Anchored Instruction and Its Relationship to Situated Cognition

THE COGNITION AND TECHNOLOGY GROUP AT VANDERBILT

In a recent Educational Researcher *article, Brown, Collins, and Duguid (January–February 1989) discussed the concept of situated cognition. We explore relationships between this concept and our Technology Center's work on anchored instruction. In the latter, instruction is anchored (situated) in videodisc-based, problem-solving environments that teachers and students can explore.*

We argue that situated cognition provides a broad, useful framework that emphasizes the importance of focusing on everyday cognition, authentic tasks, and the value of in-context apprenticeship training. Anchored instruction provides a way to recreate some of the advantages of apprenticeship training in formal educational settings involving groups of students. In addition, some of the principles of anchored instruction may make it possible to create learning experiences that are more effective than many that occur in traditional apprenticeship training. Together, the situated cognition and anchored instruction perspectives suggest ways to think differently about instruction, and they suggest important issues for future research.

Educational Researcher, Vol. 19, No. 6, pp. 2–10

During the past several years, members of Vanderbilt's Learning Technology Center[1] have been experimenting with new ways to structure the learning experiences of students. Our ultimate goal is to help students develop the confidence, skills, and knowledge necessary to solve problems and become independent thinkers and learners (see also Baron & Sternberg, 1987; Bransford, Sherwood, Vye, & Rieser, 1986; Ennis, 1987; Nickerson, 1987; Resnick, 1987; Salomon & Perkins, 1989; Schwartz, 1987; Simon, 1980; Sternberg, 1985). We have come to believe that recent computer and videodisc technologies make it easier to achieve these objectives.

One of our goals here is to discuss some of our research on the effects of situating instruction in videodisc-based, problem-solving environments (we call this the "anchored instruction" approach). A second goal is to relate our ideas on anchored instruction to the concept of situated cognition that was discussed in this journal by Brown, Collins, and Duguid (1989). Our paper is divided into three major sections: (a) theoretical and empirical background of anchored instruction, (b) discussion of two projects involving anchored instruction, and (c) discussion of relationships between anchored instruction and situated cognition.

Background of Ideas Leading to Anchored Instruction

Like Brown et al. (1989) and other researchers (e.g., Porter, 1989; Scardamalia & Bereiter, 1985), our thoughts about problems with traditional approaches to instruction have been influenced by Whitehead's (1929) discussion of what he termed the *inert knowledge* problem. Inert knowledge is knowledge that can usually be recalled when people are explicitly asked to do so but is not used spontaneously in problem solving even though it is relevant. Whitehead was instrumental in calling attention to the phenomenon of inert knowledge. He also made the provocative claim that, in schools, information was particularly likely to be presented in ways that make it inert (see also Gragg, 1940; Simon, 1980).

Bereiter (1984) provided an informative illustration of the inert knowledge problem. He described a situation in which a teacher of educational psychology gave her students a long, difficult article and told them they had 10 minutes to learn as much as they could about it. Almost without exception, the students began with the first sentence of the article and read as far as they could until the time was up. Later, when discussing their strategies, the students acknowledged that they knew better than to simply begin reading. They had all had classes that taught them to skim for main ideas, consult section headings, and so forth, but they did not spontaneously use this knowledge when it would have helped.

In Sherwood, Kinzer, Hasselbring, and Bransford (1987), we discussed an additional illustration of inert knowledge. We asked entering college students to explain how knowledge of logarithms might make it easier to solve problems,

THE COGNITION AND TECHNOLOGY GROUP AT VANDERBILT *is a multidisciplinary team of researchers located at the Learning Technology Center, Vanderbilt University, Nashville, Tennessee 37203.*

why were they invented, and what were they used for. The vast majority of the students had no idea of the uses for logarithms. They remembered learning them in school but they thought of them only as math exercises performed to find answers to logarithm problems. The students treated them as difficult ends to be tolerated rather than as exciting inventions (tools) that allowed a variety of problems to be solved. Imagine that our students had entered a contest that required them to multiply as many sets of large numbers as possible within an hour. The students could use anything they wanted to help them except a calculator or a computer. It is doubtful that they would have asked for tables of logarithms even though the tables could serve as extremely helpful tools.[2]

It is useful to contrast the mechanical procedure knowledge of logarithms that we found with entering college students to the understanding suggested by Jacobs' (1970) citation of John Briggs, an astronomer who lived in the 1600's:

> Logarithms are numbers invented for the more easy working of questions in arithmetic and geometry. By them all troublesome multiplications are avoided and performed only by addition. . . . In a word, all questions not only in arithmetic and geometry but in astronomy also are thereby most plainly and easily answered. (p. 160)

For Briggs and his fellow astronomers, logarithms were understood to be powerful tools that greatly simplified their lives.

We are indebted to theorists such as Dewey (1933) for helping us understand the importance of viewing knowledge as tools (e.g., Bransford & McCarrell, 1974). As Dewey noted, when people learn about a tool they learn what it is and when and how to use it. When people learn new information in the context of meaningful activities (e.g., when Briggs and colleagues learned how logarithms helped them understand astronomy), they are more likely to perceive the new information as a tool rather than as an arbitrary set of procedures or facts. In several demonstration studies, we have shown that one of the advantages of learning in problem-solving contexts is that students acquire information about the conditions under which it is useful to know various concepts and facts (Bransford, Sherwood, & Hasselbring, 1988). We have also discussed how the learning successes of young children strongly depend on their opportunities to learn in meaningful, socially organized contexts (Sherwood, Kinzer, Bransford, & Franks, 1987; Bransford & Heldmeyer, 1983). Furthermore, laboratory studies indicate that meaningful, problem-oriented approaches to learning are more likely than fact-oriented approaches to overcome inert knowledge problems (e.g., Adams, Kasserman, Yearwood, Perfetto, Bransford & Franks, 1988; Lockhart, Lamon, & Gick, 1988).

Of course, the idea that one needs to make information meaningful and useful to students is hardly new. Teachers usually try to provide examples of how information is useful. When teaching logarithms, for example, a teacher or textbook author might discuss how logarithms make it easier to solve computational problems. However, statements about one or two potential applications of concepts are still a long way from the situation characteristic of the 17th-century astronomers who were discussed earlier. The astronomers were intimately familiar with the kinds of problems that they confronted when trying to do their astronomy. They lived with these problems and had to spend a large portion of their time with tedious calculations. For them, logarithms did not represent a specialized tool that was useful for only one or two textbook-like problems. Logarithms represented a tool that could be used every day.

Anchored Instruction

The major goal of anchored instruction is to overcome the inert knowledge problem. We attempt to do so by creating 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. We also attempt to help students experience the value of exploring the same setting from multiple perspectives (e.g., as a scientist or historian).

Our work on anchored instruction derives from insights by theorists such as Dewey (1933) and Hanson (1970), who emphasized that experts in an area have been immersed in phenomena and are familiar with how they have been thinking about them. When introduced to new theories, concepts, and principles that are relevant to their areas of interest, the experts can experience the changes in their own thinking that these ideas afford. For novices, however, the introduction of concepts and theories often seem like the mere introduction of new facts or mechanical procedures to be memorized. Because the novices have not been immersed in the phenomena being investigated, they are unable to experience the effects of the new information on their own noticing and understanding.

The general idea of anchored instruction has a long history. Dewey discussed the advantages of theme-based learning. In 1940, Gragg argued for the advantages of case-based approaches to instruction. One variation of case-based instruction is to use a variety of minicases that serve as *microcontexts* that focus on a specific subset of a larger problem or domain. Rather than anchoring instruction in such circumscribed contexts, we anchor instruction in complex problem spaces. We refer to these as *macrocontexts*. Macrocontexts enable the exploration of a problem space for extended periods of time from many perspectives. They serve as environments for cooperative learning and teacher-directed mediation (e.g., Bransford, Goin, Hasselbring, Kinzer, Sherwood, & Williams, 1988; Bransford, Sherwood, Hasselbring, Kinzer, & Williams, in press; Feuerstein, Rand, Hoffman, & Miller, 1980; Vygotsky, 1978).

For several reasons, we prefer our contexts to be in visual rather than textual formats and to be on videodisc rather than videotape (see also Miller & Gildea, 1987; Spiro, Vispoel, Schmitz, Samarapungavan, & Boerger, 1987). One reason is that visual formats allow students to develop pattern recognition skills. (A major disadvantage of text is that it represents the output of the writer's pattern recognition processes; see Bransford, Franks, Vye, & Sherwood, 1989.) Another reason is that video allows a more veridical representation of events than text; it is dynamic, visual and spatial; and students can more easily form rich mental models of the problem situations (e.g., Johnson-Laird, 1985; McNamara, Miller, & Bransford, in press). This is particularly important for low-achievement students and for students with little knowledge in the domain of interest (Bransford, Kinzer, Risko, Rowe, & Vye, 1989; Johnson, 1987). A third reason for using videodisc technology is that it has random-access capabilities; this allows teachers to almost instantly access information for discussion (see Sherwood et al., 1987). Because one of our primary goals is to help students explore the same domain from multiple perspectives, the random-access capabilities are particularly useful for our work.

The Young Sherlock Project

The idea of anchored instruction can be illustrated by our Young Sherlock project that has been in place in two 5th-grade classrooms during the past 2½ years.[3] We are working with teachers and their classes of below-average and average 5th-grade students for approximately 4 hours each week for the entire school year. The project is designed to help students learn language arts and social studies content.

We are using two different approaches to analyze the Young Sherlock project: (a) an ethnographic analysis of the experimental classes, and (b) experimental measures contrasting pretest and posttest findings for experimental groups that receive the Young Sherlock anchor and comparison groups that do not. As much as possible, we have tried to ensure that the content taught to the experimental and comparison groups is of high quality and is identical in the sense that both receive the same information about story structures, historical facts, and targeted vocabulary, and both receive the same amount of time on major activities such as story writing. For the experimental group, all instruction is anchored (situated) in a macrocontext that involves explorations of the movie *The Young Sherlock Holmes* (the major anchor) or the movie *Oliver Twist* (a secondary anchor situated in the same time period as Sherlock). For the comparison group, we attempt to deliver outstanding instruction each day, but we situate it in a variety of different microcontexts (e.g., story A, story B, etc.) that vary across lessons. Some illustrations of topics explored by both groups are provided in the following discussion (see also Bransford, Kinzer, Risko, Rowe, & Vye, 1989; Bransford, Vye, Kinzer, & Risko, in press).

Story structures. We wanted to help students in both the experimental and control groups learn to write interesting stories. Therefore, we helped them understand the complexity of good stories by focusing their attention on a character's traits and motives for actions, and on conflicts between the protagonist and antagonist that lead to attempts to solve problems.

In our experimental groups all instruction about different aspects of well-formed stories (initiating events, character development, etc.) focused on the primary anchor *Young Sherlock* and on books (stories involving Sherlock) and video (*Oliver Twist*) that are highly related to that anchor. In contrast, our comparison groups received instruction similar to many basal reading programs in which students are introduced to the same content in the context of stories that vary from lesson to lesson. Thus, in one lesson students may read a folk tale and be asked to focus on examples of personality traits differentiating the protagonist and antagonist. In another lesson students may read a mystery and discuss the idea of setting. We are concerned that this type of instruction often fails to develop integrated knowledge structures that help students transfer to more complex tasks (e.g., writing a story of one's own). Our data indicate that in comparison to the stories written by students in our nonanchored groups, students in our anchored groups wrote stories that contained many more story elements; their plots were more likely to link character actions and events to goal statements and goal resolution (see Risko, Kinzer, Goodman, McLarty, Dupree, & Martin, 1989).

Historical accuracy. Most instruction about story structure includes a focus on the setting of a story, but setting is often analyzed only superficially. We analyzed setting in depth by focusing on the goal of assessing the historical accuracy of the Sherlock movie. It is set in turn-of-the-century England. One of our goals was to help students develop rich mental models of what it was like to live at certain important times in history. By acquiring these models of landmarks in history, we hope to build a basis for lifelong learning. As new historical facts are encountered throughout a student's lifetime, we assume that these could easily be related to these models and should be much easier to understand and retain. Our findings indicate that students in our anchored group remembered much more about turn-of-the-century history than did those in the comparison group (Risko et al., 1989).

A second, related goal was to help our students notice relevant historical information in movie settings and use it to make inferences such as those involving different characters' actions and motives. Our approach to helping students learn to notice and use relevant information is to prompt them to actively explore the video and look for clues to historical and geographic accuracy. For example, early in the Sherlock film a young Watson notes that he is in London in December in the middle of the Victorian era. This 10-second scene contains a number of clues that students can explore in more detail. Where is London? (Ideally all middle-school students know, but unfortunately many do not.) Does it really snow in London, and if so, does it snow in December? (Students can read the geography sections of their social studies texts to find out about climate.) What was the Victorian era and when was it at its height? Assuming that the date is the 1880s to 1890s, is it accurate for Watson to be riding in a horse-drawn carriage rather than using other transportation such as a car? Our students are asked to find or notice aspects of scenes that are relevant for assessing historical accuracy. They then do a great deal of reading in order to research the authenticity of the movie's details. Our findings indicate that students in the anchored groups are much more likely to use historical information to make inferences about the motives of characters in new turn-of-the-century stories they read and videos they see (see Kinzer & Risko, 1988).

Issue finding. The rich context provided by the video frequently invites students to find and define their own issues to explore. For example, during the ethnographic analysis of one of the Sherlock classrooms, Debbie Rowe and Prisca Moore captured the following conversation about one of the scenes from Sherlock on tape:

Barbara:	All the darts hit in the neck. Why?
John:	It's closer to the brain.
Kristin:	Why wouldn't they hit them in the head, that's closer to the brain!
Teacher:	Why wouldn't they have hit him in the head?
Jane:	It could have killed him.
Tyrone:	Because it might be like, because you might not feel it as much in the neck.
Bob:	It may be a blood vein, and you hit'em and

that would send it into the circulation. Another thing, if it hits him in the head, and it hit the skull, and hit the bone, so nothing would happen.

Kristin: If it had hit him in the head, it would probably bounce off.

Teacher: Why would it bounce off Kristin?

Kristin: All the hair. [Bob is mumbling in the background that it wouldn't bounce off. He doesn't buy Kristin's idea.]

Shamika: I have this body chart, and it has a vein right here [points to neck] and it is the main blood vein that travels up your neck.

Teacher: What is the name of that vein?

Shamika: It's the main vein that comes up from your arm.

Bob: [on your head] You've got hair, then the skin, then the skull you've got to go through just to get to the brain. On the neck their's no hair, and the skin won't stop it.

Tyrone: You've got clothes.

Teacher: Do you have bones in your neck?

John: In health we are studying the skeleton. [Barbara gets up and goes over to the chalkboard to look at a chart entitled "All kinds of skeletons." Teacher suggests that they could ask their health teacher, who they tell her is Mr. A. Derek says his Mom works at the health department. Teacher suggests maybe they can ask her.]

This is just one example of many discussions that were initiated by students who noticed some particularly interesting event and began to talk with other students. Rowe and Moore are still analyzing their ethnographic data but they have been struck by the high-quality discussions found in the Sherlock classroom. The questions students ask are genuine and they are motivated to answer them. This often prompts trips to the library and decisions on where to look in order to achieve specific goals. Overall, the video helps provide motivation and well-defined goals for reading in order to learn.

The initial ethnographic data also make it clear that students in the anchored group spontaneously use new, targeted vocabulary when it becomes relevant. One of the students' motivations for doing so is the desire to describe what is going on in the movie (e.g., "she is being imaginative here whereas he is being pompous"). Students also spontaneously use a number of targeted vocabulary words when referring to themselves (e.g., we need to be "perceptive"). Our experimental data indicate that students in the anchored group are much more likely to use newly targeted vocabulary spontaneously than are those in the comparison group (Risko et al., 1989).

The Jasper Series

A second anchored-instruction project that we are conducting is sponsored by the James S. McDonnell Foundation and Vanderbilt University and is designed to develop and evaluate a series of videodisc adventures whose primary focus is on mathematical problem formulation and problem solving.[4] This project also involves the development of applications that will enable students to learn science, history, and literature concepts.

The videodiscs that we are developing involve the adventures of a person named Jasper Woodbury.[5] We have completed two adventures and envision a series comprising 6 to 10 adventures. The adventures are designed for fifth and sixth grade, although we have worked with students as young as fourth graders and as old as college freshmen.

The first Jasper disc poses a very complex mathematical problem that involves the generation of approximately 15 subgoals. Its complexity was intentional. Students are not routinely provided with the opportunity to engage in this kind of mathematical thinking (e.g., Bransford, Hasselbring, Barron, Kulewicz, Littlefield, & Goin, 1988; Porter, 1989; Schoenfeld 1985; Sternberg, 1986). We believe that 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.

An important design feature of the Jasper adventures is what we have called "embedded data design." Students have to generate the problems to be solved and then have to find relevant mathematical information that was presented throughout the video story. All the data needed to solve the problem are embedded in the story.

Here is a brief overview of the first adventure. In the first scene we meet Jasper and learn that he is going to Cedar Creek to look at an old cruiser that he is interested in buying. He sets out for Cedar Creek in his little motorboat. On the video, Jasper is shown consulting a map of the area, listening to his marine radio, and so forth. As the story continues, Jasper stops for gas at Larry's dock. He leaves Larry's after buying gas with his only cash—a twenty dollar bill—and sets out up river. He runs into a bit of trouble when he hits something in the water and breaks the shear pin of his propeller. Jasper rows to a repair shop where he pays to have his shear pin replaced. He finally reaches Cedar Creek boat dock where he locates Sal, the cruiser's owner. He and Sal test drive the cruiser and find out the boat's cruising speed. They return to the dock where they fill the cruiser's gas tank (it is an old cruiser and the tank is a small, temporary tank that is being used until the real ones are fixed). Jasper decides to buy the cruiser and he and Sal conclude the transaction.

At the end of the video we see Jasper asking himself when he needs to leave and whether he can make it home without running out of gasoline. At this point students are challenged to engage in the problem-finding and problem-solving activities that were mentioned earlier. Students must identify Jasper's major goal (to get home before sunset without running out of gas), generate the subproblems that represent obstacles to this goal (e.g., running out of gasoline), and devise strategies to deal with various subproblems.

It is at this point that the embedded data design of Jasper becomes important. Throughout the story, students have been exposed to information that now becomes relevant for Jasper's decision. For example, Jasper must decide if he can pilot the boat home before dark without running out of fuel. The map from a scene shown early in the movie becomes useful for calculating the distance between Cedar Creek and Jasper's home dock. Also, the voice on Jasper's marine radio gave the time of sunset, which is one piece of information that is needed to determine the time available for Jasper's return trip (time of sunset is routinely broadcast on the weather channel of marine radios). Many other facts are embedded throughout the video. The embedded data design allows teachers to help students try to generate what they need to know, attempt to retrieve this information from memory, and then scan back on the disc to see if they were accurate.

Initial findings. The need to provide experiences with complex examples of problem formulation and problem solving is illustrated by our pretest data with sixth graders. Although these students had scored above average on standard mathematics achievement tests (Vye et al., 1989), they were extremely poor at problem identification and formulation when no instruction was provided (we expected these findings because students have few experiences like this). However, our data also indicate that 5th-grade students can become very good at complex problem formulation on tasks similar to Jasper after working with Jasper in cooperative learning groups for 4 to 5 class sessions (Van Haneghan, Barron, Young, Williams, Vye, & Bransford, in press). We also find that teachers have been extremely enthusiastic about Jasper, mainly because their students seem to be challenged to solve the problems and because even students who normally are not good at math can contribute to problem solving; for example, they may have noticed information in the video that is relevant for solving Jasper's problem.

Facilitating broad transfer. We assume that spontaneous transfer will be limited if students work only in the Jasper boating context (e.g., Bransford, Sherwood, Vye, & Rieser, 1986; Brown, Bransford, Ferrara, & Campione, 1983; Gick & Holyoak, 1980; Nitsch, 1977; Salomon & Perkins, 1989). Our current goal is to create a series of 6 to 10 Jasper discs that can provide a foundation for using key mathematics concepts in a variety of realistic settings and opportunities for explicitly training for transfer. A second disc in the series has also been completed. It involves an ultralight airplane flight in order to save a wounded eagle. Students must determine the fastest way to get to the eagle and transport it to a veterinarian without running out of gasoline and without exceeding the weight limitations of the ultralight. The problems to be formulated and solved are similar to the basic problem in Jasper; this allows students to discuss the analogies between the first and second episode and experience the fact that it becomes much easier to solve these types of problems the second time around. Evidence from other research projects suggests that an explicit emphasis on analyzing similarities and differences among problem situations and on bridging new areas of application facilitates the degree to which spontaneous transfer occurs (e.g., Bransford, Stein, Delclos, & Littlefield, 1986; Campione, Brown, & Connell, 1988; Littlefield, Delclos, Lever, Clayton, Bransford, & Franks, 1988; Salomon & Perkins, 1989).

Plans to create additional discs for the series are currently being formulated. The guidelines suggested by the National Council of Teachers of Mathematics (NCTM, 1989) have been very helpful in this regard. In addition, we are in the process of creating computer databases to accompany the discs in the Jasper series. These provide an opportunity to add new problems that students can work on. As a simple illustration, a database being developed for the Jasper boat adventure includes historical information relevant to life during the times of Mark Twain. When studying Mark Twain's world, it is very instructive for students to see how plans to go certain distances would be very different if Jasper could only travel by raft. For example, a 3-hour motorboat trip would take the better part of a day by raft. Thus, drinking water, food, and other necessities would need to be included in one's plans.

As another illustration of database problems, consider water current problems for boats and headwind and tailwind problems for airplanes. We purposely kept details about these factors simple in the boat and ultralight adventures. Nevertheless, it is an easy matter to get students to imagaine that weather or water conditions were slightly different from those shown in the video. Instead of the calm day shown in the ultralight adventure, there could be a tailwind of 20 mph on a flight from city A to city B that would become a headwind on the return flight. Does the wind's effect on flight time cancel itself out for the entire trip? With a slight twist, winds can also be imagined as coming from an angle (rather than pure headwinds or tailwinds). This variation can help students understand the value of new types of mathematics such as trigonometry.[6]

Overall, the database can help students learn history, science, geography, and other subject matters while also continuing to use quantitative reasoning in order to better understand the information being explored. Students also like to find their own problems and issues and add this information to the database. Their contributions can contain information about who submitted them, so students can be published in the school (or regional) database.

Relationships Between Anchored Instruction and Situated Cognition

Our experiences with the two projects previously discussed indicate that there are many benefits of anchoring or situating instruction in videodisc-based, problem-solving environments (see also Sherwood, Kinzer, Bransford, & Franks, 1987; Sherwood, Kinzer, Hasselbring, & Bransford, 1987). Our goal in this section is to discuss some general principles that represent our current thinking about anchored instruction. Our ideas about anchored instruction are still in the formative stage. We are attempting to formulate principles that can guide the selection or production of anchors plus guide the types of teaching activities that are associated with these anchors. We have derived some of our principles from the situated-cognition framework discussed by Brown et al. (1989), building particularly on their discussions of apprenticeships and authentic tasks. Additional principles of anchored instruction may help us improve on naturally occurring apprenticeships.[7]

Everyday Cognition, Apprenticeships, and Authentic Tasks

Brown et al. (1989) emphasized the importance of looking carefully at what we know about everyday cognition and of creating apprenticeships composed of authentic tasks. They noted that authentic activities are most simply defined as the "ordinary practices of the culture" (p. 34). Our anchored-instruction projects simulate apprenticeships that comprise authentic tasks.

Sherlock and authentic tasks. In our Sherlock project students explored the *Sherlock* and *Oliver Twist* videos in terms of (a) story structure, (b) historical accuracy, (c) resolution of student-generated issues (e.g., why did they always shoot the arrows into the neck?), and (d) student-generated productions (stories, articles for the Sherlock newsletter, and presentations for other members of the class). Are these anything other than arbitrary, school-like tasks?

Imagine being apprenticed to a film writer and producer who care about historical accuracy. Activities such as those involved in the Sherlock project are very authentic here. First, movie producers who worry about historical accuracy must do a great deal of research in order to evaluate scripts. Second, good movie writers create interesting stories that comprise interrelated sets of substories. By analyzing what these are like in various movies, apprentices begin to understand how to produce their own. Third, actions and dialogue in good movies are well-motivated, hence scenes like shooting arrows into a neck need to make sense from a factual perspective. Fourth, apprentice scriptwriters must eventually try their hand at writing.

For each of the preceding activities the students in the Sherlock project did a great deal of reading for specific purposes, and they had to find relevant information in the library and elsewhere. Reading activities that require students to find potentially relevant texts and decide if they are appropriate for their current goals are very authentic; much more so than the more typical approach to reading instruction where the teacher selects the texts and the comprehension goals.

A focus on everyday cognition and authentic tasks also reminds us that novices who enter into a particular apprenticeship have a reasonable chance to develop expertise, in part because apprentices have the opportunity for sustained thinking about specific problems over long periods of time. The Sherlock project was designed to provide a macrocontext for sustained thinking about particular issues, such as mysteries and turn-of-the-century life in England. Thus, our students had the chance to develop a considerable amount of expertise in these domains. They also had the opportunity to specialize. For example, in the first year of the Sherlock project, a girl who was considered learning disabled and who rarely contributed in her other classes became the class expert on Queen Victoria. She kept reading more and more about the Queen and classmates soon looked to her for information in this area. Needless to say, the girl became a much more enthusiastic participant in class. The important point for present purposes is that, in many classroom settings, the benefits of specializing in a single area (e.g., Queen Victoria) are not available because there is no opportunity for sustained thinking about a particular topic (e.g., Victorian England). Usually, the major topics explored in classes are ephemeral and change nearly every day.

The importance of the situated cognition framework for providing instructional guidelines can also be seen by considering modifications we made in the Sherlock project after our first year. At the end of this year, our students told us that they really liked the program but wanted a better idea about its purposes. During the second year we moved closer to an apprenticeship model and let our students see—at the beginning of the year—the kinds of activities (e.g., producing a short video production of one's own) that represent the culminating goal of their Sherlock apprenticeship. We also tried to help students understand how each task they were working on related to the overall goal. In addition, the goal of creating products for the Sherlock project (videotapes, newsletter articles, text-plus-video productions) was made more authentic by increasing the extent to which they were shared with real audiences such as other classes of peers.

Authenticity in the Jasper context. Consider our work with the Jasper context. The degree to which our instruction involves authenticity can be analyzed from several points of view. A first level of authenticity involves the objects and data in the setting. We considered this factual level of authenticity when designing episodes I and II of Jasper. For example, in the boat setting we had Jasper get a weather report from the marine radio (which is where boaters get such information), we used speeds and miles-per-gallon figures that were realistic for the boats in the video, we used formats for river maps that, though somewhat oversimplified compared to real boating charts, were true to life (e.g., they showed mile markers and other appropriate symbols). The airplane adventure is also factually authentic. Speeds, fuel consumption, required distances for takeoff of the ultralight, weight limits, and so forth are all very similar to actual values in everyday life.

A second level of authenticity—the one emphasized by Brown et al. (1989) and Pea (personal communication, February 23, 1989)—involves the degree to which the tasks that students are asked to perform are authentic. Each of the details in a setting could be authentic but the tasks given to students could be contrived. For example, Jasper could pose arbitrary problems like "If Jane had two marine radios and Mark had three, how many would they have altogether?"

In both episodes of Jasper, the tasks to be performed require students to make and evaluate decisions that seem quite authentic; namely, decisions about when to leave in order to ensure getting somewhere before a specific deadline (motorboat adventure) and decisions about the fastest way to get somewhere and return (ultralight adventure). It is authentic to be exposed to information (e.g., about weather predictions, gasoline consumption, etc.) and only later have it become relevant when specific needs arise and specific goals are formulated. It is also authentic to have to plan by *generating* sets of subproblems to be solved (e.g., "I have to see if I have enough money to buy gas") rather than by simply having specific word problems presented by someone else (e.g., Lesh, 1985; Porter, 1989).

Yet for whom are these tasks authentic? We designed the Jasper discs to help students learn to think mathematically, but our instruction does not focus on the kinds of experiences one might expect from an apprenticeship to a true mathematician (e.g., Schoenfeld, 1985, 1988). The focus of the two Jasper episodes is on the kinds of apprenticeship that one might hope to get from a well-informed parent or "mediator" (Feuerstein, et al., 1979, 1980) who helps his or her children reflect on the types of skills and concepts necessary to deal with problems that can occur in everyday life.[8]

We noted in our discussion of the Sherlock project that a focus on everyday cognition also raises the question of whether it is reasonable to assume that novices who enter into a particular apprenticeship have a chance to develop expertise. In Jasper, the idea of a series of 6 to 10 adventures makes it reasonable to believe that students will have the opportunity to develop expertise in solving a variety of planning problems. Without the opportunity for extended practive on a similar set of problem types, we would not expect the opportunity to work with Jasper to have much of an overall impact on students' knowledge and skills. Equally important, analyses of cognition in everyday settings reveal the use of a number of labor-saving inventions that reduce or eliminate the need for time-consuming computations and hence distribute intelligence across the environment (Bransford & Stein, 1984; Brown et al., 1989; Lave, 1988; NCTM, 1989; Pea, 1988). For example, many cars now have trip-planning computers that make it easy to estimate fuel consumption and arrival time. Thanks to suggestions from the situated cognition perspective (viz., Pea, 1989), we are designing materials to accompany the Jasper series that provide an opportunity to select and invent appropriate "intelligence-enhancing" tools. The opportunity to work with Jasper becomes most authentic as students adopt the goal of designing Jasper-related materials (e.g., new problems on concepts relevant to Jasper) that can be used by others. When these ideas can be shared with students across the country via telecommunications, the motivation to produce quality materials becomes very high.

Designing Efficient Apprenticeships

A major challenge for the situated cognition perspective involves issues of feasibility (e.g., Palincsar, 1989; Wineburg, 1989). One obvious advantage of anchoring instruction in videodisc-based macrocontexts is that it makes the idea of transforming school instruction into apprenticeships more feasible. It is easier to teach problem solving in the context of a Jasper videodisc than to put a class full of students on a boat or in a plane. One advantage of the videodisc context is its compression of time; hours and days can be compressed into minutes. In addition, the videodisc allows students to revisit segments and test their memories against actual events—something that is generally not possible in everyday life. In short, anchored instruction as we currently envision it has the potential to create learning experiences that are more effective than many that occur in traditional apprenticeship training.

We believe that the idea of revisiting scenes has implications for transfer. A problem with many situations in which knowledge has been acquired in real-world contexts is that this knowledge tends not to transfer to other settings (e.g., Brown et al., 1989). A major goal of our current research on anchored instruction is to discover ways to help students develop knowledge that is usable in a variety of contexts. Because we can revisit scenes in our videodisc environments, we can encourage students to engage in activities that can be difficult to orchestrate in real-world environments. The ideas of having students *find* as well as solve problems, and of providing them with the opportunity to compare environments and to experience the same events from *multiple perspectives*, seem particularly important in this regard.

Consider two different mentors. Master plumber A may work with an apprentice by going on a plumbing job and providing directives such as "loosen that joint," "turn that valve," and so forth. Master plumber B may take a very different approach and first ask the apprentice what his diagnosis of the plumbing problem is and why. Plumber B might then contrast the novice's analysis with her or his own point of view. Analogous differences in teaching strategies can occur in any type of apprenticeship. For example, some parents have been observed using a very directed approach to teaching their children to accomplish particular goals; others used much more of a guided discovery approach (see Burns, Haywood, & Delclos, 1987; Hess & Shipman, 1965). When particular types of instructional approaches are continually used across time, they should have an important impact on the kinds of skills and knowledge structures that are developed and on the degree to which transfer occurs (e.g., Bransford & Heldmeyer, 1983; Feuerstein et al., 1980; Wood, 1980).

We noted earlier that one of the goals of anchored instruction is to help students (apprentices) find as well as solve problems and experience the changes in their own noticing and understanding as they are introduced to new ideas and concepts. We therefore want them to begin with their own perceptions and understandings rather than have these imposed by the expert. This is very different than teaching by simply pointing to spots on a videodisc and saying "here is an example of A, here is an example of B." Studies are needed to assess the effects of these different approaches to instruction.

As an illustration of the kinds of studies of problem finding that are needed, imagine two groups that learn mathematics in the Jasper context. One group is helped to find and formulate the problems to be solved. The second group also works with Jasper but is always given the problems to be solved rather than helped to generate them. We suspect that the generative activities of the problem-formulation group will be very beneficial for transfer to other activities of problem formulation, but the studies remain to be conducted.[9] Results of similar studies have implications for new ways to design videos for education, such as the use of embedded data design (see Van Haneghan et al., in press).

Issues involving problem finding and the opportunity to experience changes in one's own perception and comprehension also relate to the idea of improving traditional apprenticeships by providing multiple perspectives on the same events. Brown et al. (1989) note that graduate training is basically an apprenticeship. A weakness of this approach is that students generally work in a particular subarea of a field with a mentor who holds only a subset of the possible theoretical views in the field. Of course, most mentors try to help their students develop breadth in the field by having them attend other lectures, read books about other theories, and so forth. Such activities are undoubtedly valuable, but they do not involve the opportunity for multiple perspectives on *the same anchor or set of events.* Studies on this issue—and in general on ways to make traditional apprenticeships more efficient—are important to pursue.[10]

Conclusions

We began with a discussion of the general concept of anchored instruction and its rationale and described two research projects that illustrate the concept. We then discussed the need to formulate specific principles of anchored instruction that can be used to guide the selection and construction of anchors and the selection of teaching activities to accompany them. We argued that the situated cognition perspective discussed by Brown et al. (1989) provided a useful framework for deriving principles of anchored instruction. We also argued that anchored instruction makes the idea of cognitive apprenticeships feasible and that it can sometimes improve on actual apprenticeships that occur in everyday life.

We considered several issues relevant to the selection and construction of anchors. First, we tried to choose or design anchors that illustrated realistic activities and realistic goals; we wanted anchors with inherent ecological validity. The illustrated activities tended to be complex and were capable of being explored from multiple perspectives. The anchors also included a great deal of embedded data that students and teachers could explore. We also used anchors that were video based rather than text based because the former format provides more potential for noticing and permits multiple coding in memory. Nevertheless, we noted that anchors could be verbally based rather than video based (e.g., Lipman, 1985).

With respect to teaching and learning activities, our macrocontexts attempt to provide opportunities for teacher-guided discovery. We first wanted students to view the anchors from their own perspectives; they were then able to experience changes in their own perception and comprehension as they were introduced to new ideas from the teacher, from texts, or from their peers. We also encouraged students to find their own issues in the video, to find information necessary to explore these issues and, whenever possible, to work in cooperative learning groups. The large variety of information on the videos contributed to the fact that students with varied backgrounds were all very likely to be able to contribute something unique to the rest of the class.

Overall, our goals for anchored instruction include the establishment of semantically rich, shared environments that allow students and teachers to find and understand the kinds of problems that various concepts, principles, and theories were designed to solve, and that allow them to experience the effects that new knowledge has on their perception and understanding of these environments. Over time, we want students to experience what it is like to grow from novices who have only rudimentary knowledge after a single viewing to relatively sophisticated experts who have explored an environment from multiple points of view. In the process, the students should be able to experience changes in their own noticing and understanding as new concepts and principles are introduced. We assume that these experiences allow new information to function as tools that shape perception and comprehension rather than as mere facts to be memorized.

Needless to say, there are still many questions to be answered about ways to anchor or situate instruction in specific settings. We noted earlier that an especially important issue derives from the fact that often information learned in everyday settings does not spontaneously transfer to other settings such as the classroom (e.g., Brown et al., 1989). We assume that attempts to help students reflect on their experiences (e.g., by revisiting scenes from multiple perspectives) will help solve the transfer problem. Research on these types of issues should help us understand transfer in more detail and aid in the instructional design process.

Notes

Preparation of this paper was supported in part by a grant from the James S. McDonnell Foundation and grants No. G008730072 and No. G008710018 from OERI/NIE. We thank Faapio Po'e for her excellent editorial help.

[1]Participants in the Cognition and Technology group are: Linda Barron, John Bransford, Bill Corbin, Laura Goin, Elizabeth Goldman, Susan Goldman, Ted Hasselbring, Charles Kinzer, Tim McNamara, Ann Michael, Diana Miller, Jim Pellegrino, Vicki Risko, Dan Rock, Robert Sherwood, Salvatore Soraci, Thomas Sturdevant, James Van Haneghan, Nancy Vye, Susan Williams, and Michael Young.

[2]Logarithm computations using tables and interpolation have been given less emphasis in recent years because of the availability of calculators. Logarithms, however, still serve useful computational purposes, such as the calculation of an approximation of the factorial of large numbers, a calculation important in mathematical statistics. More importantly, they provide powerful tools for mathematical modeling. Students often do not understand these uses of logarithms.

[3]This project is funded by grant No. G008710018. We thank the following graduate students who have played a very important role in the project: Dorothy Fuller, Jennifer Goodman, Debbie Griffith, Kim McLarty and Prisca Moore.

[4]The following graduate students have been instrumental in our work on mathematics and anchored instruction: Paulo Alcantara, Brigid Barron, Laurie Furman, and Betsy Montavon.

[5]It would have been impossible for us to produce the Jasper videos without the outstanding, creative talents of Thomas Sturdevant. He has taken the lead in writing scripts and is the producer and director of the Jasper adventures.

[6]We thank Joe B. Wyatt for bringing these possibilities to our attention.

[7]One of the reviewers of this paper correctly noted that there are many questions about anchored instruction that are not addressed in this paper. There are two reasons for this: One is a severe space limitation, the other is that we are still in the process of attempting to refine the concept through discussion and research. We hope that this paper will help set the stage for further discussions that will lead to refinements.

[8]We believe that it is possible to design video-based anchors that help students experience problems and opportunities faced by real mathematicians. These videos could include well-respected experts thinking aloud as they attempt to solve novel problems. One way to think about these videos is that they could represent attempts to "clone" the expertise of outstanding teachers such as Lampert (1986) and Schoenfeld (1988).

[9]Studies illustrating the general importance of focusing on "transfer appropriate processing" are discussed in Morris, Bransford, and Franks, 1977.

[10]Research by Michael (1989) lends support to the importance of helping students experience the same events from multiple points of view.

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