additional problem solving skills such as context interpretation and task planning.

6 Judging from student comments, this is one of the most appreciated features of JiTT.

* *Editors' note: Such customization is a key aspect of the learner-centered paradigm, as described in Chapter 4, Principles for Personalized Instruction.*

** *Editors' note: As mentioned in Chapter 1, authentic tasks are typically interdisciplinary.*

*** *Editors' note: These are examples of scaffolding that involve adjusting the complexity of the task and providing coaching as needed by the learner (see Chapter 1).*

* *Editors' note: This is more teacher-directed learning and less self-regulated learning (see Chapter 9) than characterizes a full implementation of the learner-centered paradigm.*

7 Completion tasks are generally short (a few minutes). Conventional tasks may take more time, up to several hours for complex tasks.

8 Individualization in this context is what a good tutor would do with one or a group of tutees. In such a one-on-one environment the lesson is in flux, completely determined by the tutor's constant monitoring of the tutee status. This is obviously impossible in large class settings.

9 Obviously all this requires extra effort in monitoring the level of JiTT "traffic" and developing ancillary resources. The payoff is improved classroom climate as the instruction starts to move towards the tutor-tutee mode.

10 Since JiTT was developed primarily by faculty in physics and other science disciplines, most of the examples in earlier works explaining and evaluating JiTT as an instructional approach address the science classroom. This section focuses on design variations applicable to other academic disciplines.

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