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Transfer of learning from school to work settings is a chronic concern of vocational

education. Constructivism, a learning theory that has received support from recent cognitive research, suggests a way to restructure the learning environment that will make transfer more effective. This Digest explores constructivism and its relationship to workplace learning. It considers whether and how it is being used in vocational education. Practices that support constructivist learning are offered.

CONSTRUCTIVISM: A MATTER OF INTERPRETATION

The theory of constructivism rests on the notion that there is an innate human drive to make sense of the world. Instead of absorbing or passively receiving objective knowledge that is "out there," learners actively construct knowledge by integrating new information and experiences into what they have previously come to understand, revising and reinterpreting old knowledge in order to reconcile it with the new (Billett 1996). The cognitive structures that learners build include "procedural" knowledge ("how"--techniques, skills, and abilities) and "propositional" knowledge ("that"--facts, concepts, propositions). Often neglected are dispositions--attitudes, values, and interests that help learners decide: Is it worth doing? Knowing "how" and "that" is not sufficient without the disposition to "do."
Other key features of knowledge construction are functional context, social context, and usefulness. The process works most effectively when it is embedded in a context in which new knowledge and skills will be used. Research on thinking and learning reinforces the idea that people learn through interaction with others (Johnson and Thomas 1994). Although learning is a matter of personal and unique interpretation, it takes place within the social context. In addition, learning must be useful to the learner; intrinsic motivation emerges from the desire to understand, to construct meaning (Billett 1996).

Using a constructivist approach, teachers facilitate learning by encouraging active inquiry, guiding learners to question their tacit assumptions, and coaching them in the construction process. This contrasts with the behavioralist approach that has dominated education, in which the teacher disseminates selected knowledge, measures learners' passive reception of facts, and focuses on behavior control and task completion. A constructivist teacher is more interested in uncovering meanings than in covering prescribed material.

The concept of situated learning--that "knowledge is created and made meaningful by the context in which it is acquired" (Farmer, Buckmaster, and LeGrand 1992, p. 46)--is embedded in constructivism. Situated learning results from undertaking authentic activities guided by expert practitioners situated in a culture of practice (Billett 1994a). Studies of differences in the performance of novices and experts (Billett 1993, 1994b) demonstrate that experts organize or index their base of constructed knowledge in order to recognize patterns and solve problems in new situations. Through experience,

experts amass a rich index of cognitive structures that they can easily recall and use. A constructivist method for helping novices to acquire expertise is cognitive apprenticeship.

In cognitive apprenticeship, experts model the strategies and activities needed to solve problems, and learners approximate doing the activity while articulating their thought processes. Experts coach learners with appropriate scaffolds (physical aids and supporting materials), gradually decreasing assistance as, through continued practice, learners internalize the process by constructing their own knowledge base and understanding (Farmer, Buckmaster, and LeGrand 1992).

THE CONSTRUCTIVE NATURE OF WORKPLACE LEARNING

Research on how people learn in the workplace demonstrates that what is taking place is constructivist, situated learning, often through cognitive apprenticeship. Studies of practitioners in several professions (Farmer, Buckmaster, and LeGrand 1992) reveal that what helped them most in learning to deal with ill-defined, complex, or risky situations is having someone model how to understand and deal with the situations and guide their attempts to do so. Hart-Landesberg, Braunger, and Reder (1992) studied how hospital workers "learn the ropes." These workers learn and do concurrently, reflecting on their actions in order to interpret and reconstruct the knowledge they acquire.
Billett (1993, 1994b) conducted several studies of coal miners and workers in other industries, concluding that, in the informal learning setting of the workplace, effective learning resulted from learners' engagement in authentic activities, guided by experts and interacting with other learners. Although construction of understanding was unique to each individual, it was shaped by the workplace culture of practice. These workers valued direct instruction only for information they were unlikely to learn without it being made explicit (so-called opaque knowledge). However, the quality of that instruction was important: they wanted it to help them understand why things had to be done and they wanted it to be at their level, not "talking down to them" (Billett 1994b).

Activity is a key factor in knowledge construction (ibid.), and participation in everyday work activities "forces" learners to access higher-order procedural and propositional knowledge. Repeated experience adds to their index of knowledge, and active engagement in routine problem solving reinforces learning. In the constructivist view, reinforcement is the internal satisfaction that results from making sense of new stimuli (adapting them to existing knowledge structures), in contrast to the behavioral approach of reinforcement from external sources.

To summarize, the workplace has a number of strengths as a learning environment (Billett 1996): (1) authentic, goal-directed activities; (2) access to guidance--both close

assistance from experts and "distant" observing and listening to other workers and the physical environment; (3) everyday engagement in problem solving, which leads to indexing; and (4) intrinsic reinforcement. There are also limitations to workplace settings (ibid.): (1) construction of inappropriate knowledge (e.g., racist or sexist attitudes, unsafe work practices); (2) lack of sufficient or more challenging authentic activities; and (3) reluctance of experts to participate or restrictions on their assistance.

CONSTRUCTIVISM AND VOCATIONAL EDUCATION

Research findings support the value of contextualized learning that provides opportunities for knowledge acquisition and construction, practice and reinforcement, in "natural settings" such as the workplace (Billett 1993). Shouldn't schools be "natural settings" for learning? Wouldn't vocational education, which has emphasized apprentice learning, problem solving, and workplace context, support a constructivist view of learning? Although a literature search found numerous examples of constructivist approaches in such areas as science, mathematics, and English, there were very few explicit references to constructivism in vocational education literature.
According to Parnell (1996), the philosophical position of academic education has been "learning to know is most important; application can come later"; of vocational education: "learning to do is most important; knowledge will somehow seep into the process" (p. 19). In addition, the behaviorist (Prosser) position has predominated over the pragmatic/constructivist (Dewey) position in vocational education for most of this century (Lynch 1997). Johnson and Thomas (1994) note that "technology education researchers...have shown little interest in cognitive science-based research" (p. 33), although instructional strategies supported by such research include those "that have been used by technology educators for years" (ibid.).

"The irony for vocational education...is that studies of cognitive development in vocations are leading reforms of general education, but the full import of the theoretical advances is not being applied in vocational education itself" (Stevenson 1994, p. 8). For example, a study of technical and further education college trade courses in Australia found that the most common teaching practice was lecturing, especially in theory classes. Although practice classes featured demonstration and some experiential activity, there was little emphasis on organizing information and relating it to existing knowledge (ibid.).

Elements of constructivist, situated learning may be seen in recent developments such as tech prep, school to work and integrated vocational and academic education. Perhaps constructivist methods are being used without being identified as such. In addition, such barriers as time constraints, administrative procedures, community pressures (accountability demands, standardized testing), and lack of consensus on the goals and purposes of education limit teachers' ability to implement constructivist

approaches (Parnell 1996). How can vocational education realize its potential to develop minds that seek meaning, make connections, and apply constructed knowledge to real-world tasks?

SUPPORTING CONSTRUCTIVIST LEARNING

Research confirms that the "focus in teaching and learning should be on the individual's active construction of knowledge" (Stevenson 1994, p. 29). The essential role of vocational education is "to facilitate construction of knowledge through experiential, contextual, and social methods in real-world environments" (Lynch 1997, p. 27). Because the focus is on the learner, vocational education should be conceptualized as a learning process rather than a teaching process (Stevenson 1994).
The vocational teacher's role is not to set tasks, but to organize experiences that allow learners to develop their own knowledge and understanding. Using the methods of cognitive apprenticeship, the teacher is a coach who provides guidance that gradually decreases as learners become more proficient, and who models, mediates, diagnoses, and scaffolds. The learning environment should reproduce the key aspects of communities of practice: authentic activities sequenced in complexity, multiple experiences and examples of knowledge application, access to experts, and a social context in which learners collaborate on knowledge construction.

Examples of constructivist practices include the following: (1) when students reach an impasse during an electronics lab, the teacher plays a logic game as a scaffold until students can articulate the logic of the electronic circuit for themselves (Rahn 1996); (2) an electronics student is matched with a repair shop where she accomplishes her school tasks through regular repairs assigned by the shop owner (Schell and Babich 1993); and (3) agriscience students are asked to learn why swine on a nearby farm are not reproducing successfully, a problem where more than one answer may be correct (ibid.).

According to Hyerle (1996) constructivist approaches such as cooperative learning and portfolio assessment are already being used in schools, but most of these "create the environment for constructivism but do not center explicitly on how an individual learner constructs knowledge" (p. 15). He describes how a variety of visual tools such as brainstorming webs, thinking process maps, concept mapping, and multimedia and the World Wide Web support knowledge construction. Stevenson (1994) and Billett (1993) advocate assessment of performance in multiple settings, attention to dispositional factors including learner interests and ways of knowing, and combining constructivist practices with direct instruction for the occasions when presentation of information or theory is necessary. In this volatile contemporary world, the goal of constructivist teaching is to develop self-directed yet interdependent learners who can access and use a wide range of cognitive structures in order to transfer learning to contexts they have yet to encounter.

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