# A Socratic Approach to Using Computers with At-Risk Students

Did your district purchase computers to help at-risk students learn better? Did the computers help? If you answered *yes* to the first question and *no* to the second, it's time to take an approach that blends ancient and modern wisdom.

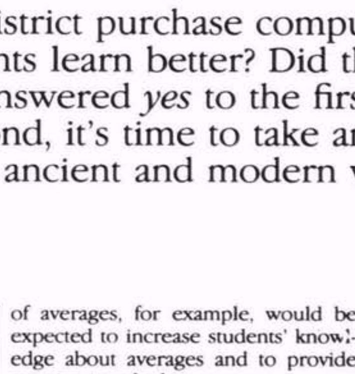
Suppose you're in New York, and you want to go to Beijing. You could try to get there by boring straight through the earth, but you'd almost certainly get to China a lot quicker by using a roundabout approach. Similarly, if you want to enhance the learning of at-risk children, you could try to do it directly by using ordinary computer-assisted instruction (CAI), but you'd probably have better luck with a Socratic approach.

### Right Solution, Wrong Problem

Alarmingly, conventional computer-assisted instruction (CAI) with at-risk students beyond the 3rd grade is producing little overall effect; CAI may, in fact, widen the gap between good and poor achievers.[1] Indeed, over the past decade, educators have spent millions of dollars on technology, yet the at-risk problem has substantially worsened.

In conventional CAI, the explicit goal of the software is to teach toward a curricular goal, to provide instruction and practice toward the achievement of an immediate learning objective. Software to teach the calculation of averages, for example, would be expected to increase students' knowledge about averages and to provide practice in calculating averages.

Moreover, new computer tools such as word processing and simulations, while frequently distinguished from CAI, are applied in much the same way. Word processing is expected to improve writing ability, for instance, and a simulation of chemical titration is designed to enhance knowledge of specific chemical reactions. Thus, both packages explicitly intend to produce topical learning, and both end up being used essentially as drill and practice CAI.



*In Oceanside, California, teacher Judy Reimer and a student engage in dialogue prompted by software chosen to stimulate student thinking.*

Since the inception of computers, educators have placed great faith in the use of explicit-goal software. After all, linking learning objectives with practice satisfies common sense. And the belief that software by itself can instruct—and thus produce substantial amounts of learning—has so dominated the use of computers that there are few reports of alternative curricular approaches.

This faith, if borne out, would certainly be a beacon. Then our only concern would be the coordination of software materials with learning objectives. There would be no need to rework the curriculum, change instructional strategies, or develop more sophisticated approaches—computer drill would solve the problems.

But we can no longer maintain that naive belief. Beyond the primary grades, CAI (whether in the form of expensive integrated learning systems or computers as tools) has not lived up to its promises to help at-risk students, because explicit-goal approaches to using technology are predicated on an incorrect assumption: that at-risk students fail to internalize concepts because of insufficient practice or practice too boring to have an effect.

The root cause of poor performance among at-risk students in grades 4–7, however, is not inadequate practice. According to Brown (1982), the primary cause is inadequate metacognitive skills. That is, at-risk students do not consciously apply and test mental strategies to deal with normal thinking activities like reading and problem-solving.

I believe that at-risk students have another difficulty, too: they do not understand what it means to understand something. They do not know what it means to work with ideas. They rarely form the elaborate linkages among the things they have learned that are critical for retention and problem-solving. They do not readily generalize, hypothesize, or predict—or even recognize that they are supposed to. They have no idea how to manipulate the types of knowledge used in school, and many do not seem aware that anything represented by symbols *can* be understood.

Logically, if students cannot consciously deploy and regulate thinking strategies or derive meaning from symbols, they will not benefit from CAI practice. If they have not grasped the principles of understanding, they will not be able to process information in ways that enable them to retain or apply it, even when it is presented on a computer screen. For students with deficits of metacognition and understanding, the literal curricular approaches of CAI are simply the right solution to the wrong problem.

**In learning dramas, the software is selected for motivation, not for its explicit goals.**

### Learning to Think, Not Just to Respond

Seven years ago I set out to develop a more effective way to use computers with at-risk students, particularly during the critical years in grades 4 to 7. The result is a thinking skills program that combines two of the oldest pedagogical traditions—Socratic dialogue and drama—with the newest technology and learning theory (that is, information processing theory).

The program, called HOTS (for higher order thinking skills) has been demonstrated on a large scale to be very effective. In fact, with Chapter 1 students in grades 4–7, the program's indirect curricular approach ("learning dramas") produces larger gains in basic skills than other remedial approaches, computer-based or otherwise, even though no basic skills are explicitly taught (Pogrow 1988a).

The HOTS program (which is now in the National Diffusion Network) uses software very differently from conventional CAI. Furthermore, computer use is only one of four elements that collectively comprise the learning scenarios. The four components of the HOTS program include (1) computers as problem-solving settings, (2) dramatic techniques, (3) Socratic conversations, and (4) thinking skill development. The following is a discussion of each element.

### Computers as Problem Solving Settings

In the HOTS program, the software is selected for motivation, not for its explicit goals. The programs, usually games or adventure stories, are used solely to present an interesting activity, not to develop content knowledge or technical expertise.

Words and concepts in the menus and instructions on the screen provide occasions for teachers to invent Socratic questions that lead students to discover and then to practice key thinking skills. Thus, in these learning dramas, thinking becomes a means to reaching a captivating goal.

**Students learn to use contextual clues to figure out how to use the software.**

Suppose, for example, the teacher wanted students to learn the concept of *average*. Instead of using software designed to teach averages, he would find a piece of software that would be interesting to students, produce a numerical score, and require a strategy.

After students tried the program, the teacher would stir up interest in devising and testing better game plans by telling them: "Yesterday you got some very good scores, but also some poor ones. That means you were guessing. If, on the other hand, you have a good strategy, you will get good overall scores."

After students played the game a few more times, the teacher would encourage them to test their strategies by keeping track of averages. Perhaps he would say, "An average tells you how good your overall score is, and therefore, how good your strategy is." He would quickly show them how to calculate an average and have them go back to playing the game. Thereafter, he would ask whether their averages were improving and what strategies they were using to get better averages.

Tying the concept of *average* to an interesting problem-solving activity—while using software intended to teach something else—produces greater understanding and retention with just a small amount of discussion than does prolonged CAI practice in calculating averages. As students read the clues and talk about strategies, they are also discovering and practicing reading comprehension and metacognition skills. In short, students are learning content and thinking skills simultaneously. This helps explain a surprising finding: covering a fairly limited number of objectives in this manner enhances the learning of all content objectives in the regular classroom (Pogrow 1988b).

### Dramatic Techniques

Why should dramatic techniques be used with technology? Because drama intrigues. It heightens curiosity and motivation, involves people in problems and tasks, and promotes the emotional engagement that deepens learning.

In learning dramas, teachers often wear costumes, tell jokes, and so forth, but the curriculum is much more than funny hats. Just as a good stage drama engages an audience with the characters and their problems by employing techniques like identification and suspense, teachers construct classroom scenarios to engage students emotionally in their learning tasks.

Each piece of software used in learning dramas can be used to choreograph a situation that generates passion. For example, HOTS twists the way "Word Master" (a popular vocabulary drill and practice program) is used in order to teach a lesson on the importance of rules and the clues that determine what the rules are. In the process, students feel excitement, frustration, anger, and pride.

At the beginning of this learning drama, the teacher points out the word *antonym* at the bottom of the screen. Players have to turn a pointer to match antonyms on the screen. If they don't match words quickly, they lose. On the first day, the students get good scores. The next day, the students come in confident that they are going to get very high scores. The teacher does not mention that the computers have been switched to require *synonym* matches.

The students go to their computers. As their certainty about their ability to master the environment quickly evaporates, excitement turns to frustration. They start to complain that the computers are broken, that their poor scores are all the computer's fault.

The teacher calmly explains that the computers are working perfectly and that if they would just think carefully, the information they need is available. When students finally become convinced that their former strategies are not going to work, they start to look closely at the screen. Eventually, someone will notice that the word on the bottom is now *synonym*. Students then adjust their strategies and get good scores.

The next day, the teacher engages the students in a conversation about the importance of words in understanding what the rules are. She goes on to discuss how you cannot develop strategies until you have first read the available information carefully or, in the case of the classroom, listened to the information she provides.

After that, the students do not forget about the importance of rules, and they are attentive during subsequent discussions about rules. Their behavior change bears out Vygotsky's (1978) finding that interaction about ideas in socially meaningful situations is critical to the internalization of those ideas. In other words, when students experience and discover important thinking concepts on their own in socially meaningful situations, they learn more than they would from the most stirring adult lecture on the same concepts.

**Drama heightens curiosity and motivation and promotes the emotional engagement that deepens learning.**

### Socratic Conversations

The sophistication of the learning produced by technology depends on the sophistication of the conversation surrounding its use, not the sophistication of the technology. That was true of television, it is true of calculators and lab experiments (McPartland and Wu 1988), it is true of computers, and it will be true of the next generation of shiny boxes, no matter how many impressive dials, switches, and flashing lights they have.

Therefore, conversation is the heart of learning—conversation between teachers and students and among students. The dialogues must be more than just talk for the sake of talking, though. To produce substantial amounts of learning, teachers must react to students' questions and answers in ways that maintain the ambiguities, probes, and clues that guide students to construct meaning on their own. If, instead, teachers respond didactically, the learning drama will quickly deteriorate into rote learning, and its power to help students understand how to understand will be lost.

Learning to engage students in Socratic dialogue is not easy. Teachers have to learn how to (1) understand students' answers, rather than classify them as right or wrong; (2) probe responses so that students construct understanding on their own; and (3) guide students to a discovery of information, rather than act as a dispenser of information. Even good teachers need a week of practice to *start* to become Socratic. Then, they report, it takes a year of self-monitoring before the techniques become automatic.

In the HOTS Project we identified the key types of student-teacher interactions that occur in the development of understanding (Pogrow 1990). Then we developed a system of Socratic techniques that teachers can use to deal with each key situation. Teachers learn to use these techniques by teaching each other lessons from the HOTS curriculum in workshop sessions.

During the training, each teacher encounters each of the key dialogue situations many times. In a debriefing at the end of each teaching session, the teachers discuss whether they used effective Socratic strategies in the situations each encountered. This practice and feedback enable them to become metacognitive about their teaching.

## Thinking Skills Curriculum

The curriculum, then, consists of key questions that teachers ask, which in combination with the Socratic techniques, channel the conversation in ways that develop critical thinking skills. Let's examine this process applied to a popular simulation called Oregon Trail, for an example (fig. 1). In this program, the students' explicit goal is to reach Oregon along the trail that pioneers used to travel from Independence, Missouri, to Fort Vancouver, Washington. Players have to budget food and supplies to make it safely through a variety of computer-simulated problems, such as Indian attacks and bad weather. As you would expect, the goal of reaching Oregon is incidental. It is just an interesting excuse to initiate discussions that nudge students into using the four key thinking skills. The quality of the conversations is far more important to the learning process than successful arrival in Oregon or the quality of the software. (Indeed, the new color version of Oregon Trail is not as good for learning dramas as the old black-and-white version.)[2]

In this fashion teachers can build their thinking skills curriculum around many pieces of software, concentrating on four important skills from information-processing theory: (1) metacognition, or the conscious application of strategies while solving problems; (2) inference from context, or the use of known clues to figure out unknown information; (3) decontextualization, or the extraction of a generalization from one setting and the application of it in another setting; (4) information synthesis, or the identification, combination, and use of relevant information from two or more sources. Here are a few more examples of effective techniques.

**Learning dramas are more effective for at-risk students than either the literal use of software or nontechnology-based interventions.**

*Metacognition.* To improve metacognitive skills, teachers can continuously ask students what strategy they used for solving a problem. How did they know the strategy is a good one? How could students tell if a strategy did not work? What might be a better strategy? If they tried it, what would happen?

*Inference from context.* To develop inference from context, teachers can use two simple techniques. In the first, students must use clues to negotiate their way through a computerized twist-a-plot story. Every time students make a choice as to what twist the story should take, they are asked to predict what will happen. They must base their prediction on clues in the combined text and graphics of the program.

The second technique is the purposeful inclusion of key words that students will not understand. (It does not matter what the words are or whether they are part of the curriculum.) Students are told that every time they come to a word they do not understand, they should (1) write down the sentence in which the word appears, (2) circle the confusing word, and (3) call the teacher over and make a guess about what the word means.

The next day, conversations begin and student answers are probed. The teacher lists the sentences on the board and asks students to determine what the circled words mean and why they think so. Students are also asked to compare their predictions with what actually happened.

*Decontextualization.* The ability to decontextualize can be advanced in two ways. First, when familiar words appear in the software, students are asked to make predictions about what the words mean in the computer context. For example, in the menu of the graphics

**Fig. 1. Sample Learning Drama Questions for the Oregon Trail Program**

| Thinking Skill | Metacognition | Decontextualization | Inference from Context | Information Synthesis |
|---|---|---|---|---|
| Basis of Question | At end of game, system indicates whether the player made it to Oregon and how much money was left. | The system shows a picture of the wagon as it moves across the country. | The instructions tell the student to budget for an ox and a yoke. | The instructions indicate that the trail closed in 1897 and that it took five to six months to reach Oregon if you didn't get stopped along the way or killed. |
| Key Questions | Before you play the game again, you must tell me the following: What strategy did you use to get to Oregon, and why was it more successful than the previous attempt? *or* What strategy did you just use, and why was it unsuccessful? | From what perspective were you viewing the wagon, and how did that differ from the perspective you had when you were flying the balloon in the "Ride the Wind" program? | Read the instructions and tell me if you think a yoke as used in this program is part of an egg. Why not? What do you think it might be? Why do you think it would be important? | Is anyone who traveled the Oregon trail still alive today? How could you figure this out?<br><br>Each time before you play, call me over and predict what month you will reach Oregon if you are successful. |

program "DAZZLE DRAW," there is a choice called *flood fill*. The teacher asks students to predict what that choice means, based on what they know about the word *flood*. They then go to the computers to test their predictions.

The second technique stems from the recurrence of concepts. Ideas presented in one piece of software will also be found in others that are very different. For example, students discuss the differences and similarities of *perspective* as it was used when flying a hot-air balloon, in writing a story from the perspective of an object, and when discussing how a character in a story views a given situation.

*Information synthesis.* Teachers encourage information synthesis by creating situations that require students to use information from a variety of sources or to use several different types of information. For example, in tracking down the arch criminal Carmen San Diego, students have to use information from the screen, an almanac, and a dictionary to decide where to go to find the quarry.

These curriculum development techniques, described in detail elsewhere (Pogrow 1990), can be adapted to any collection of software.

### Computers Don't Teach, Teachers Do

At this point you may be skeptical. I have implied that districts should: spend money to buy computers, spend more money to buy software, and then use both in ways they weren't intended to be used. Why go to all that expense and trouble?

There's a simple justification. Learning dramas are more effective for at-risk students than either the literal use of software or nontechnology-based interventions.[3] After seven years' work with teachers and students (there are now nearly 10,000 students in the HOTS program), I have concluded that learning dramas stimulate complex thinking processes in much the same way that adult speech prompts children to learn to talk: by social imitation, one of the most powerful forms of learning. If, over a period of a year or two, adults consistently model these behaviors in situations that the students find engaging, students will imitate the thought processes that are so critical to learning content and to the transfer of learning. Apparently, once students understand how to link ideas, they transfer that ability to the learning of other content. There is no need to build extensive content objectives into the learning drama curriculum or to use integration or scope and sequence analyses. Simply providing extensive experience in conversations that model understanding seems to enable students to learn conventionally taught content objectives more effectively.

If the heart of learning dramas is Socratic dialogue, why use expensive technology? Good teachers have used Socratic techniques around the printed word for hundreds of years, and books are certainly going to be around for years to come. But computers offer several advantages apart from their motivational effects as a stimulus for Socratic conversations, especially among students with poorly developed thinking processes. First, computers mix visual, tactile, and listening modalities, so students can learn through whatever modality they prefer. Second, computers provide a private environment in which students can test their ideas at their own speed before having to display their thinking publicly. Last, the immediate feedback that computers give enables students to test their ideas as soon as they think of them and for teachers to engage them in thinking about whether the computer's reaction is what they expected and whether it supports or disconfirms their idea or strategy.

**Learning dramas stimulate complex thinking processes in much the same way that adult speech prompts children to learn to talk: by social imitation.**

Computers thus provide a great vehicle for developing creative and sophisticated curriculums and pedagogical practices. But we have to stop viewing computers as deliverers of instruction. Technologists must go beyond mere promotion, paying only lip service to pedagogy, and curriculum specialists must assert their knowledge of teaching. We must all, in short, combine our points of view if we are to best apply the power of technology, new theories of cognition, and learning traditions from other disciplines, cultures, and art forms. And we must recognize that a roundabout but sophisticated approach to using technology may improve the learning of at-risk students much more than direct but simplistic routes.□

[1]Research reviews such as Bangert-Drowns, Kulik, and Kulik (1985), and Niemiec and Walberg (1987) find that the major effects from CAI decline rapidly at upper elementary grade levels. In comparison to other interventions, Haller, Child, and Walberg (1988) found that instruction in metacognition (without technology) had twice the effect of CAI. Hativa (1988) found that when high- and low-performing students used CAI, learning gaps between the two groups widened. No evidence was found to indicate that word processing improves the writing of at-risk students.

[2]The new version of Oregon Trail uses color graphics and provides many more decision-making situations but takes an hour to reach Oregon, as compared to 10 minutes in the old version. This delay interferes with the development of metacognition, which requires students to determine whether a strategy did or did not work.

[3]The report to the National Diffusion Network cited research results showing that HOTS students gained almost twice as

much in reading and math as the national average for Chapter 1 students. Since that study was conducted, a newer version of the HOTS techniques has been developed, and sites are reporting gains greater than in the original study.

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Papers should be written in direct, conversational style and be as brief as possible (five to ten double-spaced pages).

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