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Source: *Educational Technology Research and Development*, Vol. 43, No. 2 (1995), pp. 53-69
Published by: Springer
Stable URL: http://www.jstor.org/stable/30220993
Accessed: 08/09/2014 03:51

Situated Cognition and Learning Environments: Roles, Structures, and Implications for Design

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Situated cognition has emerged as a powerful perspective in providing meaningful learning and promoting the transfer of knowledge to real-life situations. While considerable interest has been generated in situated learning environments, few guidelines exist related to their design. The purpose of this paper is to examine the theoretical underpinnings of situated cognition and to derive implications for the design of situated learning environments. The conceptual framework centers on four basic issues: the role of context, the role of content, the role of facilitation, and the role of assessment.

□ Many students experience problems in utilizing the knowledge and skill acquired via formal learning to everyday contexts (Carraher, Carraher, & Schliemann, 1985; Lave, 1979; Perkins, 1985). According to Bransford and his colleagues, this problem stems from decontextualized formal learning experiences, that is, the learning of facts that are isolated from the contexts in which they derive meaning (Cognition and Technology Group at Vanderbilt, 1990). Highly decontextualized and simplified knowledge promotes understanding that is rigid, incomplete, and naive (Spiro, Feltovich, Jacobson, & Coulson, 1991). In formal education settings, skills and knowledge are operationalized very differently from how experts and practitioners use them in real life. Thus, students may pass exams but be unable to apply the same knowledge in everyday circumstances.

Situated cognition, in contrast, recognizes the inextricability of thinking and the contexts in which it occurs, and exploits the inherent significance of real-life contexts in learning (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1992). Knowledge is assumed to be the dynamic by-product of unique relationships between an individual and the environment; learning, then, is a natural by-product of individuals engaged within contexts in which knowledge is embedded naturally (Bednar, Cunningham, Duffy, & Perry, 1991; Brown, Collins, & Duguid, 1989). The emphasis is on providing enabling experiences in authentic versus decontextualized contexts, and cultivating learning processes versus learning outcomes.

While considerable interest has been generated in situated cognition, few guidelines exist related to design of situated learning environments [see Young (1993) for an exception]. While attempts have been made to derive the instructional implications of emerging philosophical constructs such as constructivism (see, for example, Lebow, 1993; Rieber, 1992), the basic foundations often remain misunderstood. The purpose of this paper is to examine the theoretical underpinnings of situated cognition and to derive implications for the design of situated learning environments. Four aspects are addressed : the role of context, the role of content, the role of facilitation, and the role of assessment. Key concepts within each of these roles are summarized in Table 1.

THE ROLE OF CONTEXT

Situated cognition emphasizes the importance of context in establishing meaningful linkages with learner experience and in promoting connections among knowledge, skill, and experience. According to Rogoff (1984, p. 2), context is ". . . the problem's physical and conceptual structure as well as the purpose of the activity and the social milieu in which it is embedded." Context, therefore, includes the general atmosphere and physical setting as well as concurrent "background" events (Ruth, 1992). Situated cognition advocates suggest that learning is effective when it occurs in meaningful contexts, but why is context so important? How does context influence learning? In the following sections, three constructs are introduced and analyzed with respect to the influence of context on learning: everyday cognition, authenticity, and transfer.

Everyday Cognition: Formal vs. Informal Learning

Researchers have suggested that individuals think and behave quite differently in everyday versus controlled environments (see, for example, Lave, 1988). These differences are critical in formal learning settings (e.g., schools) and informal everyday activities. For example, a child who experiences difficulty in laboratory memory tests can often remember precise locations of objects hidden at home by its parents. Individuals who perform poorly on logic or communication problems in test situations often reason precisely and communicate persuasively in more familiar contexts (Rogoff, 1984). Formal education contexts are comparatively unfamiliar and impoverished compared with the real-life experiences of an individual, and provide little support for everyday thinking or behaving. The inability to apply formal knowledge to everyday problems may be a consequence of academic cognition, which emphasizes ordered, "compliant" cognitions (McCaslin & Good, 1992) to accommodate teacher or curricular expectations. In informal learning contexts, on the other hand, individuals apply knowledge practically and routinely to solve everyday problems (Brown, et al., 1989).

Research on everyday cognition reveals many differences between formal and informal learning (Resnick, 1987). Formal learning emphasizes abstract and systematic problem-solving strategies. Students are taught procedures for solving problems—procedures presumed to be sufficiently robust as to permit application across diverse problem contexts. However, in everyday circumstances, individuals tend to apply practical strategies, such as efficiency or opportunistic solutions, rather than formal, bottom-up methods (Rogoff, 1984). For instance, while grocery shopping, individuals rarely use formal mathematics. Their strategies are structured fundamentally by the setting of the grocery store and the activity of shopping rather than fitting the problem to a formal strategy (Lave, Murtaugh, & De la Rocha, 1990). They combine mental calculations, approximations, and features of the physical environment to help them make decisions (e.g., tags on the products, prior experience, and so forth).

Formal learning settings emphasize knowledge that is context-free and symbolic. However, in everyday situations, people use concrete referents and tools extensively, referencing thought and knowledge to specific contexts. For instance, whereas in conventional

Table 1 ☐ Principles of each framework

Framework	*Principles*	*Authors*
The role of context	• Everyday cognition	• Brenner (1989), Lave (1988), Lave, Murtaugh, & De la Rocha (1990), Rogoff (1984)
	• Authenticity	• Brown, Collins, & Duguid (1989), Harley (1993), Newmann (1991)
	• Transfer	• Larkin (1989), Perkins & Salomon (1989)
The role of content	• Knowledge as tool	• Brown, et al. (1989), Cognition and Technology Group at Vanderbilt (1990), Collins (1988)
	• Content diversity and transfer	• Bransford, Franks, Vye, & Sherwood (1989), Cognition and Technology Group at Vanderbilt (1992, 1993), Collins (1988, 1993), Larkin (1989), Winn (1993)
	• Cognitive apprenticeships	• Brown, et al. (1989), Collins, Brown, & Holum (1993)
	• Anchored instruction	• Cognition and Technology Group at Vanderbilt (1990, 1992, 1993), Young (1993)
The role of facilitation	• Facilitation methods Modeling Scaffolding Coaching, guiding, and advising Collaborating Fading Using cognitive tools and resources	• Brandt, Farmer, & Buckmaster (1993), Brown & Palincsar (1989), Collins, et al. (1993), Greenfield (1984), Scardamalia, Bereiter, McLean, Swallow, & Woodruff (1989), Tobin & Dawson (1992)
The role of assessment	• Problems and issues	• McCaslin & Good (1992), Nickerson (1989), Shepard (1989), Slack (1993)
	• Trends in situated learning environments Self-referencing Flexible, transferable knowledge and skill Diversity and flexibility of learner-centered measures Generating and constructing Continuous, ongoing process Ecological validity	• Bruder (1993), Campione & Brown (1990), Collins (1990), Collins, Brown, & Newman (1989), Cunningham (1991), McLellan (1993), Young & Kulikowich (1992), Zimmerman (1992)
	• Assessment methods Portfolios Performance assessment Concept maps	• Bergen (1993), Cliburn (1990), Dana & Tippins (1993), Gardner (1989), Holmes & Leitzel (1993), Vargas & Alvagez (1992), Wolf (1989), Zimmerman (1992)

school tests individuals are prohibited from using computational tools other than pencil and paper, they routinely use calculators, measures, computers, and so forth to solve everyday arithmetic problems. People acquire practical knowledge and skill continuously through day-to-day experience and observation. They evolve an understanding of how and when to deploy their knowledge and skill within these contexts.

Lave (1988) described how the cognitive processes of students in formal school systems differ from those of just plain folks (JPFs) and practitioners. Through their everyday activities, JPFs develop general strategies for reasoning intuitively, resolving issues, and negotiating meaning. Through school activities, in contrast, students are typically involved in precise, well-defined problems, formal definitions, and symbol manipulation. Both JPFs' and practitioners' activities are situated in the cultures in which they work, within which they negotiate meaning and construct personal understanding. However, students accept as valid information provided by a teacher or textbook seeking to adopt "correct" ways of thinking or solving problems. The context exists, but it promotes uniform rather than unique understanding.

Brenner (1989) demonstrated significant cognitive gaps related to the concept of money. In school, money is treated as symbols which students must learn to recognize, and arithmetic rules for its utilization must be taught. Money concepts are used to solve pencil-and-paper currency. In everyday settings, individuals develop many money concepts through purchasing experiences. They do not calculate price according to the exact decimal system, or use "same size" coins, such as pennies, as in typical word problems. They use authentic paper currency. They observe that paper money is broken into smaller units when they receive change from a purchase. Knowledge of money is used as a tool in everyday situations, enabling individuals to determine their own goals and solve their own problems.

While it may be neither feasible nor desirable to employ everyday contexts for all formal learning, we can learn a great deal from the study of everyday cognition. Significant discrepancies are evident between how students are taught and how they think and act in everyday circumstances. In some cases, the differences may be warranted; in many other, they may not. Attention to cognitive ergonomics is needed, where teaching and learning methods are better situated to reflect the cognitive demands and processes of everyday situations.

Authenticity and Context

According to Newmann (1991, p. 459), "People in diverse fields face the primary challenge of producing, rather than reproducing, knowledge. This knowledge is expressed through discourse, through the creation of things, and through performance." In order for students to develop the skills used by experts, they need to engage in similar cognitive activities—authentic tasks in authentic contexts. Authentic tasks are coherent, meaningful, and purposeful activities that represent the ordinary practices of a culture (Brown et al., 1989). Authentic tasks involve activities that practitioners and experts engage in during real problem-solving situations, rather than the simulated processes typically demanded in formal schooling (Wilson, 1993).

Authenticity has important motivational potential. In traditional classrooms, students are frequently given problems or tasks that are of little relevance and bear little meaning (Newmann, 1991). The task is detached from the student's experience, and apart from the prospect of pleasing a teacher or parent, serves no apparent personal function for the student. Authentic tasks are ordinary activities in everyday situations that possess extraordinary motivational potential. Authentic tasks are more likely to become self-referenced and purposefully engaged by learners.

Since authentic tasks are often problem based, students are better able to gauge what they are learning and how to use it (Collins, 1993; Collins, Brown, & Newman, 1989). They learn, based on first-hand experience, when a particular method or strategy is appropriate in authentic, rather than contrived, contexts. Harley (1993, p. 48) noted that ". . . students will learn how to exploit contextual resources for their goals by looking for, recognizing, evaluating, and using information resources productively." Students learn to respond to changes in circumstances that influence their own problem solving. The context itself provides guidance for the activity by helping students to develop a sense of *situational intent*. In effect, the authentic context both cues the learner to situational resources and serves as an advance organizer for related problem-solving contexts.

Transfer

Many researchers have attributed knowledge and skill transfer problems to formal learning methods. Typically, formal education emphasizes general, abstract abilities based on the assumption that students can generalize these abilities for their use (Lave, 1988; Papert, 1993). Increasingly, however, researchers have suggested that general skills often do not promote the transfer of knowledge (see, for example, Bransford, Sherwood, Vye, & Rieser, 1986; Bransford, Franks, Vye, & Sherwood, 1989; Brown & Duguid, 1993; De Leeuw, 1983; Larkin, 1989; Perkins & Salomon, 1989; Stratton & Brown, 1972). It appears that both knowledge and cognitive skills are highly dependent on the contexts in which they are acquired.

Even on relatively near-transfer tasks, contextual cues and patterns are used extensively in problem solving. Studies in expertise and expert systems have shown that expert performers utilize vast amounts of detailed, domain-specific knowledge rather than general skill (Larkin, 1989; Perkins & Salomon, 1989). Research on master chess players, for example, suggests that tactics depend on the ability to cross-reference an enormous and complex knowledge base, derived through personal and vicarious experiences, of critical attack and defense patterns. Like experts of all kinds, master chess players reason using connected, chunk-like configurations rather than isolated units, suggesting that cognition is highly context dependent. It is an intricately interwoven and conditionally-sensitive process referencing the individual's knowledge, experience, and the problem to be solved.

The transfer of knowledge or skill, therefore, is influenced by situational factors such as social climate, physical features and attributed, and mediating agents present during initial learning. According to Greeno, Moore, and Smith (1993, p. 161) for example, ". . . analyses of transfer focus on structures of activity, considered as interactions of agents in the situations of initial learning." Successful transfer occurs when individuals acquire "general symbolic schemata"—broad understanding of the properties and relationships within an initial context—which are referenced and deployed according to their similarity to new circumstances. Transfer—both successful and unsuccessful—is influenced by the individual's capacity to represent experience symbolically, and by ". . . constraints on activity that result from the structure of situations [versus] mental representations of structure" (p. 161–162).

Summary

Several researchers have suggested that formal education has proven unsuccessful in preparing students to apply their knowledge in everyday life. In everyday situations, people reason intuitively, based upon experiences within specific contexts, using a variety of methods to solve problems. However, formal education often emphasizes abstract, decontextualized knowledge which is often difficult to transfer to real-life situations. Learners are rarely given access to everyday tools but must learn under engineered, often overly simplified, non-authentic contexts. Situated learning methods attempt to induce everyday cognition by anchoring knowledge and skill in realistic contexts. Since authentic tasks provide practical situations in which knowledge has meaning and which reflects the ambiguity and imprecision inherent in everyday circumstances, situated learning environments are more likely to support transfer to real-life problem solving.

THE ROLE OF CONTENT

While context influences cognition, it does not ensure learning. Context and the content embedded therein are inextricably connected. Context provides the framework for learning, but content determines its authenticity and veracity. It is important to understand the relationships between context and content in order to better facilitate cognitive processing and self-referencing. In this section, several content-context issues are presented: knowledge as tool, content diversity and transfer, cognitive apprenticeships, and anchored instruction.

Knowledge as Tool

In formal education settings, knowledge is often acquired in isolated, decontextualized form. The knowledge is inert. It can be recalled on tests, but is not readily deployed in problem-solving situations (Cognition and Technology Group at Vanderbilt, 1990). "Knowledge and tools can only be fully understood through use, and using them entails changing the user's view of the world" (Brown et al., 1989, p. 33).

Brown et al. also suggest that meaning is not universal, but is influenced heavily by cultural factors: "The community and its viewpoint determine how [knowledge] is used (p. 33)." For example, carpenters and cabinet makers use chisels differently; physicists use mathematics differently from engineers. Appropriate use of tools is not engendered simply by knowing about the abstract concepts, but is a function of the culture and the activities within which the tool evolves. It is unlikely, therefore, that tools will be used appropriately without an understanding of the culture of their use. Several parallels to formal education practice are apparent. Often, students are asked to use mathematics without knowing how practitioners use the knowledge of their domains, science concepts without the benefit of seeing how scientists employ them, and historical information without the framing provided by historians. Their content knowledge, as a consequence, lacks contextual anchors that help to define its meaning.

Transfer, for example, is impeded when instruction isolates knowledge and skill from settings in which they are, or will be, used (Winn, 1993). In formal settings, students acquire the computational knowledge and skills needed to answer physics problems, yet chronically fail to apply them when encountering everyday phenomena (diSessa, 1982; McDermott, 1984). When acquired in meaningful contexts, lesson content becomes more transferable because context provides support for its use (Collins, 1988). When dealing with real problems, learners reference their personal experiences and strategies which evolve through continuous self- and context-referencing. Students learn to use their knowledge flexibly as a tool to deal with everyday, as well as novel, situations.

Content Diversity and Transfer

While abstract knowledge and skill often fail to promote successful transfer, domain-specific knowledge also fails to transfer to dissimilar situations in many cases. How then can learners acquire powerful, but flexible and transferable knowledge and skill? Transfer is facilitated by the availability of powerful concrete instances which are interrelated in important ways. Transferable knowledge is interwoven with domain-specific knowledge (Larkin, 1989). For example, people often fail to apply purely logical, abstract rules to solve problems. Instead, they extract relevant aspects of various experiences to better analyze how to approach and solve problems. (Bransford, Franks, Vye, & Sherwood, 1986; Cognition and Technology Group at Vanderbilt, 1993). Recent research suggests that when general principles of reasoning are taught together with self-monitoring practices, problem-solving as well as metacognitive skills are more successfully transferred (Butterfield & Nelson, 1989; Perkins & Salomon, 1989).

According to Winn (1993, p. 17) ". . . flexibility in performance is engendered not by placing students in all situations in which their knowledge and skills will be applied, but by teaching at a level of generality that allows application in multiple settings. . . . Generality is indeed achieved by varying the situations in which students practice what they have learned." By providing varied content reflecting similar concepts, students learn different ways knowledge can be used and begin to generalize accordingly (Collins, 1988; Young, 1993). They also acquire general knowledge that is essential to expert thinking in various domains. Rather than teaching abstract skills and methods for applying them in varied contexts, situated learning environments emphasize the use of diverse concrete instances in authentic contexts. In this way, knowledge and skill become both specific and general (Collins, 1993).

The ability to recognize similarities among different contexts is a basic mechanism of analogical reasoning needed to facilitate transfer. Upon completing contextually-anchored videodisc mathematics and science problem-solving tasks in the Jasper Series, students were better able to solve problems that were analogous to the original (Cognition and Technology Group at Vanderbilt, 1993). Analog and extension problems ". . . help students develop flexible knowledge representations, to better understand key mathematical principles embedded in the Jasper adventures, and to make connections between the adventures and the thinking and planning that took place in many historical and contemporary events" (Cognition and Technology Group at Vanderbilt, 1992, p. 71). Analog problems are formed by altering one or more parameters of the original problem. Extension problems help students to integrate knowledge across the curriculum. They map the meaning of problem concepts to related domains, such as extending the mathematical concept of ratios to cooking and mixing chemicals.

Activities may also include contrast sets (examples and non-examples) which progress from large differences to finer distinctions (Bransford et al., 1989). This helps to increase the conditional sensitivity of the novice's knowledge. Over time, domain experts acquire the ability to discriminate among subtle features by virtue of experience across a range of situations that provide relevant contrasts. In order for novices to perceive the relevant features, ". . . a great deal of perceptual learning must occur. This requires experience with a set of contrasts so that the features of particular events become salient by virtue of their differentiation from other possible events" (p. 484). It is important for novices to detect important substantive aspects of varied contexts to better understand how new situations are similar to, and different from, those previously encountered. When novices fail to recognize important distinctions, they are unable to access information necessary for solving problems.

Cognitive Apprenticeships

The precedent for apprenticeships can be traced to the onset of civilization. In ancient times, learning was completely situated in the workplace. People learned to speak, grow cops, craft cabinets, and tailor clothes by observing and imitating their parents and masters (Collins, Brown, & Holum, 1991). When problems arose in the everyday context of work, apprentices naturally understood the reasons. When the apprentice potter needed to know how to glaze, he or she observed the master, asked necessary questions, and imitated the observed steps (Puterbaugh, 1990). Apprentices acquired skills through a combination of observation, coaching, and practice, which promoted mental models, scaffolding, and gradual self-reliance (Winn, 1993).

In modern times, apprentice settings have been largely replaced by formal education. In formal education, activities often focus on superficial aspects of complex problems. Insufficient attention is paid to the reasoning processes and strategies that experts employ when applying knowledge and performing complex, real-life tasks. To improve formal education, Collins, Brown, and Holum (1991, p. 8) suggest that, "We need both to understand the nature of expert practice and to devise methods that are appropriate to learning that practice. To do this, we must first recognize that cognitive strategies are central to integrating skills and knowledge in order to accomplish meaningful tasks." Cognitive apprenticeships emphasize relationships between the content knowledge and thought processes experts employ to perform complex tasks.

The "apprenticeship" concept emphasizes the importance of experiential activity in learning, and highlights the inherently context-dependent, situated, and enculturated nature of learning. In traditional apprenticeships, the steps involved in executing to-be-learned tasks are usually easily observed. In cognitive apprenticeships, however, thought processes need to be made more overt. When the mentor's thinking is made accessible to the apprentice, and the apprentice's thinking is evident to the mentor, it is increasingly possible to improve both action and underlying processes (Brown, Collins, & Duguid, 1989; Collins, Brown, & Newman, 1989; Collins, 1988).

Anchored Instruction

Anchors are embedded within problem-rich environments to promote exploration and understanding of the use of knowledge (Cognition and Technology Group at Vanderbilt, 1992). In anchored instruction, realistic settings are created in which knowledge and skills are naturally embedded within authentic contexts. Anchored instruction also extends the notion of cognitive apprenticeships by proposing "macro-contexts" that can anchor instruction in subjects across the curriculum (Young, 1993).

There are two primary ways to anchor learning. One way, which is often used in traditional instruction, is to provide a variety of mini-cases, or micro-contexts, for each subject. Alternatively, students can be provided macro-contexts that are sufficiently rich and complex to be meaningfully viewed from several perspectives (Cognition and Technology Group at Vanderbilt, 1992). In learning environments, anchored instruction provides macro-contexts within which students explore problems from diverse perspectives.

Anchored instruction has several important implications for the design of situated learning environments. First, anchors emphasize authentic activities and goals. Authentic tasks can be considered at two levels: (1) authenticity of objects and data in the setting; and (2) authenticity of problem situations. Within the Jasper Series, for example, students are asked to solve authentic problems (e.g., how to reach a certain place and return in the fastest way) using authentic data (e.g., speed limit signs, head winds, fuel consumption rates, fuel capacity, etc.). These scenarios provide authentic anchors for mathematics computation and reasoning. The problems themselves, while unlikely to be experienced directly by students prior to the lesson, are realistic and complex, and require the detection and/or application of specific knowledge and skills. Next, the lessons contain a great deal of embedded data including both essential and irrelevant data. Anchored instruction requires students to generate problems to be solved, then find relevant information within the story contexts. In the Jasper Series, all data needed to solve the problem are distributed throughout the story. Learners must identify or generate the problems they need to solve, discriminate important from unimportant data, and test and revise various solutions.

Finally, complex problems can be explored from multiple perspectives. Anchors help to create environments that ". . . permit sustained exploration by students and teachers and enable them to understand the kinds of problems and opportunities that experts in various areas encounter and the knowledge that these experts use as tools: (Cognition and Technology Group at Vanderbilt, 1990, p.3). By exploring problems from multiple perspectives, individuals can better understand why, when, and how to use knowledge in various situations, as well as ways to analyze problems and settings from multiple perspectives (for example, analyzing identical problems from the perspectives of a scientist, a mathematician, and a historian).

Summary

The importance of contexts in learning depends on the degree to which learning content is appropriately embedded. When presented in problem-based contexts, students acquire knowledge as well as a sense of when and how to use it. Concepts need to be represented via various content in order to promote both general reasoning and specific situated skills. In order to apply knowledge in various settings, students must discriminate similarities and differences among settings. These abilities can be facilitated by experiences in a range of relevant contrasts, analogs, and extensions. Cognitive apprenticeships provide the opportunity for learners to internalize learning and develop self-monitoring and self-correcting skills. Anchored instruction attempts to create authentic, problem-rich environments that encourage exploration and diversity of perspectives.

THE ROLE OF FACILITATION

Since learning is assumed to be indexed by personal constructions of reality, experience is fundamental to understanding and using knowledge and skills. In situated learning environments, students are provided support to facilitate personal constructions of meaning about the world they experience. Ongoing, interactive, and continuous facilitation is provided. Facilitation provides learners with opportunities for internalizing information, thereby promoting the higher-order, metacognitive skill development (self-monitoring and correction skills) as well as self-regulation and self-assessing abilities. In situated learning environments, facilitation has assumed several forms: modeling, scaffolding, coaching, guiding and advising, collaborating, fading, and using cognitive tools and resources.

Modeling

In modeling, the cornerstone of cognitive apprenticeships, the apprentice observes, then mimics, the master in the performance of a task. Modeling is most effective when it occurs during task performance and engages the learner in important ways. Two kinds of modeling are critical in situated learning environments:

1. Modeling of the physical processes of the phenomena learners need to understand, such as demonstrating how to mix ingredients in baking a cake; and
2. Modeling the thought processes underlying the performance, such as explaining why various ingredients and amounts are used to create desired consistency, texture, and flavor (Collins, Brown, & Holum, 1991). Through modeling, students observe normally invisible processes and begin to integrate *what* occurs with *why* it happens.

Scaffolding

Greenfield (1984) characterized five benefits of scaffolding, a metaphor adopted from building construction:

1. It provides a support
2. It functions as a tool
3. It extends the range of the worker
4. It allows the worker to accomplish a task not otherwise possible, and
5. It is used selectively to aid the worker where needed.

Scaffolds are not needed when cognitive structures are sufficiently developed; they are needed while the structures are incomplete or unstable (Brown & Palinscar, 1989). By supporting the integration of established understanding and know-how, scaffolds facilitate the transfer of what students already know to the task at hand (Harley, 1993). Scaffolding supports and simplifies a task as much as necessary to enable learners to manage their learning, allowing them to accomplish otherwise impossible tasks. This involves maintaining optimal challenge: Too little challenge will prove boring, while too much will foster frustration (Brandt, Farmer, & Buckmaster, 1993). Thus, scaffolding closes the gap between task requirements and skill levels by, ". . . creating 'the match' between the cognitive level of the learner and the characteristics of instruction" (Greenfield, 1984, p. 188).

Scaffolding ranges from performing an entire task to providing occasional hints (Collins, 1988, 1993). Scaffolding can be reduced, reorganized, or eliminated as learners become more complete in their understanding. "The instruction occurs in the interaction between novice and expert, who together structure their communication so that the novice is brought into the expert's more mature understanding of the problem. . . . The expert modifies the scaffold as the novice's capabilities develop, adjusting support to a level just beyond that which the novice could independently manage" (Rogoff & Gardner, 1984, p. 116). This, in effect, expands Vygotsky's (1978) "zone of proximal development" wherein the novice, with the support of the expert (human or technological), achieves what cannot be achieved autonomously (cf. Salmon, Globerson, & Guterman, 1989).

Coaching, Guiding, and Advising

Coaching involves observing and helping individuals while they attempt to learn or perform a task (Brandt, Farmer, & Buckmaster, 1993). It includes directing learner attention, reminding of overlooked steps, providing hints and feedback, challenging and structuring ways to do things, and providing additional tasks, problems, or problematic situations. The coach explains activities in terms of learners' understanding and background knowledge, and provides additional directions about how, when, and why to proceed. The master also identifies errors, misconceptions, or faulty reasoning in learners' thinking and helps to correct them.

In situated learning environments, advice and guidance help students to make maximum use of their own cognitive resources and knowledge. Learners have to have opportunity to experience their own decision-making process and problem-solving strategies (Tobin & Dawson, 1992). In this sense, guidance and advice are implicit rather than explicit, and non-directive rather than directive, being provided when needed by students.

Collaborating

Within a culture, ideas are exchanged and modified and belief systems developed and refined through conversation and discourse (Brown, Collins, & Duguid, 1989). Since learning is in part cultivated through social discourse, group interaction is essential. Within groups, social interaction and conversation occur in ways that professionally create and modify the beliefs on individuals.

Collaboration is inherent in everyday interaction. Individuals attempt to solve problems by interacting with other people using socially provided schemata and contextual cues. Collaboration occurs in many ways. In cooperative learning, students learn to negotiate meaning with others and experience shared responsibility for learning. Students clarify, elaborate, describe, compare, negotiate, and reach consensus on the meanings of various experiences (Hooper, 1992). Students can become experts in particular topics or problem domains, and engage in reciprocal teaching. According to Brown and Palincsar (1989, p. 414), "All members of the group, in turn, serve as learning leaders, the ones responsible for orchestrating the dialogue, and learning listeners or supportive critics, those whose job it is to encourage the discussion leader to explain the content and help resolve misunderstandings."

Fading

Over time, modeling, hints, and other supports must be gradually reduced, then eliminated as students become more knowledgeable and skillful. Fading involves the gradual reduction of support until students can perform independently (Collins, Brown, & Holum, 1991). For example, students in science classes are often provided supplementary materials and reminders how to implement a complicated experiment. When they begin the experiment for the first time, they may be asked to read all the procedures which need to be followed and use detailed checklists to ensure that they do not skip important steps or engage in hazardous activity. However, as they become familiar with the procedures, they are provided fewer, or simpler, reminders or checklists. Once able to demonstrate the requisite skills consistently, few, if any, prompts are provided. Through fading, students become more self sufficient and self regulatory, and not unduly dependent on external structural support.

Using Cognitive Tools and Resources

Cognitive tools are devices that allow and encourage learners to manipulate their thinking and ideas (Kozma, 1987). Situated learning environments provide a variety of cognitive tools and resources to support student-centered learning. Tools take various forms, from simple job-support devices such as calculators, notebooks, dictionaries, and checklists, to resource files, databases, simulations, and communication tools (Tobin & Dawson, 1992).

Tools can provide profound opportunities for students to optimize their own cognitive potential. In CSILE (Computer-Supported Intentional Learning Environment), for example, students socially construct a database of their understandings in the form of pictures and written notes (Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989). Each student makes his or her own pictures and notes, then "publishes" them as part of a socially-constructed knowledge base. Students can manipulate objects to zoom in or out to elaborate them further. In addition, they can annotate via written notes, as well as link to other notes and comment on them. Through the process of creating a database, students are encouraged to think more about how they process and reprocess thoughts on projects.

Summary

Facilitation is a natural dimension of the teaching-learning process. Contrary to traditional instruction, which encourages students to imitate external knowledge, situated learning environments attempt to help students to improve their cognitive abilities, self-monitoring, and self-correcting skills. Learning environments need to encourage active learning and provide opportunities for students to internalize information. In this sense, facilitation in situated learning is less directive, more continuous, and highly interactive.

THE ROLE OF ASSESSMENT

Educational tests serve many purposes in many contexts. At a macro level, tests are used to evaluate the effectiveness of teachers, instruction, curricula, and educational systems and to determine the relative standings of school districts. At the micro level, tests are used to direct student attention to certain topics, to diagnose student learning difficulties and provide support accordingly, and to report student progress to students, teachers, and parents (Collins, 1990).

However, there is a growing consensus that traditional methods, such as standardized testing, criterion-referenced tests, and teacher-constructed tests fail to measure important learning outcomes (Shepard, 1989). Such tests focus heavily on recall of declarative and procedural knowledge, and provide little to indicate either the level at which a student understands or the quality of individual thinking (Nickerson, 1989; Slack, 1993). Given the nature of situated learning environments, the selection of appropriate assessment measures and methods is especially relevant.

Problems and Issues

The content of tests influences, explicitly and implicitly, teaching and learning processes. Teachers often "teach to the test" rather than emphasizing underlying concepts. Skills are taught in the manner measured on tests rather than how they are used in everyday contexts. When tests require the recall of memorized information, students develop memorization strategies that tend to decontextualize their knowledge, promoting compliant cognition (McCaslin & Good, 1992). As a consequence, traditional testing strategies are often counterproductive for the solving of real-world problems (Collins, 1990).

Another problem with traditional testing is that it tends to emphasize evaluation, or classification, as a primary goal. Evaluation typically involves a judgment of the value, worth, or merit of one's effort according to external criteria. Students are judged as having learned or not learned relative to such criteria. The purpose is not to promote individual cognitive growth, but to determine the external importance of such growth. In traditional tests, the criteria for acceptability are based on the instructional goals or objectives of teachers, curricula or administrators; the testing is separated from the learning process.

Both traditional and contemporary approaches to assessment play important roles in gauging performance. However, evaluation methods tend to underestimate growth in cognitive and learning processes and decontextualize assessment from authentic situations. Since a primary goal of education is to promote students' thoughtfulness, the basic concept of testing needs to change, not just the structure of the tests (Brown, 1989).

Trends in Situated Learning Environments

In order to become capable, learners need experience in solving real problems and understanding complex tasks. Assessments, therefore, need to approximate real-life tasks more closely and invoke more complex and challenging mental processes; assessment standards need to reflect multiple perspectives and diversity-versus-singularity of problem solutions (Shepard, 1989). Several trends have emerged.

Self-Referencing

In situated learning environments, one's progress is considered relative to his or her own goals, intentions, and past achievements. Assessment focuses on perception-action processes as they occur in realistic problem-solving contexts (Young & Kulikowich, 1992). Assessment enables learners to focus not only on performance outcomes, but on diagnosing the cognitive processing components, strategies, and knowledge structures that underlie performance (Collins, Brown, & Newman, 1989). Progress and achievement are measured against the individual's unique goals or past achievements rather than against group norms or criteria (Zimmerman, 1992).

Flexible, Transferable Knowledge and Skill

In situated learning environments, the goal is to process information deeply and restructure knowledge accordingly, and to apply knowledge and skills flexibly across related problems. Assessment, therefore, places emphasis on flexibility in higher-level thinking skills rather than recollection of a formal body of knowledge (Spiro et al., 1991). Assessments stimulate students to think, to react to new situations, to review and revise work, to evaluate their own and others' work, and to communicate results in verbal and visual ways (Bruder, 1993; Campione & Brown, 1990). They cause learners to invoke knowledge as a tool to manipulate and interpret novel circumstances, not simply to verify those previously encountered.

Diversity and Flexibility of Learner-Centered Measures

In everyday life, as well as in situated learning environments, there are many ways to assess what has been learned. To understand student thinking, for example, we need to recognize the range of strategies students use to solve problems, the circumstances under which students use the approaches, and the advantages that varied strategies offer the students (Siegler, 1989). We assess students by observing whether or not they construct plausible solutions to problems at hand, can provide varied points of view on a problem or issue, can supply well-reasoned rationales for their beliefs and so on (Cunningham, 1991). Likewise, since learner intentions vary widely, the standards used to assess students cannot be absolute. Instead, the standards are fluid and reflect differences between rather than similarities among learners. Assessment, therefore, is a multidimensional process involving diverse measures and standards related to student thought, behavior, or performance.

Generating and Constructing

Whereas most real-world tasks require planning and executing, multiple-choice tests require only choosing the best answer. In situated learning environments, it is important that assessments address the generation of ideas and the presentation of problem-solving processes such as planning, implementing, and revising. Situated assessment requires generation as well as selection (Collins, 1990). For example, the Jasper Series requires students to generate problems not only to assess understanding of the content but also to engage them in authentic experience as experts. An emphasis on doing, rather than simply on measuring aptitudes, reflects more realistically how everyday decisions are made (McLellan, 1993).

Continuous, Ongoing Process

When embedded in realistic tasks, assessment arises naturally. Assessment is not a separate or terminal activity carried out after instruction, but an integral aspect of learning (Cunningham, 1991). Consequently, assessment is an on-going, embedded process. In cognitive apprenticeships, for example, the student is provided the means to construct individual interpretations of problems contained in the environment. The master provides and demonstrates tools with which to inquire into problems and manage cognitive growth. Assessment, therefore, becomes a natural process through which learners diagnose their needs and seek support to bridge the gaps between apprentice and master performance.

Ecological Validity

Finally, assessment should be integral to learning and authentic (Collins, 1990; Young, 1993). In problem-solving settings beyond the classroom, individuals decide what tools to use, what information is pertinent, how the information should be organized, what parameters restrict the solution, and which ideas should be explored further or discarded. After processing information, students must be able to communicate results to others. Assessments are not intrusive to learning, but rather are a natural and integral aspect of it.

Assessment Methods

Since assessment in situated learning environments emphasizes cognitive and learning processes, improvement of learning strategies, and higher-order thinking skills, assessment alternatives typically require varied evidence. Three methods are addressed: portfolios, performance assessment, and concept maps.

Portfolios

Many educators have recommended portfolio-based assessment. Portfolios are purposeful collections of student work-in-progress and final products, through which external aides can facilitate individual growth and students can become active in their own assessments. Portfolios can include various learning materials, such as videotapes, written papers, drawings, computer programs, and so forth. For example, an artist's portfolio might include art works created with a range of art media and techniques, works in progress, preliminary sketches and completed works, and journal entries as well as commentaries by teachers, students, and peers (Zimmerman, 1992). Portfolios allow students to examine cognitive growth over time to become better informed, thoughtful, and reflective assessors of their efforts. They provide concrete referents with which teachers can guide and support the learner in attaining his or her own goals (Gardner, 1989; Wolf, 1989).

Performance Assessment

Performance assessment refers to the process of asking the student to produce things or to perform tasks that require given skills. Performance assessment requires a collection of complementary sources such as observations of student performance, exhibits, presentations, interviews, student-generated projects, simulations, and role-playing (Dana & Tippins, 1993). In order to be authentic, the performance must have some connections to the real world or some aspect of that world; that is, it must be an application rather than a recollection of knowledge (Bergen, 1993). Good performance assessments reflect the complexity of real worlds and measures many facets simultaneously.

Performance assessment involves the presentation of a task, special project, or investigation associated with either a routine or problematic situation. For example, assessments in science might examine the handling of devices for experiments, the design of experiments to prove hypotheses, and the development of argumentation supported by empirical evidence. During performance assessments, students have the opportunity to demonstrate wide-ranging abilities. The performance task allows students to function in roles similar to those expected in real-world settings. Through performance assessment, students recognize that learning is not simply an exercise in memorization, but one of developing a sense of both the depth of particular disciplines and an appreciation for the complexity of areas under study (Dana & Tippins, 1993).

Concept Maps

Concept maps help students to represent concepts in concrete, meaningful ways. Concept maps are diagrams that indicate the organization of lesson, unit, or domain knowledge (Vargas & Alvarez, 1992). After identifying concepts relevant to a particular topic, students create mental models by organizing along dimensions such as hierarchies and chronologies. The relationships are then identified and labeled. Through mapping, students connect concepts to represent the personal meanings they hold for these concepts. Since concept maps provide a rich view of knowledge and the ability to differentiate among concepts, they provide a useful way to assess different levels of understanding and cognitive growth (Cliburn, 1990; Holmes & Leitzel, 1993).

Summary

Often, traditional tests and testing methods fail to measure important educational outcomes. They emphasize homogenized recall of memorized factual knowledge and procedures rather than unique, and highly differentiated reflection. Because traditional tests judge performance based on external criteria, they typically emphasize standards which can be applied to typical students. In order to be useful in promoting higher thinking skills, testing needs to shift from domain-referenced evaluations to student-centered assessments. Student-centered assessment emphasizes the ability to diagnose and manage cognitive growth rather than to evaluate student achievement.

IMPLICATIONS AND CONCLUSIONS

Situated cognition has several implications for learning system design as well as teaching and learning processes. First, situated cognition emphasizes higher-order thinking skills over memorization of factual information. By providing complex, ill-defined, and authentic tasks, situated learning environments attempt to cultivate awareness, the ability to retrieve relevant information when needed, skills in the metacognitive monitoring of progress toward a solution, and the reasoning experts experience in real-world problem-solving. Situated learning environments induce inferential reasoning, monitoring and regulation of problem solving, and utilization of metacognitive skills (Winn, 1993).

Next, situated learning systems focus on growth, primarily in student cognition. The Cognition and Technology Group at Vanderbilt (1990), for example, suggested that a primary goal of situated learning was to allow students (and teachers) to experience the effects of new knowledge on their perception and understanding of their environments. They wanted students ". . . to experience what it is like to grow from novices who have only a single viewpoint to relatively sophisticated experts who have explored an environment from multiple points of view" (p. 9).

Through exploration, students construct understanding rather than being taught specific knowledge (Winn, 1993). According to Brown and Duguid (1993), "One of the powerful implications of situated learning is that the best way to support learning is from the demand side rather than the supply side; that is, rather than deciding ahead of time what a learner needs to know and making this explicitly available to the exclusion of everything else, designers and instructors need to make available as much as possible of the whole rich web of practice, allowing the learner to call upon aspects of practice as they are needed." The designer moves from the organization of content and sequence to the creation of environments that induce, then facilitate, understanding.

Situated learning environments often require powerful, but different, roles for teachers. Young (1993) characterized the need for teacher-support materials: "A major reason for the lack of emphasis on problem generation and on complex problem solving is the difficulties teachers face in communicating problem contexts that are motivating and complex yet ultimately solvable by students." In addition, since situated learning requires the change of the teacher's role from a knowledge transmitter to a coach or facilitator of students' understanding, more and better guidance is required (Bednar et al., 1991; Duffy & Jonassen, 1991; Winn, 1993).

Finally, situated learning requires a fundamental change in test traditions. For some time, tests have played a significant role in the judging of ability and achievement. However, since situated learning environments focus on the individual's cognitive progress and transfer of knowledge, assessment needs to be dynamic, and reflect ever-emerging samples of the learner's progress (McLellan, 1993). The litmus test for successful situated learning is the transfer of knowledge and skills to novel situations in which the relevant knowledge is applied. Therefore, the emphasis of the evaluation needs to shift from largely local and near-transfer tasks to problem solving and far transfer.

The role of context in learning is not new in educational research. However, situated learning environments provide a broader, more inclusive way to conceptualize the process. Several questions, however, need to be answered related to the practical implications of situated learning. While "just plain folks" behave and learn in everyday life, their knowledge and performance is not the same as the experts'. They do many things inaccurately and inefficiently and possess many misconceptions about daily life. Some understanding, such as scientific concepts like gravity and earth rotation, require opportunities beyond our everyday experience. In many cases, everyday experiences actually hinder learning. We need to know more about how learning occurs in everyday life, how the cognitive processes and mental models derived in everyday life differ from formal learning models, and how the learner interacts with his or her environment.

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