DOCUMENT RESUME

ED 337 689 CE 059 380

AUTHOR	Berryman, Sue E.
TITLE	Designing Effective Learning Environments: Cognitive Apprenticeship Models.
INSTITUTION	Columbia Univ., New York, NY. Inst. on Education and the Economy.
SPONS AGENCY	William T. Grant Foundation, Washington, DC. Commission on Work, Family, and Citizenship.
PUB DATE	Sep 91
NOTE	5p.
AVAILABLE FROM	Institute on Education and the Economy, Box 174, Teachers College, Columbia University, New York, NY 10027 ($7.50).
PUB TYPE	Collected Works - Serials (022)
JOURNAL CIT	IEE Brief; n1 Sep 1991
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Academic Education; *Apprenticeships; *Cognitive Processes; *Educational Improvement; *Epistemology; Integrated Curriculum; *Learning Theories; *Models; Postsecondary Education; Secondary Education; Vocational Education
IDENTIFIERS	*Cognitive Apprenticeship Model

ABSTRACT

Using cognitive science as the knowledge base for the discussion, this paper reviews why many school learning situations are ineffective and introduces cognitive apprenticeship models that suggest what effective learning situations might look like. Five wrong assumptions about learning are examined: (1) people transfer learning from one situation to another; (2) learners are passive receivers of wisdom; (3) learning is the strengthening of bonds between stimuli and correct responses; (4) learners are blank slates; and (5) skills and knowledge should be acquired independent of their contexts of use. Cognitive scientists use a wide array of knowledge and experience to design effective learning environments, including the work of 19th- and early 20th-century educators, analyses of apprenticeship learning and of the spectacular learning of young children, and an extensive body of cognitive science research. The Collins, Brown, and Newman cognitive apprenticeship model is recommended; its four building blocks--content, methods, sequence, and sociology--together define an effective learning situation. Current programs for integrating academic and vocational education and apprenticeships in light of the cognitive apprenticeship model are described. The paper concludes that the cognitive apprenticeship model could be a good vehicle for learning and should be implemented in more situations. (13 references) (KC)

INSTITUTE ON EDUCATION AND THE ECONOMY
IEE BRIEF
Number 1/ September, 1991

Designing Effective Learning Environments: Cognitive Apprenticeship Models

Sue E. Berryman

Too often, schools—not only elementary and secondary schools, but also college classrooms, adult literacy classes, and corporate training courses—fail to capitalize on what is known about how people learn most effectively. To design effective school-based learning, we need to rethink the assumptions that underlie formal schooling.

Using cognitive science as the knowledge base for the discussion, this Brief reviews why many school learning situations are ineffective and introduces cognitive apprenticeship models that suggest what effective learning situations might look like.

Five Assumptions About Learning—All Wrong

What makes many school learning situations so ineffective is that they are based on mistaken assumptions about learning.

1. That people predictably transfer learning from one situation to another.

The ultimate point of education is to prepare students for effective functioning in nonschool settings. Yet research, extensive and spanning decades, shows that individuals do not predictably transfer knowledge to new situations where transfer should occur:

- From school knowledge to everyday practice.
- From everyday practice to school endeavors.
- From one discipline to another within school.

2. That learners are passive receivers of wisdom—vessels into which knowledge is poured.

This assumption arises from a notion that the purpose of education is to transmit society's knowledge and culture from one generation to the next—an assumption that encourages a lecture mode of teaching, with the teacher as controller of the learning process.

Control over learning in the hands of the teacher undercuts the student's development of cognitive management skills, including goal-setting, strategic planning, monitoring, evaluating, and revising—capabilities critical for effective learning. Students develop no confidence in their own ability to learn or in their own sense-making abilities, and their opportunities to learn from experience are highly constrained.

Another consequence of passive learning is that since students are not drawn into the learning process, they adopt a "waiting-it-out" attitude, investing minimal attention and involvement in the learning process. Waiting-it-out often translates into discipline and crowd-control problems. Further, passive learning places a premium on reproducing the "right answers" to teachers' or test questions, but often without real learning. Passive learning thus encourages "veneers of accomplishment"—changes in ways of talking, but not in behavior.

3. That learning is the strengthening of bonds between stimuli and correct responses.

Instruction based on this assumption arises out of a behavioral theory of learning and results in a curriculum of disconnected items, subtasks, and subskills, without an understanding of the context in which they fit. This approach misses the point that human beings are quintessentially sense-making, problem-solving animals. Instruction that is fractionated and out of context fails to mobilize this powerful property of human beings. As Farnham-Diggory (1990) says, "Today's school programs could hardly have been better designed to prevent a child's natural learning system from operating."

Publication and dissemination of this Brief is supported, in part, by funding from the William T. Grant Foundation Commission on Work, Family and Citizenship.

4. That learners are blank slates on which knowledge is inscribed.

Yet the evidence is that learners carry into every situation ideas and constructs that they have acquired elsewhere. If these are not fully examined in school, students tend to revert to their old ideas when confronted with out-of-school situations.

5. That skills and knowledge, to be transferable to new situations, should be acquired independent of their contexts of use.

Context, however, is critical for understanding and thus for learning. Context, in fact, gives meaning to learning. Brazilian street vendor children, for example, solve context-embedded problems much more easily than ones without a context (Carraher et al., 1985).

Since school practice is based on these mistaken assumptions, it is not surprising that we find no predictable transfer to new situations. Knowledge and procedures not well learned or understood will not transfer appropriately.

Designing Effective Learning Environments

To design more effective learning environments, cognitive scientists have been drawing on a wide array of knowledge and experience, including: the work of 19th century and early 20th century educators, analyses of apprenticeship learning and of the rapid learning of young children, and cognitive research.

Early Inspirations. John Dewey, drawing on Francis Parker's ideas, founded a laboratory school with a curriculum that progressed from practical experiences (planting a garden) to formal subjects (botany) to integrated studies (the place of botany in the natural sciences).

The Child as Spectacular Learner. Analyses of the conditions for spectacular learning by the young child offered clues for designing effective learning environments (Pea, 1989).

- Learning takes place in context. Children learn during their first five years in the midst of meaningful, ongoing activities and receive immediate feedback on the success of their actions.
- Parents and friends serve as models for imitative learning and provide structure to and connections between their experiences.
- Learning is functional. Concepts and tools are acquired as tools to solve problems.
- The need for and purpose of the learning are often explicitly stated for the child.

Traditional Apprenticeship Learning. Another source for ideas about effective learning environments is how individuals learn in traditional apprenticeships. Whereas school curricula tend to be a specification *of* practice, apprenticeships arrange opportunities *for* practice (Lave et al, 1988).

Jordan (1987) identified several characteristics of traditional apprenticeship learning including:

- Work is the driving force. The progressive mastering of tasks by apprentices is appreciated not as a step towards a distant, symbolic goal (such as a certificate), but for its immediate value in getting the work done.
- Apprentices start with skills that are relatively easy and where mistakes are least costly.
- Learning is focused on bodily performance. It involves the ability *to do* rather than the ability *to talk about* something.
- Standards of performance are embedded in the work environment. What constitutes expert execution of a task is obvious, and judgments about the learner's competence emerge naturally and continuously in the context of the work. The apprentice "owns the problem" of moving on to the acquisition of the next skill.
- Teachers and teaching are largely invisible. In apprenticeship learning—and informal job training in American workplaces—it looks as though little teaching is going on. Whatever instruction the apprentice receives, originates not from a teacher teaching, but from a worker doing his or her work that the apprentice observes.

In short, apprentices are inducted into a *community of expert practice* in which the "teacher" continuously engages in and is a master at the practice being learned. His or her performance constitutes the standard for the apprentice.

Actual Trials. Clearly, traditional apprenticeships are not entirely transferable to a modern society where many skills, such as mathematics, law, or computer-based machining, are at best only partly visible. Because of this, cognitive scientists have conducted a number of trials of effective learning situations and curricula appropriate for learning today's less visible practices. These efforts span a number of subjects—mathematics, physics, reading, writing, and interior design.

Cognitive Apprenticeship Models

These precedents—nineteenth century innovations, analyses of traditional apprenticeships and of the spectacular learning by the young child, actual attempts by cognitive scientists to create different kinds of learning environments, and an extensive body of cognitive science research—add up to a solid foundation for designing effective learning environments. Collins, Brown, and Newman (1989) have proposed a model of "cognitive apprenticeship" incorporating key elements of those environments.

The model ignores the usual distinctions between academic and vocational education, its objective being to initiate the novice into a community of expert practice. The model presumes that learning is learning, however we label the subject. In fact, as the American economy and its skill requirements restructure, many "vocational" domains involve substantial amounts of symbolic activity, and the distinction between vocational and academic is rapidly becoming less useful.

Ideal Learning Environments. The Collins, Brown, and Newman model has four building blocks—"content," "methods," "sequence," and "sociology." Many parts of this model are not new, but *together* they define an effective learning situation, with very different classrooms and roles for teachers and students.

Content

Schools usually focus exclusively on the concepts, facts, and procedures of a subject. To operate effectively in any setting, however, students also need three other types of content:

1. "Tricks of the trade"—problem-solving strategies that experts pick up with experience.
2. Cognitive management strategies —goal setting, strategic planning, monitoring, evaluation, and revision.
3. Learning strategies—knowing how to learn, including exploring new fields, getting more knowledge in a familiar subject, and reconfiguring knowledge already possessed.

Methods

Teaching methods should give students the chance to observe, engage in, invent, or discover expert strategies in context. The Collins, Brown, and Newman model includes a variety of methods that systematically encourage student exploration and independence.

Teachers coach—offering hints, feedbacks, and reminders; provide "scaffolding"—support for students as they learn to carry out tasks; and "fade"—gradually handing over control of the learning process to the student.

Sequencing

Learning should be staged so that the learner builds the multiple skills required in expert performance and discovers the conditions under which they apply. This requires a sequence of increasingly complex tasks, increasingly diverse problem-solving situations, and the staging of learning so that students develop a feel for the overall terrain before attending to details.

Sociology

The learning environment should reproduce the technological, social, time, and motivational characteristics of real world situations where what is being learned will be used. It is only through encountering subject matter knowledge in context that most students will learn when, where, and how the knowledge applies to other situations. For example, in the real world, people have to work with others; this model calls for students to work together to solve problems and carry out tasks.

An Example of Cognitive Apprenticeship. There are instances of such apprenticeships in high school courses and projects, designed by high school teachers.

Students from Conval High School in Peterborough, New Hampshire, built and raced a solar-powered car as an applied science project. The project evidenced all four blocks of the cognitive apprenticeship model. The project extended over nine months, an unusually long time frame for a school, but a realistic one for real world tasks. The project required the students to acquire and use a wide variety of skills spanning many academic and practical disciplines, including physics and mathematics, solar engineering, hydraulics, electronics, drafting, model fabrication, metal working, and welding.

The students also had to acquire business skills to manage grant funds, and English, journalism, and graphics skills for a public relations effort. To the surprise of the students, they also had to acquire leadership, management, and interpersonal skills to divide the labor rationally and keep the project moving forward.

How Do Cognitive Apprenticeship Ideas Fit Current Policies and Programs?

How do these ideas fit into policy discussions about (1) integrating academic and vocational education, (2) work-based apprenticeship, (3) technical preparation ("tech prep") and 2+2 programs, and (4) cooperative education?

1. Models for Integrating Academic and Vocational Education (Grubb and Plihal, 1990).

The curricular (what) and pedagogic (how) principles of cognitive apprenticeship are not only consistent with integration ideas. *They in fact rigorously define what a vocationally and academically integrated learning environment looks like.*

The best of vocational education reflects several of the pedagogic principles of cognitive apprenticeship; the best of academic education, its content principles. Thus, *cognitive apprenticeship can function as the model for integrating academic and vocational education*—the model for what to teach and for how to teach it.

Good vocational education is more apt than academic education to use some of the methods of cognitive apprenticeship (such as modeling and coaching) and contextualized and cooperative learning. However, it is generally weaker on the content side—in academic knowledge and the higher-order cognitive skills. The principles of cognitive apprenticeship *systematically* preserve and integrate the best of academic and vocational education into a single model that can be used to teach either academic subjects like mathematics or vocational subjects like interior design.

We now see elements of cognitive apprenticeship in integrated programs, but these elements are often implicit or accidental; they are rarely the result of explicit design, and they are not routinely found.

2. Work-Based Apprenticeship.

At least two factors have sparked the interest in work-based apprenticeships. One is the lack of a national system to move young people from school into the workplace. The other is the recognition that most school-based programs—even many vocational ones—are divorced from the needs of the workplace.

But must apprenticeships be work-based? One assumption is that the best way to move youth into the workplace is to put them there. Another seems to be that if schools are bad learning places for work, workplaces must be good places—which may turn out to be true, but is bad logic. In fact, evidence on informal on-the-job training and on employers' training investment patterns suggests that workplaces are not good learning places for the young or the less educated (Scribner and Sachs, 1990; Tan, 1989). Unless work-based apprenticeships are deliberately designed for *learning*, they will have potentially serious holes and inefficiencies.

A cognitive apprenticeship strategy should be able to deliver powerful learning relevant to the workplace in a school-based environment. The principles of cognitive apprenticeship were derived from school-based programs. And recent work indicates that cognitive apprenticeship is compatible with learning the generic skills of the modern workplace

Institute on Education and The Economy
Box 174, Teachers College, Columbia University
New York, New York 10027
212-678-3091
Director: Sue E. Berryman

(Berryman, 1990; SCANS, 1991; Stasz et al., 1990).

3. Technical Preparation ("Tech Prep") and 2+2 Programs.

In federal law, technical preparation denotes a four-year curriculum, starting in the last two years of high school and culminating in a two-year associate degree in a technical field of work—hence "2+2." The courses are expected to integrate academic and vocational content and to be vertically integrated across the four years and across high schools and community colleges. The relationships between these programs and cognitive apprenticeship are the same as those for integrated academic/vocational models, discussed above.

4. Co-Operative Education.

Co-operative education is a school-based effort to facilitate learning at work. The classroom instructor arranges job placements, writes a training plan detailing what each student is expected to learn on the job, and visits job sites to monitor the training. Job supervisors evaluate students' performances in terms of training objectives (Stern, 1990). In theory, cognitive apprenticeship principles could be built into co-op programs. In reality, however, co-op programs have to take the workplace as they find it, fitting training plans around the uneven training skills of supervisors and the uneven (and often limited) authority of supervisors to alter the work process to support learning.

In the Final Analysis: How Effective Is Cognitive Apprenticeship?

We do not yet know, especially if the question is whether cognitive apprenticeship is effective in routine, as opposed to hothouse, learning situations. However, the ideas are unusually well-grounded. Cognitive apprenticeship strategies build on traditional apprenticeships, a tested, cross-cultural strategy for effectively acquiring visually observable skills. They also build on and incorporate the ideas and findings of a community of serious thinkers and researchers, from John Dewey to today's cognitive scientists.

However, there are very few learning situations that reflect cognitive apprenticeship principles. Extending the ones that exist and creating new ones requires dealing with regulatory, institutional, curricular, pedagogic, assessment, and professional training issues. The model itself will change as we gain experience with it in the bruising real world of teaching and learning.

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This Brief is a distillation of a paper by Sue E. Berryman entitled, *Cognitive Science: Challenging Schools to Design Effective Learning Environments*. The paper is available from the Institute on Education and the Economy for $7.50. Please prepay orders with checks payable to IEE Publications.