TECHNOLOGY AND THE FATE OF AT-RISK STUDENTS

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Over the past decade, the school systems of the United States have engaged in an unprecedented buildup of educational technology. On the promise that technology will help us solve some of the crucial issues facing education, governors, legislators, and business leaders have called for a massive infusion of computers, satellite hookups, and networks. Hardly a month passes without another superintendent announcing a millage or bond issue to finance the district's plans to install technology throughout its schools.

Evidence is growing that emerging technologies can facilitate learning (Kozma, 1991). Whether or not they will improve our educational system is another issue. It is a particularly salient issue for those who are at the greatest risk of school failure. Although these students could benefit most from the effective use of technology, an equally probable consequence is that the achievement gap between these students and their more successful counterparts will widen. Indeed, given the impact of technology throughout history (Travers, 1973) and the findings on the initial use of computers in schools (Center for Social Organization of Schools [CSOS], 1983-1984), we must begin with the assumption that the latter is the more likely outcome.

In this article, we will discuss the potential that media and technology have for facilitating learning. We will review briefly the cognitive, motivational, and social needs of at-risk students and the underlying causes of school failure. We will examine ways technology might improve learning of at-risk students. Finally, we will look at how technology might facilitate school restructuring and the ways schools must be restructured to increase the effective use of technology.

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LEARNING WITH MEDIA

What reason is there to believe that media can facilitate learning? We might expect a medium, such as television or computers, to influence learning to the extent that the characteristics and capabilities of the medium correspond to and support the ways we think, learn, and solve problems. Therefore, it would be useful to examine learning with media from the perspective of our growing understanding of the learning process, an understanding informed by developments in cognitive and social psychology.

LEARNING AND FAILURE TO LEARN

Current evidence from cognitive psychology suggests that learning is an active, constructive process whereby the learner strategically manages the available cognitive resources to create new knowledge from information available in the environment and from knowledge already stored in long-term memory. Consequently, a learner's current understanding (or prior knowledge) plays an important role in new learning. The content of this knowledge and how it is structured, organized, and represented in memory has bearing on the outcome of a learning episode.

Knowledge can be represented in long-term memory in at least two ways: perceptual-like images and language-like propositions (Paivio, 1990). Information stored as images tends to be more memorable. And, if information is stored in a particular form, there may be an advantage for certain tasks. For example, information stored as images appears to be more useful for tasks involving spatial arrangements (Anderson, 1990), such as estimating the trajectory of a moving object, than information stored as verbal descriptions. In addition, information stored both as images and propositions is more likely to be remembered or retrieved on subsequent occasions (Paivio, 1990). So, if a student connects her images of moving objects with verbal statements of the physics of forces and motion, this prior knowledge is more likely to be recalled.

This knowledge is organized into structures, sometimes called *schemas* (Anderson, 1990) and sometimes called *mental models* (Johnson-Laird, 1989), which provide meaning for information in memory and understanding for new information entering from the environment. These structures may also contain information about the situations in which this knowledge is relevant. People use these structures to analyze current situations, connect this information with prior knowledge, and solve problems.

A student's mental model within a particular domain, such as physics, may be incomplete and relatively unconnected. This would make it less likely to be recalled in response to a problem situation and less likely to result in a problem solution. But as learning occurs, a student's existing schemas or mental models are elaborated by new information, perhaps with little or no change in the way these schemas are structured (Rumelhart & Norman, 1981). As learning continues, these knowledge structures become more complete, interconnected, and useful in solving problems.

But understanding may fail, or misunderstanding may occur, if the content and structure of a student's prior knowledge in a particular domain conflicts with new information from the instructional environment. For many students, learning requires a major restructuring of old schemas or the creation of entirely new ones. This is a more difficult process than the elaboration of existing structures and thus is less likely to occur.

Understanding may also fail if accurate knowledge that exists in long-term memory is not activated and available in short-term memory. Existing knowledge may not be available because it is not structured in a way that is activated by the current situation and the student's purpose or motivation. Or it may be activated merely to be replaced by competing information. Only a limited amount of information can be activated at one time, and this activation fades over time (Anderson, 1990). If relevant prior knowledge is not activated at a particular moment, it is not available to aid the understanding of new information or its incorporation into memory, and learning will not occur.

The description above emphasizes the internal aspects of learning, but much of what goes on with mental representations and processes is influenced by the external, social environment. Vygotsky (1978) discusses the inherently social means by which externally used symbols become internal representations. External symbols, such as words and numbers, are first given meaning as they are used in social contexts. When a word is initially encountered, its meaning is inferred from other words, gestures, intonations, and behaviors that accompany it. Also, the internalization of these symbols and meanings is a social process. The way symbols are used by others serves as a model for their internal use; interpersonal processes are transformed into intrapersonal ones. This internalization occurs within what Vygotsky calls the *zone of proximal development*, the difference between what a learner can do alone and what he or she might be able to do in interaction or collaboration with another, such as a more knowledgeable peer or an adult (Brown, Palincsar, & Purcell, 1986). The boundaries of the zone reinforce the importance of both the learner's current level of knowledge and skill and the role that others play by modeling the meaning and use of new knowledge and skills. This creates a reciprocal relationship within which, as Resnick (1985) puts it, "the child does what he or she can, and the adult does the rest" (p. 179). Consequently, in addition to various internal conditions that may result in failure to learn, failure may be due to the lack of external conditions that support these internal processes.

HOW MEDIA FACILITATE LEARNING

How do media fit into all of this? Learning with media can be viewed as a complementary process within which representations are constructed and procedures performed, sometimes by the learner and sometimes by the medium (Kozma, 1991). This creates another reciprocal relationship, one between the medium and the learner, which Salomon, Perkins, and Globerson (1991) call a *cognitive partnership*. As such, learning with media is sensitive to characteristics of both the learner and the medium: what the medium is capable of and what the learner does. To paraphrase Resnick (1985), the medium does what it can do and the child must do the rest.

Media vary in two ways that are relevant to this reciprocal relationship: They vary in the symbol systems they employ and the processes that operate on these symbols. A medium's symbol systems are those "modes of appearance" (Goodman, 1976) that can be used to construct its messages. For example, television can use moving pictures and spoken words (among other symbols systems), whereas radio, obviously, can employ only spoken words and other sounds, and books can use text and show pictures but these pictures do not move. Salomon (1979) contends that information presented in different symbol systems may be represented differently in memory and may require different mental skills to process, a contention supported by the work of Paivio (1990). The capability of video to employ motion pictures can be used to provide dynamic information, such as the trajectory of moving objects, that may be critical to understanding certain phenomena, such as the relationship between force and motion. Video can also be used to connect mental representations to real world situations in a way that learners with little prior knowledge may have trouble doing on their own.

A second way that media vary is in their processing capabilities. These are the operations that are performed on symbolic expressions. For example, one can search, pause, and review information with a videotape or videodisc player but not with broadcast video or radio. Computers are, of course, especially distinguished by their extensive processing capabilities. Computers can transform information from one symbol system to another; for example, numeric data can be transformed to graphs or coded map displays. And the computer's ability to operate on logical or numeric statements can be used to create procedural systems, or simulations, in which the computer uses information provided by the learner to determine what happens next.

These processing capabilities of a medium play a particularly important role in learning. Specifically, they can complement and interact with the cognitive structures, skills, plans, purposes, and processes of the learner. A medium with the appropriate capabilities may perform or model certain operations that can facilitate learning. If such processes are explicit, the learner may come to incorporate them into his or her own repertoire of cognitive skills (Salomon, 1988).

In summary, the symbol systems and processing capabilities of media correspond in many ways to the representations and operations required of learning and problem solving. Some learners will benefit from certain media because those media will provide representations and perform operations that learners cannot yet supply for themselves. Other learners will benefit because they can use the medium to capitalize on the representations and operations they already have.

SCHOOL LEARNING AND SCHOOL FAILURE

The evidence presented above describes the way students learn and fail to learn and establishes the potential for media to facilitate learning. But this is really only half of the story. The other half is knowing something about learning and failing to learn in actual schools. We turn to this part of the story next.

BREADTH AND DEPTH OF SCHOOL FAILURES

No one knows how many students fail in school, but the number is probably large. Evidence for this position comes from a variety of sources (Applebee, Langer, & Mullis, 1989; Sedlak, Wheeler, Pullin, & Cusick, 1986). Results from National Assessment for Educational Progress (NAEP) 1984 and 1986 surveys (Applebee et al., 1989) indicate that many students underachieve in reading, math, and science. In fact, according to NAEP, somewhere between one half and two thirds of all students graduate from high school with relatively low levels of achievement (Applebee et al., 1989).

Low achievement, however, is not randomly distributed, and certain groups of students experience it more often and more deeply than others. For example, NAEP's 1984 and 1986 surveys reported that Black and Hispanic students were less proficient than their White classmates in reading, math, and science, regardless of their age or grade. Among 17-year-olds, achievement discrepancies were especially pronounced, as Black and Hispanic students displayed proficiencies in basic subject areas that were roughly equivalent to those of White 13-year-olds (Applebee et al., 1989). Not all Black and Hispanic students fail in school, of course. But on average, and for a variety of reasons, minority group students, such as Blacks and Hispanics, persistently achieve at lower levels than their White classmates (Neisser, 1986).

CAUSES OF SCHOOL FAILURES

School failure is severe and profound for a disturbingly large and identifiable number of students. The cognitive conditions previously described that complicate learning are compounded by social and cultural conditions that contribute to failure in school. The relationships between sociocultural conditions and cognitive conditions that result in school failure are complex. Nonetheless, we believe that there are at least three aspects of school failure that educational technology can address successfully.

The gap between in-school and out-of-school learning. Minority group students, Banks (1988) argues, fail because they come from cultures that are different from those of school administrators, teachers, and curriculum planners. The gap between what is learned in school and out of school is much wider for these students, making the task of bridging more difficult for them and their teachers. This places at-risk students at a severe disadvantage in the classroom. Not only must they develop new schemas or mental models, ones more akin to those anticipated for school-related learning, they must also decide what to do with what they learn outside of school, knowledge that is often devalued by their teachers and school administrators (Cummins, 1986).

Overemphasis on lower order skills and basic knowledge. At-risk students often fail to develop higher order cognitive skills because they are placed in classrooms that deemphasize the need for them. Classes for at-risk students break lessons into small, sequentially related tasks that emphasize drill and practice, work sheets, and extensive desk work (Levine, 1988). Studies that compare these classrooms to those attended by high- and moderate-achieving students report more discipline problems, low teacher expectations, slower paced instruction, fewer academically oriented interactions with classmates or adults, and an emphasis on social goals, such as learning to be punctual or accept responsibility for assignments (Oakes, 1985). As Levin (1988) argues, these classes make few academically oriented demands on students, which may actually retard learning and cause at-risk students to fall even further behind.

Low engagement and motivation. Engagement is influenced by both characteristics of the learning task and student (Salomon et al., 1991). Tasks that engage students are generally more demanding, require considerable student involvement and decision making, often in conjunction with other classmates and adults. But, as mentioned above, at-risk students are seldom given tasks of this nature. Rather, many teachers give low-achieving students simplified, discrete tasks that require recitation or considerable desk work (Levine, 1988; Oakes, 1985). Ogbu (1986) also suggests that at-risk students may disengage from learning because they believe that they must work twice as hard for minimal rewards in the future. They may sense a ceiling to the rewards that they can obtain through school achievement. Without frequent rewards for achievement, interactions with positive role models, and an emphasis on the possible applications of learning, many low-income and minority group students become disillusioned and disengage from learning (American Association for the Advancement of Science [AAAS], 1984; Cole & Griffin, 1987; Cummins, 1986).

HOW MEDIA MIGHT FACILITATE SCHOOL LEARNING OF AT-RISK STUDENTS

Is there any reason to believe that technology might be particularly beneficial for students at risk of school failure? Technology by itself cannot be expected to address such profound problems. But the capabilities of technology as they are matched to and integrated with the social and curricular arrangements of the school might begin to make a difference.

RECOMMENDATIONS FOR EFFECTIVE USE

Reports from the Laboratory of Comparative Human Cognition (LCHC) (Cole & Griffin, 1987; LCHC, 1989) examine the cognitive and social needs and contexts of at-risk students, making several recommendations about how computers might be more effectively used with these students. They suggest that

- Computers would best be used in conjunction with collaborative groups of students organized around goal-oriented tasks. Students working in pairs or groups with the computer tend to correct each other's mistakes, cooperate in the completion of tasks, and discuss the assignments in ways that clarify the task.
- Rather than drill and practice software, these tasks should involve rich, interactive simulations and microworlds that embed the need for basic skills in higher order thinking. Such tasks should challenge the capabilities of both students and technology. Instruction within such environments shifts the emphasis from information giving and receiving to an emphasis on finding relevant information and learning how to solve problems, ask questions, think critically, and communicate ideas. Social interaction within this context reduces low-level errors and creates support for higher level activities.
- Finally, LCHC suggests that media can be effectively used to connect students to family, community, and other cultures, particularly those in which their ethnic and language characteristics are dominant.

To these recommendations we add that technological interventions can help at-risk students if they build on the students' current representations, if they connect these representations to the real world, and if they are used within effective school environments:

- The use of interactive multimedia allows students to operate on and see phenomena simultaneously represented in several linked symbol systems (graphs, pictures, sounds). This can help the students leverage their current mental representations and media skills to create knowledge structures that are stored in multiple, interconnected, representational forms, thus deepening student understanding.
- In addition, multimedia can connect students' school-based learning to real world situations. Interactive video can present problems embedded in real world situations that cue knowledge structures associated with personal experience, integrating these with formal, school-based knowledge.
- Improved school financing, increased availability of preschool instruction, collaboration with social service agencies, the elimination of curriculum tracking, and increased parent participation and community involvement—all these things will improve the quality of schools as well as increase the impact new technologies can have on school learning.

PROMISING PROJECTS

Two field-based projects that incorporate many of the recommendations in this article look particularly promising.

The Jasper Series. The Cognition and Technology Group at Vanderbilt University has developed a set of videodisc-based problem sets in mathematics, called the Jasper Series (Van Haneghan, Barron, Williams, Vye, & Bransford, 1992). The set provides teachers and students with real-world contexts for learning complex mathematics problem solving. The videodisc is used to provide rich stories that embed both problems to be solved and data that can be used in the solutions. For example, in one story the principal character, Jasper Woodbury, takes a river trip to examine a used boat, which he decides to buy. Because the running lights do not work, Jasper must determine if he can return to his home dock before sunset. The students are left to solve this problem. Two major questions are embedded in Jasper's decision: Does he have enough time to return home before sunset, and is there enough fuel in the boat's gas tank for the return trip?

Students work in groups with the teacher's guidance to determine the solution. As students work through the problem, they come to discover that this seemingly simple problem involves a great deal of thinking. These challenging problems involve complex, multistep solutions and require sustained mathematical thinking. A considerable amount of structured social interaction supports this process. Initial evaluations look promising (Van Haneghan et al., 1992), although additional studies with at-risk students will be needed before it is clear that this project can significantly contribute to school improvement.

What does the videodisc contribute to this environment? First, the video-based stories provide students with rich mental models of situations, mental models that they would otherwise need to construct on their own with text. Text would also place more demands on reading ability and prior knowledge. With these demands preempted, the students can use their cognitive resources for problem-solving strategies. Second, the visual nature of the story is more likely to activate the situation-based prior knowledge that students have and connect their new learning to it. The use of several different video-based stories that require the same kind of analysis and solutions connects these solution strategies to different situation schemas and promotes transfer. Finally, the video contains a great deal of detail and information, information crucial to the solution of the problem. During the story, information about distances, available money, and other relevant conditions are embedded in maps, what people say, and what they think. The random access capabilities of videodisc allow students to use a remote control device to pause, review, and search for information that they would otherwise have missed.

The HOTS project. A computer-based project with goals similar to the Jasper Series was specifically designed for and has been widely used with at-risk students. The Higher-Order Thinking Skills (HOTS) project (Pogrow, 1990a, 1990b) was designed with four components: (a) computers as problem-solving settings, (b) dramatic techniques, (c) Socratic conversations, and (d) thinking skill development. Rather than using them to develop content knowledge, software packages are used to create problem situations that students solve in groups. The teacher often wears costumes, tells jokes, and uses other dramatic techniques to arouse motivation and curiosity and promote emotional engagement. Socratic questions are used to create problems and ambiguities and to provide probes and clues that guide students to construct meaning on their own. Finally, thinking skills are explicitly taught and used to solve problems. These include metacognitive planning and monitoring, making inferences from context, decontextualizing strategies from one setting and applying them to others, and synthesizing information from two or more sources. All of these techniques are used in a pullout program with disadvantaged students, which involves groups of fewer than 15 children, for 35 minutes a day, 4 days a week.

Pogrow (1990a, 1990b) contends that a 2-year involvement in this program significantly enhances the learning of all content by at-risk students. Although comprehensive test results are not widely available, those that are (Pogrow, 1990b) support his claims and argue for expanded use and assessment.

TECHNOLOGY AND SCHOOL IMPROVEMENT

Current evidence suggests that emerging technologies can facilitate learning, including the learning of students at risk of school failure. We are enthusiastic about these new technologies, but we are skeptical about whether or not their potential will be fully realized in most schools and classrooms. We are fearful that these technologies may actually create greater disparities in learning between traditionally high- and low-achieving students (Cole & Griffin, 1987; CSOS, 1983-1984). Realizing the benefits of these technologies and safeguarding against harm will require widespread and dramatic changes in educational policies and practices. At a minimum it will require that teachers, school administrators, and policymakers ensure that all students have access to these technologies, that the technologies are used effectively, and that other aspects of schooling also promote high levels of student learning.

Access to technology. The benefits of new technologies can only be realized if teachers and students have access to them. Despite a dramatic buildup of technology over the past decade, the numbers available are still small compared to the numbers of students in schools. Mecklenburger (1990) estimates that the ratio of students to computers in public and private schools is somewhere between 20 to 1 and 40 to 1. If older and outdated models are eliminated, he contends that the ratio might well be 400 to 1 or even 1,000 to 1. Consequently, teachers and students seldom have access to more than one or two machines in a classroom (CSOS, 1983-1984).

Although the ratio of computers to students is generally low across the country, it is particularly low for certain schools. Schools with large enrollments of low-income and minority group students, for example, have fewer computers than schools with small enrollments. Higher achieving students have greater access than lower achieving students (CSOS, 1983-1984). Extrapolating from these early assessments, at-risk students and their teachers will find themselves at an even greater disadvantage than they are now if educational policies and practices do not compensate for these trends.

Effective use of technology. The use of technology in schools is a mixture of electronic media and pedagogical practices (Mecklenburger, 1990; Salomon, 1990). The capabilities of computers, videodiscs, and other media are part of this mix; more traditional instructional concerns, such as how teachers ask questions, evaluate progress, pace instructional goals, or interact with students, are another part. The effective use of technology, therefore, can be seen as the appropriate integration of the capabilities of media and pedagogical practices. The more successful technological mixes, such as the Jasper Series and HOTS, couple media with many capabilities and progressive practices that encourage student-directed learning, high student interest, activity-based instruction, integrated curriculum, and student cooperation and involvement.

These techniques, however, have never characterized the bulk of instruction in schools, even though reformers, such as Dewey, have advocated their use since the turn of the century. Why? Cuban (1989) argues that progressive techniques simply demand too much from most teachers and school administrators. Consequently, as advanced technologies are introduced into schools, most teachers and administrators readjust the technology mix to fit existing practices (Cuban, 1986, 1989). These changes, however, dilute the contributions that advanced technologies can make to student thinking and learning (Levinson, 1990; Mecklenburger, 1990; Salomon et al., 1991).

As with other considerations, this general problem is compounded for at-risk students. Typically, the effective mix of technology and progressive methods is less likely to be used with low-income and minority group students. CSOS (1983-1984) reports that computers are primarily used for rote drill and practice in schools that enroll large numbers of low-income and minority group students. These schools are under substantial pressure to teach basic skills and raise standardized achievement scores (Levine, 1988; Stedman, 1987). Consequently, these schools may be more resistant than other schools to the uses of technology that involve major changes in pedagogical technique.

Other aspects of schooling that affect at-risk students. In examining the potential that technology has for improving school learning, it is important to maintain the broader perspective. The fate of at-risk students will ultimately depend on what is done to address inequities, stereotypes, prejudices, and discriminatory practices that have hindered their education in the past and threaten to hinder their education in the future. These problems do not require new and more powerful technologies to solve (Bredo, 1989). They require a commitment to educational policies and practices that enhance the achievement of at-risk students (AAAS, 1984; Slavin, Karweit, & Madden, 1989), foster effective practices in their schools (Stedman, 1987), and empower at-risk students and the communities in which they live (Cummins, 1986). Improving the condition of at-risk students, therefore, will require that we also give attention to other aspects of schools that affect learning, such as the reform of school financing, increasing the availability of preschool instruction, collaboration with social service agencies, the elimination of curriculum tracking, and increasing parent participation and community involvement. We believe that such changes will improve the quality of schools as well as increase the impact new technologies can have on school learning.

In conclusion, we contemplate the impact of technology on at-risk students with both optimism and dread. Although there is growing evidence that new technologies can facilitate learning, there is also evidence that they are unlikely to do so dramatically. Indeed, it is possible that technology may even hinder the achievement of students who have traditionally been at risk of school failure. To realize the potential benefits of these technologies, we will have to develop policies and practices that make them more available to students and teachers and encourage their effective use, especially in schools that enroll large numbers of low-income and minority group students. We will also have to encourage other school reforms that affect learning and develop safeguards against inequities that would disadvantage students traditionally at risk of school failure. Without implementing these changes, along with the technologies that can facilitate learning, exciting possibilities may well become future failures.

REFERENCES

American Association for the Advancement of Science (AAAS). (1984). *Equity and excellence: Compatible goals. An assessment of programs that facilitate increased access and achievement of females and minorities in K-12 mathematics and science education.* Washington, DC: Office of Opportunities and Science.

Anderson, J. R. (1990). *Cognitive psychology and its implications* (3rd ed.). New York: Freeman.

Applebee, A. N., Langer, J. A., & Mullis, I.V.S. (1989). *Crossroads in American education: A summary of findings.* Princeton, NJ: Educational Testing Service.

Banks, J. A. (1988). Ethnicity, class, cognitive, and motivational styles: Research and teaching implications. *Journal of Negro Education, 57,* 452-466.

Bredo, E. (1989). Supportive contexts for learning. *Harvard Educational Review, 59,* 206-212.

Brown, A. L., Palincsar, A. S., & Purcell, L. (1986). Poor readers: Teach, don't label. In U. Neisser (Ed.), *The school achievement of minority children: New perspectives* (pp. 105-144). Hillsdale, NJ: Lawrence Erlbaum.

Center for Social Organization of Schools (CSOS). (1983-1984). *School uses of microcomputers: Reports from a national survey* (Issues 1-6). Baltimore, MD: Johns Hopkins University.

Cole, M., & Griffin, P. (Eds.). (1987). *Improving science and mathematics education for minorities and women.* Madison: University of Wisconsin, Wisconsin Center for Educational Research.

Cuban, L. (1986). *Teachers and machines: The uses of technology since the 1920's.* New York: Teachers College Press.

Cuban, L. (1989). Neoprogressive visions of organizational realities. *Harvard Educational Review, 59,* 217-222.

Cummins, J. (1986). Empowering minority students: A framework for intervention. *Harvard Educational Review, 56,* 18-36.

Goodman, N. (1976). *Languages of art.* Indianapolis, IN: Bobbs-Merrill.

Johnson-Laird, P. N. (1989). Mental models. In M. I. Posner (Ed.), *Foundations of cognitive science* (pp. 469-499). Cambridge, MA: MIT Press.

Kozma, R. B. (1991). Learning with media. *Review of Educational Research, 61*(2), 179-211.

Laboratory of Comparative Human Cognition (LCHC). (1989). Kids and computers: A positive vision of the future. *Harvard Educational Review, 59,* 61-73.

Levin, H. M. (1988). Accelerating elementary education for disadvantaged students. In Council for Chief State School Officers (Ed.), *School success for students at risk: Analysis and recommendations of the Council of Chief State School Officers* (pp. 209-226). Orlando, FL: Harcourt Brace Jovanovich.

Levine, D. U. (1988). Teaching thinking to at-risk students: Generalizations and speculations. In B. Z. Presseisen (Ed.), *At-risk students and thinking: Perspectives from research* (pp. 117-137). Washington DC: National Education Association.

Levinson, E. (1990). Will technology transform education or will the schools co-opt technology? *Phi Delta Kappan, 72*, 121-126.

Mecklenburger, J. A. (1990). Educational technology is not enough. *Phi Delta Kappan, 72*, 104-108.

Neisser, U. (1986). New answers to old questions. In U. Neisser (Ed.), *The school achievement of minority children: New perspectives* (pp. 1-18). Hillsdale, NJ: Lawrence Erlbaum.

Oakes, J. (1985). *Keeping track: How schools structure inequality*. New Haven, CT: Yale Press.

Ogbu, U. (1986). The consequences of the American caste system. In U. Neisser (Ed.), *The school achievement of minority children: New perspectives* (pp. 19-56). Hillsdale, NJ: Lawrence Erlbaum.

Paivio, A. (1990). *Mental representations: A dual coding approach*. New York: Oxford University Press.

Pogrow, S. (1990a). Challenging at-risk students: Findings from the HOTS program. *Phi Delta Kappan, 71*, 389-397.

Pogrow, S. (1990b). A Socratic approach to using computers with at-risk students. *Educational Leadership, 47*, 61-66.

Resnick, L. B. (1985). Cognition and instruction: Recent theories of human competence and how it is acquired. In B. L. Hammond (Ed.), *Psychology and learning: The Masser lecture series* (pp. 160-183). Washington, DC: American Psychological Association.

Rumelhart, D. E., & Norman, D. A. (1981). Accretion, tuning, and restructuring: Three modes of learning. In J. W. Cotton & R. Klatzky (Eds.), *Semantic factors in cognition* (pp. 37-60). Hillsdale, NJ: Lawrence Erlbaum.

Salomon, G. (1979). *Interaction of media, cognition, and learning*. San Francisco: Jossey-Bass.

Salomon, G. (1988). AI in reverse: Computer tools that turn cognitive. *Journal of Educational Computing Research, 4*, 123-134.

Salomon, G. (1990). Studying the flute and the orchestra: Controlled vs. classroom research on computers. *International Journal of Educational Research, 14*, 521-532.

Salomon, G., Perkins, D. N., & Globerson, T. (1991). Partners in cognition: Expanding human intelligence with intelligent technologies. *Educational Researcher, 20*(3), 2-9.

Sedlak, M. W., Wheeler, C. W., Pullin, D. C., & Cusick, P. A. (1986). *Selling students short: Classroom bargains and academic reform in the American high school*. New York: Teachers College.

Slavin, R. E., Karweit, N. L., & Madden, N. A. (1989). *Effective programs for students at risk*. Needham Heights, MA: Allyn & Bacon.

Stedman, L. C. (1987). It's time we changed the effective schools formula. *Phi Delta Kappan, 69*, 215-224.

Travers, R.M.W. (1973). Educational technology and related research viewed as a political force. In R.M.W. Travers (Ed.), *Handbook of research on teaching* (2nd ed., pp. 979-996). Chicago: Rand McNally.

Van Haneghan, J., Barron, L., Williams, S., Vye, N., & Bransford, J. (1992). The Jasper Series: An experiment with new ways to enhance mathematical thinking. In D. Halpern (Ed.), *Enhancing thinking skills in the sciences and mathematics* (pp. 15-38). Hillsdale, NJ: Lawrence Erlbaum.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.