THE COMPUTER AND THE TEACHER-EDUCATOR: OR SHOULD IT BE VICE VERSA?

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We are just opening our office door and the phone is ringing. If the caller is either a school teacher or a school administrator, the conversation might begin: "We have been thinking about computers and want to know which one(s) we should buy," or "We just bought one (or sometimes a whole bushel) of Peach 0.3 computers and wondered if you might be able to tell us what to do with them."

Such conversations came to mind when we began this article, originally on the theme of "The Computer in Teacher Education." Had we continued that theme, we would have been caught in the same dilemma as our caller—putting emphasis on the computer before defining the task. But, then, aren't the concerns of teacher-educators similar to those of practitioners regarding the exploding learning technology? Few have had sufficient training or opportunities to develop real expertise in computer applications. It is in this vein that we present the following analysis.

What precisely is the task of teacher-educators? In addition to research and professional service, they train prospective teachers to: (1) plan lessons to teach content, (2) evaluate and select learning materials, (3) facilitate mastery of objectives, (4) facilitate problemsolving, (5) diagnose learning problems, (6) manage the learning environment, (7) evaluate performance/achievement, (8) motivate students to learning, (9) make instructional decisions, and (10) know content and how to talk about it.

As written, these objectives are not specific enough to be relegated to a computer. However, they might be compared to the educational problems that computers can address. More than two decades of research and demonstration have shown computers to be effective at: (1) delivering individualized tutoring, (2) assisting mastery achievement, (3) coping with definable individual differences, (4) simulating some learnings not effective or not otherwise possible, (5) providing continuous availability of instruction, and (6) making appropriate instruction more efficient and effective. In teacher education, the computer can assume a dual role. On the one hand, it can assist in teaching about computer applications to learning by serving as a model of these applications. On the other, it can be a medium for teaching content and the principles of the teaching act.

Planning Lessons: From Macro to Micro

Conventional teacher education programs emphasize the preparation of objectives and lesson plans. If one examines typical teacher-made plans, one sees a view of instruction from a linear and rather distant perspective. Such plans contain reasonable detail on instructional events, but virtually no details on instructional decisions that will be made during the teaching. This macroscopic view pays no attention to instructional dialogs between the teacher and the individual student.

The view one must take in planning a computer lesson is more microscopic. One learns very early that not only will a computer do only what one tells it to do, but it will do it with exactly the degree — or lack — of precision with which the task has been defined. Planning a computer lesson requires great detail about both instructional events and instructional decisions that must occur as a lesson progresses. Watching persons interact with even the shortest computer lesson provides valuable insight into how conversations develop and how the decisions must be made. These aspects are dealt with "on the spot" in actual teaching situations. Historically, the only way prospective teachers could learn these insights was through experience or through detailed critiques of videotapes or personal performance[1] — both of which are less controlled than in computerized environments. An important focus, then, at a later stage of preservice teacher education, is planning both teacher-presented and computer-presented lessons. The two perspectives offer complementary views of instruction.

Determining How Good Materials May Be

To support instruction, teachers must select appropriate materials, including those that are computerized. The selection of computerized materials, however, usually demands more of the teacher than do other types. This is particularly true since the electronic materials industry is just developing its own procedures and perceptions of quality. We must remember that the electronic materials industry is about as sophisticated as the text materials industry would be had the printing press been invented in 1950.

The key to assessing computerized teaching materials is the quality of the dialog between an individual student and the computer. At this time, the only way to evaluate dialogs is to participate in them. But good computer dialogs will behave differently with a successful student than with a not-so-successful one. To evaluate a computer lesson, the teacher must assume different roles while reviewing the materials. Using the materials first as a successful student will give a picture of the content domain, while playing the role of a student with a predictable confusion about the content will reveal how the computer deals with marginal success and how it attempts to mold learning. Varied user success and behaviors should produce noticeably different reactions by the software. This is the essence of the phrase "user friendly."

For the teacher-in-training, evaluating live or filmed teaching performance has limitations. The trainee has no control over the events and can only react to them as they unfold. The same limitations apply to the review of text materials. Evaluating computer lessons provides the students with not only an experience, but also with an experience that can be altered by individual choice. At various points in the lesson, a trainee can ask "I wonder what would happen if. . . ." Of course, trainees must be taught to approach materials in this way. Coupled with discussion and debriefing led by a skilled teacher-educator, trainees encounter more dimensions of teaching and the concomitant instructional decisions.

Facilitating Mastery

It is difficult to think of a school subject that does not require mastery of either rapid-recall material or algorithmic processes. Drills of many types are used to master rapid-recall content as well as to maintain motivation. Practice activities are used to help students master both the logic and the mechanics of processes. In either case, many teachers view the teaching task as little better than pure drudgery.

There is considerable evidence that properly designed computer courseware can make instruction for mastery objectives more efficient and effective.[2] A computer is infinitely patient and is tirelessly on-call to deliver individually tailored instruction. With a competent substitute, the teacher has additional time for other instructional activities. The task of the teacher-educator should be to assist the trainee in identifying, defining, and performing a new, uniquely human role in the instructional environment. What this role might be will vary with the subject. For example, in first-language instruction, the additional time might be devoted to a renewed, more intense emphasis on composition. In second-language instruction, an oft-mentioned but frequently ignored priority is competence in conversational listening and speaking. In mathematics and the sciences, renewed emphasis on problemsolving might be in order. Specific training in these alternate activities is eesential since many trainees will remember having teachers, most of whose time was invested, sometimes poorly, in mastery achievement tasks. As a result, trainees may not have appropriate models to call upon in these situations.

Learning To Diagnose

One important revelation from the computers-in-instruction movement has been the realization that we know little about either individualizing instruction or preparing teachers to do it. This is evident in the teaching activity of diagnosing student misconceptions. Student teachers are trained to recognize the presence of a learning problem, but not necessarily to recognize the cause(s) of the problem, through such experiences as tutoring students with difficulties (which have often been diagnosed by the regular teacher), preparing critiques of videotape interviews, or role playing students with misconceptions. Again, these situations are often uncontrolled. Such "reactive" situations usually do not permit systematic development of diagnostic skills. An efficient method is needed that permits large amounts of experience over a short period of time, with learning problems controlled to allow for appropriate practice geared to the experience and skills of the trainee.

This method is similar to training medical students in the diagnosis of disease. The common approach has been clinical experience, but this also is hard to control for optimal learning, particularly early in the student's training. Computer simulations have been shown to be a successful and efficient surrogate clinical experience. Computerists, aided by practicing doctors, have developed models of the decisionmaking processes used in the diagnosis of many diseases. Through repeated executions of these simulations, the medical trainee practices diagnosis.

The same techniques are now being applied to the training of teachers to diagnose learning problems with much of the current effort being directed by people involved in artificial intelligence. Burton and Brown[3] have reported interesting results in the diagnosis of learning difficulties in arithmetic. Their computer program, BUGGY, can recognize hundreds of erroneous rules or patterns people use in doing arithmetic. BUGGY can identify, from a stu-

dent's answers to arithmetic problems, the "bug" (faulty procedure) used by the student. A related program, DEBUGGY, allows the teacher to practice diagnosis of arithmetic learning problems by identifying the bugs of a computer-simulated student.

There are several implications for the teacher-educator. First, as training tools of this type become available, we need to incorporate their positive experiences into all levels of teacher education. Second, we need to follow the evolution of this kind of research potentially applicable to our training tasks. More importantly, we need to identify and articulate the "error pattern" knowledge of our own subject matter.[4] It is this knowledge on which such computer activities can be built.

Managing Learning

Every classroom teacher is also a classroom manager, either supervisory or executive. Supervisory activities include recording, assigning, evaluating, arranging, and reporting. Although most of these are quite routine, they account for a large portion of a teacher's time. The more sophisticated executive management activity involves planning, organizing, commanding, coordinating, and controlling. For more efficient and effective instruction, emphasis must shift from the former to the latter management activity. To implement this shift, there must be a viable alternative for the supervisory functions. In the days of the individually prescribed instruction (IPI) movement, para-professionals assumed much of the supervisory load. Today, a better alternative is to relegate this activity to a computer.

Prospective teachers should have frequent encounters with learning management systems to become familiar and comfortable with the interactions among student, teacher, and computer. Simultaneously, teacher-educators need to revise training curricula to include more emphasis on the nature and execution of executive management activities.

Student Evaluation

Computers can make evaluation processes more individual and improve the quality of classroom evaluation by controlling large collections of different kinds of questions, as well as by organizing the questions according to many different attributes. Such an organized collection can be used for student self-evaluation and for teacher-initiated evaluation. When coupled with quantitative methods of measuring the performance of tests and test questions, computer-assisted testing can be a powerful tool for improving the learning environment.[5]

Another application of computers to evaluation is computerized adaptive testing which combines diagnosis and evaluation of performance. In this application, successive items are individually assigned on the basis of each person's performance up to that point. To date, most of these testing applications have been done in signed-number, fraction, and decimal arithmetic.[6]

In order to benefit from computer-based testing, as well as other computer applications, teachers will need to change their perceptions significantly in such areas as test security. Teacher anxiety often increases when it is suggested that the same questions they use for evaluation of performance could be used also as study aids, primarily because of their concern over the integrity of the evalution instrument. What these teachers do not appreciate is the power to randomize or otherwise vary the experiences being constructed. Telling or describing does little to change these views. Trainees will benefit from interacting with test management or adaptive test systems. Indeed, a trainee should try these systems both as a student and as a teacher.

Motivating Learning

Teachers need some assistance in the difficult task of motivating reluctant learners. While computers have shown a significant and long-lasting appeal to many students, one should not generalize (as many proponents do) that because children obviously enjoy their computer experiences, significant learnings are taking place. In an article summarizing several studies comparing learning from and enjoyment of different teaching methods, Clark reports a disturbing incidence of high enjoyment of methods that result in the least learning.[7]

It is the role of the teacher-educator, then, to bring reason and balance to the teaching environment. Trainees need experience and guidance in identifying highly motivating materials that also teach. Trainees also need counsel in achieving an effective balance of instructional media in a classroom. Finally, the teacher-educator is responsible for the generation and interpretation of research investigating instructional effectiveness.

Learning To Decide

Every working day, teachers make decisions about curriculum, instruction, discipline, and interpersonal relations. Where, and how, does one learn to make these decisions? These are often learned through somewhat random experiences.

Learning to make decisions is an integral part of many vocations such as air transportation and medicine, where computers have become an important training medium. A few such efforts have also appeared in teacher education.[8] A simulation gives one an intimate experience with the content and logic of a decisionmaking environment. More than this, a simulation allows the user to practice optimal decisionmaking as well as to compensate for poor choices or an accidentally occurring barrier. Neither of these learning experiences is available in other ways except through direct experience.

Simulated decisionmaking is enriched by skillfully led discussions. Because different participants will have different experiences with a simulation, group debriefings bring closure and allow the participants to synthesize their learnings. This illustrates again how the teacher-educator and the computer together become a more effective vehicle of learning than either of them alone.

Knowing and Talking Content

Colleges normally present thorough treatments of the individual's teaching field. As is the case at all levels of education, this knowledge is incorporated by the recipients with varying degrees of completeness. Prospective secondary school teachers must complete major concentrations in their teaching area. On the other hand, prospective elementary school teachers must prepare to teach many different subjects. In either case, however, the content and coverage of university courses are usually beyond that which trainees will actually teach. How knowledgeable are they of their field(s) and how skillful are they in talking about content?

Three groups of trainees can be identified: those who know the content and can articulate it well; those who know but cannot talk about it, and those who neither know nor can articulate knowledge. Our concern is with the latter two. The teacher-educator and the computer can be an effective team in training both.

For the trainee who knows the content but cannot articulate it well, the teacher-educator can emphasize the need for and provide opportunities to develop effective speaking skills. Training in this area would probably follow a master/apprentice model. The computer could be used in two ways to complement the teacher-educator. First, the prospective teacher could become familiar with commercially prepared computer materials in the content area to note different verbalization techniques and strategies. Observing students interacting with these lessons could help the student determine why such techniques are or are not effective. Later, the trainee might develop computer materials that would present content and provide students with feedback and remediation geared to specific learning difficulties. Again, the trainee could observe interactions with the lessons, and then revise the lessons and repeat the observations.

Occasionally, there are prospective teachers who have not mastered all the content they will be teaching. In these cases, the computer could be used to individualize instruction on the school topics that will be taught. Having mastered the subject, a trainee could begin learning more about articulating the material.

Getting From Now To The Hereafter

Schools of education should be leaders in inventing and validating applications of technology and in the training of consumers of the technology. How do they do this, and where do educators get their expertise? Silence usually follows these questions.

The more successful efforts to bring together educators into the technology age involve a wide variety of teaming methods. Two or more educators addressing the issues significantly multiply the effects of their individual efforts. Teaming teacher-educators and practitioners accelerates the growth of those involved and provides important checks and balances for both points of view. The most important message for teacher-educators is that involvement with technology requires more than just reading and thinking about it. Because interactive learning environments differ when experienced, personal involvement is a must.

Footnotes

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