

An Historical Perspective on Instructional Design: Is it Time to Exchange Skinner's Teaching Machine for Dewey's Toolbox?

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Abstract

Student learning is not accidental: it is the direct result of what has been designed, intentionally or unintentionally, by teachers, schools, curriculum developers and communities. Behind teaching and learning events are beliefs about learning which directly influence what students experience. This paper provides an historical perspective on current instructional design practices. While attendees at this conference may find it easy to discount the inadequacy of traditional theories of instruction, an understanding of the historical evolution of these theories and their pervasive influence on K-12 education is necessary if we want to support teaching reform efforts. Without an understanding of the evolution of current teaching practices, change efforts may be unsuccessful.

1. The Efficiency Movement

Prior to 1900, educational practice possessed little in terms of a theoretical framework, was certainly not considered scientific or subject to scientific study, but was a holistic enterprise in which teachers were expected to teach facts while also shaping character. Popular curricula included the *McGuffey Readers*, a collection of moral tales designed to build character in American students.

In the second half of the 19th century, European scholars theorized that it was possible to develop methods which would make the study of human behavior more scientific. The ideas of Wilhelm Wundt in Germany and Francis Galton in England heavily influenced the development of a new American School of Psychology and along with it the emerging field of educational psychology. Stanley Hall and William James, leading American psychologists at the time, had as one of their students, Edward Thorndike, who enthu-

siastically applied the new scientific psychology to the control of learning. In his still influential book, *Principles of Learning* (1921) Thorndike suggested that learning would occur if subject matter were carefully refined and sequenced and students appropriately reinforced. His popular prescription for intense practice as a condition of learning remains popular today.

Educational theories advocating the scientific control of human behavior reflected larger reform efforts in society and business after the turn of the century. Frederick Taylor, an industrialist had developed a method for studying the movements of workers on assembly lines and through a process of measuring and control, speed up production. Eliot Eisner writes about the scientific managerial approach as it relates to workers:

What one sees here is a highly rationalized managerial approach to the production process. The worker's job is to follow the procedures prescribed. In this system, individual initiative and inventiveness by workers were regarded as sources of error, like sand in a motor, they impeded the operation of a smooth running machine that depended on adherence to formula"

p. 10, Eisner (1994)

When schools faced criticism in the early 1900's related to "inefficient" practices and poor learning by students they turned eagerly to scientific management as a way to improve. This standardization model remains attractive today and can be seen in the 1990's school reform efforts, e.g. the call for a standardized curriculum, *cultural literacy*, (Hirsch, 1987) and specific, identical student outcomes.

2. An Alternative Scientific View

Like Thorndike, John Dewey, was also interested in the application of science to educational practice. However, unlike Thorndike, his scientific views were influenced not by connectivism but by an approach to the study of human organisms made popular by Darwin. As a result of this study, Dewey saw learning as an activity driven, not by reinforcement, but by the learner's sense of disequilibrium when presented with new experiences and ideas. For Dewey if real growth was to occur the student must want to learn and be active in the learning process. He argued that the traditional reinforcement of information-- given by the teacher, memorized and given back by the child --led only to superficial learning. The job of the teacher was to create a classroom in which the child would be presented with problematic situations which she/he would be motivated to resolve by learning. While Dewey's thinking did not influence the early development of instructional technology for a variety of reasons, his work served as an alternative framework for the study of learning through out the 20th century.

3. The Origins of Instructional Technology

Perhaps one of the reasons that Thorndike's views regarding learning came to dominate instructional design was the political situation in which the United States found itself as it faced two world wars. The country had a need to rapidly train military personnel. The training required was concrete and sequential, such as how to assemble an M-1 rifle, and could be easily described and arranged in step-by-step fashion. The rapid growth of audiovisual tools during the first half of the century also made it possible to tap the advantages of using sound and visualization for the design of the required training. The resulting training materials could then be used over and over successfully, without the need for extensive teacher preparation.

Robert Gagne in his book on the foundations of instructional technology (1987) describes early industrial technology as the confluence of the scientific study of human learning practiced by Thorndike and his followers and the availability of new technologies. The technologies of interest included both procedures and tools. New techniques, such as programmed learning tied to the use of audiovisual materials, were conceptualized as a way to increase the precision with which the learner is appropriately stimulated and thus increase learning. Such materials were easily replicable and usable in far away locations without additional teacher training. Much of the training related to military objectives was accomplished with speed and precision using these methods.

Extensive research around these early audiovisual experiments helped to define instructional technology

as an attempt to provide "conditions for effective learning" (Gagne, 1987p. 3) . Growth in the field came from work in two areas 1) research on human learning, most recently human information processing, and 2) research and development designed to increase the capacity of instructional technology to provide better strategies for learning, exemplified in intelligent tutoring systems (ITS). These two fields, the study of optimal conditions for human learning and the use of well-developed procedures and tools, combined into what is now generally accepted as "a systems approach for designing instruction" (Association for Educational Communications and Technology, 1977). Within this systems approach increased emphasis has been put on improving the accuracy of the procedures involved in defining learning tasks, learner characteristics and needs, conditions for optimal implementation, and the tools and procedures needed for managing the instructional design process. However, within this paradigm no question are asked about the purpose of learning or the social context in which it is to occur.

The systems approach received additional support and funding from the federal government during the 1950's as a result of America's reaction to the Sputnik launch. In response to what was perceived as an educational crisis, Americans called for training and education which they believed to be scientific, systematic, rational, and reliable. Instructional technology had served the nation well during the war, why couldn't it also lessen what was perceived as a gap between American students as potential scientists and more scientifically skilled students in other countries, especially Russia.

4. Influence of Instructional Design on Public School Practice

A variety of instructional systems theories have had a profound and persistent influence on educational practice in K-12 settings. Several examples of these approaches will be discussed in the next section including programmed learning (Skinner, 1958), instructional objectives (Mager, 1962), conditions of learning (Gagne, 1965), mastery learning (Bloom, Madeus, & Hastings, 1981), and the work of Madeline Hunter (1967) in popularizing these instructional theories.

4.1. Programmed Instruction

B.F. Skinner, the father of operant conditioning, is usually credited with the development of programmed instruction. In his classic 1954 article, *The Science of Learning and the Art of Teaching*, Skinner described the conditions of the typical classroom as particularly adverse to learning. A single teacher can not individually and appropriately reinforce thirty or more students at the same time.

In this article Skinner first conceptualized a teaching machine for the classroom for use by individual students. This machine could present information, reinforce appropriately and then branch to the next level of difficulty depending on the individual's performance. The roots of computer-assisted instruction can be easily seen in Skinner's teaching machine.

4.2. Task Analysis and Behavioral Objectives

In order to fully implement programmed instruction two other areas of development were needed, task analysis and behavioral objectives. Task analysis is the process of identifying the tasks and subtasks that must be performed in order to complete a task or job. The concept of task analysis was applied to general education in early work by Frank and Lillian Gilbreth, expanded by Robert Miller (Miller, 1953) and utilized by Gagne (1987) as part of his description of the hierarchical nature of learning.

Methodologies associated with programmed instruction also required the identification of specific, observable behaviors that were to be performed by the learner. While objectives were advocated in teaching as early as the 1900's, Ralph Tyler has been called the father of behavioral objectives since he suggested as a result of his famous 8 year study of schools (1975) that many of the problems of instruction seem to be related to the fact that schools did not specify objectives, and that teachers and students were not aware of what they were supposed to be learning. However, the major implementation of behavioral objectives occurred only after Benjamin Bloom and his colleagues published the *Taxonomy of Educational Objectives* (1956). Even then, behavioral objectives were not widely used in practice until the publication of a small, humorous book by Robert Mager, *Preparing Instructional Objectives for Programmed Instruction*. This book has since been republished as *Preparing Instructional Objectives* (1962) and is still widely used today in both teacher education and training technologies. Robert Mager provides an excellent introduction to his book:

Before you prepare instruction, before you choose materials, machine, or method, it is important to be able to state clearly what your goals are. This book is about instructional objectives. In it I will try to show how to state objectives that best succeed in communicating your intent to others. The book is NOT about the philosophy of education, nor is it about who should select objectives, nor about which objectives should be selected.

Mager, 1962, p. viii

This is a very interesting little book which one reads in the manner of programmed instruction. Every aspect of the preparation of terminal behavioral objectives is well outlined and the reader is asked frequent questions the answer to which determines one's path through the book. After completing this book, the learner will be able to develop complete and precise objectives which define clearly the *terminal behavior* to be displayed by the learner, the *criterion* or standard by which the behavior will be evaluated, e.g. 70% items correct on the test, and the *conditions* under which the behavior will be displayed.

One of the barriers to implementing programmed instruction and behavioral objectives in schools was the current organization of schooling. Classrooms were not organized to support individualized learning. Benjamin Bloom developed a method for reorganizing instruction to allow for more individualized learning which became known as mastery learning.

4.3. Mastery Learning

Bloom's method is based on the idea that the learner will succeed in learning a task if given the exact amount of time he or she needs to learn the task. Bloom was a passionate opponent of the common educational practice of assuming that only about a third of the class will learn the material taught suggesting "this set of expectations, which fixes the academic goals of teachers and students, is the most wasteful and destructive aspect of the present educational system" (Bloom, Madeaus and Hastings, 1981, p. 51). Bloom suggested a variety of strategies that can be used in classrooms to provide conditions for mastery learning including the use of tutors, small group study, peer tutoring, programmed instruction, audiovisual materials and games. Research by Bloom and others in many countries demonstrated that slow learners can indeed achieve as much as faster learners when given the opportunity (Block & Anderson, 1975; Bloom, 1976; Yildiran, G., 1977)

4.4. The Conditions of Learning Model

Robert Gagne is best known for his development of a model of instruction based on human learning. Prior to Gagne, learning was often conceptualized as a single, uniform concept. No distinction was made between learning to load a rifle and learning to solve a complex mathematical problem. Among Gagne's contributions was the notion that there are various types of human learning and that each of these types of learning require different kinds of instructional strategies. For example, while Thorndike advocated continuous practice as the key to learning, Gagne suggested practice was effective only for certain types of learning, such as typing or playing ball which involve kinesthetic learning. The learning of cognitive strategies for problem solving is

a very different type of learning, requiring different instructional strategies and conditions. In order to learn cognitive strategies, the learner must be presented with and assisted in solving puzzling problems. For this type of learning, practice without a change in perception can be counter-productive.

Gagne's development of a model of human learning foreshadowed later discoveries of human information processing and added significantly to our understanding of stages in cognitive processing and their relationship to instruction. He argued that an understanding of the characteristics of and functions of short term and long-term memory were important for instructional designers. Students will not be able to retrieve learning from long-term memory for later use if they are not assisted in incoding new concepts in meaningful ways during the initial learning experience. These ideas influenced instructional designers to include the cognitive needs of the learner but within the same top-down instructional approach.

4.5. Instructional Theory Into Practice

Many educators found in Gagne's work a foundation for addressing the instructional problems found in schools, perhaps none more so than Madeline Hunter. She suggests that her strongest contribution to education was not additional theory, but the development of the technologies needed by teachers to implement new theories of learning. She describes her purpose in the opening to one of her many publications.

Psychological knowledge that will result in significantly increased learning of students is now available for teachers. In most cases, this knowledge remains unused because it is written in language that takes an advanced statistician to decode, or is buried in research journals in university libraries. This book is one of a series written to make this important knowledge available to the classroom teachers.

Hunter (1967), forward

In her years as a professor at UCLA and a prolific writer she had a significant influence on educational practice. Students in teacher education programs over the last 20 years, studied her writings and videos and inevitably learned to write precise instructional objectives, engage in task analysis, design appropriate guided and independent practice and write for their student teaching supervisors six-step lesson plans. Hunter's work provided the basis for a popular approach to remediation of students who were not doing well in school. The model, diagnostic-prescriptive teaching was widely adopted by federally-funded programs designed to provide what became known as *compensatory*

education for children from the lower socio-economic classes. It was theorized that basic skills teachers trained in Hunter's instructional technologies would be able to quickly and efficiently remediate the learning difficulties of those children who had received inequitable educational opportunities.

5. Commonalities

Both traditional instructional design and design aided by insights from cognitive and humanistic psychology had in common certain characteristics which will be described in this section. It is these commonalities which prevailed current instructional practice and which may limit the design of computer-based collaborative learning environments.

5.1. An emphasis on Method or Technique

All of the designs for learning discussed thus far reflect a technological approach to learning. The aim is to avoid philosophy as Mager suggests when he writes that his book is "NOT about the philosophy of education, nor is it about who should select objectives" rather, one must learn the techniques required to make learning more efficient. The value or importance of what is to be learned is not considered. Questions are not asked, as Dewey might have asked them, about the kinds of learning that would be useful to the larger society. As Dewey suggested, one can learn to be a better thief but such learning, however rapid, might be socially undesirable, an example of what he termed *miseducation*..

5.2. Psychology and the Individual Learner

In addition, the instructional design models described focus solely on the individual learner. None of the models consider the social or cultural context in which learning is to occur. The only relationships which are well-described are the relationship between the teacher or the teaching machine and the individual learner. This reflects the dominant influence of American individualistic psychology on both education and the development of instructional technology. Thorndike stressed the need for individual practice and reinforcement for learning to occur. Skinner proposed a system of individualized programmed instruction which would focus specifically on the reinforcement needs of each individual in order to increase learning in schools. Bloom with mastery learning provided an approach to teaching which would allow some reorganization of instruction in classrooms in order to increase the likelihood of individualized learning. Diagnostic-prescriptive teaching, task analysis, and individualized remediation were all based on the individual, much like a doctor's prescription for an individual patient.

5.3. Focus on Content

While larger questions about the social value of what should be taught were not asked, each of these models was designed around the assumption that the important act in school was the learning of content--facts, figures, and concepts. In terms of Dewey's original question (1905) concerning the distinction between the focus on the child versus the focus on content, instructional technology is grounded in the content to be taught, not the needs of the learner and group, or the social context in which the learner is situated. Traditionally, instructional designers have asked themselves: What are the concepts to be learned? How should they be presented and sequenced? What ideas need to be taught prior to others? What media can be most useful in presenting each concept? One can only reflect on the meaningfulness of content with context.

6. Alternative Conceptions of Learning Relevant to Design

Perhaps the most eloquent critic of the technological approach to education is Eliot Eisner (1982,1994) Eisner, whose work is well-grounded in the work of Dewey with whom he agrees that there is an important distinction between education and learning. In his discussion of different philosophical orientations to education, Eisner identifies the technical approaches discussed in this paper as unconcerned with the larger purpose of education. He also describes the limitations of teaching to objectives which are an essential element of current instructional design practice. Eisner describes the result of an exclusive use of behavioral objectives which breaks learning into small, manageable pieces. These pieces of learning are easily reinforced and measured. The problem is that students while mastering each of these pieces is unable to put the pieces together and apply them to new situations. For example, a student may be able to name each of the vowels with 100% accuracy but not be able to distinguish between vowels in new words. Eisner argues, in addition, that there may be some very important goals of education, such as an appreciation of the arts or the valuing of open-minded skepticism in science, they are not easily broken down into small units of behavior which can be taught and reinforced. Finally, he proposes that the evaluation of students has and always will drive the curriculum. So long as we evaluate students in terms of easily measured small units of behavior students will only learn such small units of behavior. If we want students to gain problem-solving skills we will have to evaluate and value problem-solving, a type of learning which, as Gagne pointed out, is not learned by rote practice.

7. Training vs. Teaching

It was desirable in many of the situations in which instructional technology evolved, such as the need to quickly train soldiers during World War II, that teaching and learning materials not require extensive training and involvement of on-site teachers. Yet there is a real danger in continuing to conceptualize teachers as factory workers. In fact, one can argue that it is this conceptualization that may be partially responsible for the fact that so few teachers have access to telephones and thus to Internet connections. After all, factory workers don't need telephones.

However, current educational reform movements recognize the important role of the teacher in supporting changes in instructional practice in classrooms. Without changes in teacher behavior, the best possible curricula will remain unused and have little or no effect on student learning. Teachers have always had a significant influence on student learning. As the diversity of our population and the complexity of what students need to know increases, teachers who are capable of designing learning appropriate for their community and the students who will work in an information age become increasingly important. Any instructional design theory in which teachers do not have a central role as designers and facilitators of learning will become less and less useful. The tasks of the teacher have become increasingly complex and the staff development needed is no longer one shot training programs or providing teachers with so-called teacher-proof materials, but rather continuous opportunities for professional development that occur in the context of the everyday work of the school.

8. The Social Context for Learning

Traditional approaches to instructional design assume that knowledge is independent of the situations in which it is learned and used. More recent research on learning in everyday situations and different cultural settings suggests the knowledge is not an independent phenomena, but situated in the activity, context and culture in which it is developed (Brown, Collins, and Duguid, 1988). An understanding of the need to connect learning with doing leads to a fundamentally different view of teaching and learning than that advocated by current instructional design practices. Tharp (1989) and others have suggested that learning is a process which occurs in social interaction. For example, Tharp and Gallimore (1976) describe how Hawaiian children who are used to working with peers may be perceived by their teachers as possessing low academic motivation rather than as seeking their own preferred learning environment which stresses peer cooperation. Therefore

an important task in the design for learning is to make the organizational structures of schools ones in which students from a variety of cultures will be productive and engaged participants.

The purpose of this paper was not to develop a theoretical framework for such communities of learners. Work by Brown (1994), Roschelle, J. (1994) and many others attending this first international conference in computer-based collaborative learning has already begun in this direction. Rather, this paper was written to provide insight into the paradigm within which instructional design operates. This paradigm is particularly pervasive in current school practice, especially as it applies to the implementation of educational technology. In much of the computer education community we are still building and selling Skinner's teaching machines. A recent book, *Computers as Cognitive Tools* provides what one reviewer describes as a "dialectic of instructional technology" (Koschmann, 1994) between those who would design better controls and models for learning, the roots of which can be found in Thorndike, and those who believe in a social constructivist approach, origins of which can be found in Dewey. An expanded concept of instructional design that includes the purpose of education, the need to teach the person as well as the content, and the importance of the social context of learning is required before we can implement computer-based collaborative learning for the children in our schools.

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