Roles of IT in Improving Our Educational System. Part 7. Highly Interactive Computing in Teaching and Learning


This article is about roles of teachers, learners, and computers in highly interactive teaching and learning. When most educators think about highly interactive computing, their first thought is about computer-assisted instruction. But, there are many other situations in which one uses a computer in a highly interactive manner. The development of a spreadsheet model, and the use of it in asking and answering "What if?" questions, provides a good example. The interaction one does in editing a photograph provides another example. This article explores various aspects of highly interactive computing and makes some suggestions about how to improve our educational system.

**Computer-Assisted Instruction**

We all know that a computer can be a powerful aid to learning. We know about "drill and practice" and tutorial computer-assisted instruction (CAI), and we know about simulations used to train airplane and spaceship pilots. In all of these teaching/learning situations, there is interactivity between the computer system and the learner.

In the pilot training simulations, the learner is involved in a highly interactive simulation of a real world environment. The simulation is attention-grabbing and realistic, and usually there is a high intrinsic motivation to learn. These characteristics contribute significantly to the learning process.

Drill and practice or tutorial CAI tends to lack the real world flavor of pilot-training simulations. A standard attempt to overcome this difficulty is to embed the CAI in a game-like, entertainment environment. The game-like environment may prove both attention-grabbing and intrinsically motivating. On the other hand, it is possible that it contributes little to the desired learning outcomes. This is because there may be little transfer from the learn environment to situations in which the learning is to be applied.

**Transfer of Learning**

Transfer of learning is closely related to the CAI ideas given above. The computer simulations used in pilot training are so realistic that there is a high level of transfer of learning to real world piloting situations. Flying the training simulator is less expensive and less dangerous than flying a real airplane or spaceship. Moreover, the computer simulation also allows the pilot to gain experience in dealing with dangerous emergency situations that are not apt to occur very frequently in the real world. All things considered, such CAI simulations have many advantages over emerging a trainee in a real world training environment.

On the other hand, the learning that occurs in more traditional CAI environments faces two transfer of learning difficulties. First, there is the transfer from the computer environment to the
non-computer environment. Second, there is the transfer from the non-computer environment to
the real world. To illustrate, a child may become adept at quickly doing certain mental arithmetic
feats in a highly interactive and entertaining game environment. Will the child be able to display
the same level of skill in the non-game environment of a traditional classroom or on a traditional
pencil and paper test? And, will such traditional classroom knowledge and skill transfer to
recognizing and solving somewhat similar problems that the student encounters outside the
classroom?

We know how to use computers to make highly interactive simulations that are so real world-
like so that there is a high level of transfer of this learning to the real world. This provides us
with a target to aim at as we develop other types of CAI for use in our schools. We have not
come very far in this endeavor.

Learning and "Attention" in the Human Mind

The body/brain receives input from the five senses: aural, taste, touch, visual, and smell. (For
simplicity, in the remainder of this article I will use the term mind in place of the term
brain/body.) Learning takes place inside the mind. This learning is influenced by what the mind
consciously does to promote learning, as well as what it unconsciously does. Thus, we can think
about improving learning by improving the external stimulus (what is provided from outside the
mind) and by training the mind to learn better from the stimuli that it receives and from what it
has stored in the past.

The mind's various input systems are easily overwhelmed by the amount of input that is or
can be available. Thus, the mind is designed to not pay attention to most of the input. That is,
there is a continual filtering mechanism being applied. The mind only pays attention to a very
small part of the input. It pays special attention to life threatening and other dangerous situations.

The mind can consciously decide to focus its attention on certain internal and external
components of its environment. That is, the conscious mind can focus its attention on stored data,
information, knowledge, and wisdom, and it can also decide to pay attention to external stimuli.

This selective attention mechanism presents a major challenge to teachers. As a teacher, you
want students to pay attention to what is going on in the classroom. But, you are competing
against built-in mechanisms that are designed to have the mind only pay attention to really
important things. Many students automatically filter out (that is, do not pay attention to) what is
going on in the classroom. After all, classrooms are designed to be safe places, so there is little
chance of life-threatening events occurring, such as an attack from a tiger or a poisonous snake.
In a classroom, a student's mind can safely consider events of past days or possible events in the
future. These events may be far more attention-grabbing than the current events within the
classroom. The student pays attention to and learns about these past and possible future events,
rather than what the teacher would like the student to be learning.

From a teacher point of view, there is a competition going on for the attention of a student's
mind. The good teacher is able to create an interactive learning environment that helps to focus
student attention on important curriculum topics. A good teacher and a good educational
environment can grab the attention of the students in a class. Highly interactive computer
environments can add significantly to such a learning environment.
Interactivity in Tutorial Settings

The mind is designed to be able to learn. Consider a situation faced by a very young baby. The baby's mind recognizes some form of discomfort (a belly ache, too cold) and produces the action of crying. The crying is heard by a parent. The parent makes a guess as to the source of the discomfort and takes an action to remedy the situation. This baby-parent interaction leads to learning on the part of both the baby and the parent.

A similar description fits well with a child learning other non-verbal and verbal language. This is a good example of highly interactive one-on-one "tutoring," with both the child and the adult learning from the interaction. There is a very important point to be made here. The nature, extent, and timing of the feedback provided by the tutor (the adult) is determined by the best judgment of the tutor. It is individualized and highly personalized based upon past interaction with the child.

From the type of analysis given in this section, we can identify some of the characteristics of a good tutor. It needs to:

1. Have a good "understanding" of what is to be learned and how humans learn it.
2. Have a good understanding of what the learner already knows and learning characteristics of the learner.
3. Provide feedback and interactivity that is appropriate in nature, extent, and timing.

Over the years, some progress has been made in the development of drill and practice and tutorial CAI that has these features. There has been encouraging progress in the development of Intelligent CAI systems that make use of progress that has been occurring in the field of artificial intelligence. However, we have a long way to go. Much of the interaction needed to make current CAI into a rich learning environment must come from and through the learner. This means that students need to learn to make effective use of the types of CAI that we are currently able to produce.

This is not a whole lot different than a student learning to learn from books. The CAI can be thought of as an interactive type of book. Little learning occurs in drill and practice or tutorial CAI unless the student is consciously and actively engaged, and has learned to make effective use of the medium.

Non-CAI Interactivity

I spend a significant fraction of my work time seated at a computer. I mainly use general-purpose computer tools such as word processor, spreadsheet, paint and draw graphics, E-mail, Web browser, and Web authoring software.

Typically, my goal is to solve a problem or accomplish a task. I use all of my computer tools in a highly interactive manner. This type of interaction is much different than one finds in a CAI drill and practice or tutorial environment. Sometimes I do most of the work in the interactions, such as when I am authoring using a word processor or a Web authoring system. Other times the software carries much of the burden, such as when my word processor is checking my spelling and grammar. Sometimes there is a nice balance, as my Web browser and I work together to solve an information retrieval problem.
As I work to solve problems and accomplish tasks, I learn a great deal. The combination of my mind and the computer system provides me with information to be learned and feedback during the learning process. This is consistent with Situated Learning, a learning theory that supports putting the learner into rich, real world problem-solving environments (Moursund; Roschelle). Situated Learning theory helps to explain the success of problem-based learning and project-based learning. Computers can be a valuable component of a situated learning environment.

At one time in my life, I spent a lot of time doing and teaching computer programming. In the early years, the nature of my interaction with the computer was limited by the slow turnaround of using punched cards on a batch-processing computer. Then timeshared computing was developed, and this greatly improved the interaction. Microcomputers have further improved the human-machine interaction in computer program. Computer programming is now an example of highly interactive computing. It is also an excellent example of a situated learning environment.

Final Remarks
Learning occurs in one's mind. This article focuses on various types of learning environments in which there is interaction between a computer system and a person's mind. Such interactive learning situations can be improved by:

1. Improving the computer system. For example, we are making progress in developing Intelligent CAI systems that have some of the characteristics of a good human tutor. There are a number of examples of computer simulations that are excellent aids to learning, but relatively few have been designed for use at the precollege level.

2. Helping the student learn to make effective use of the various types of interactivity that a computer can provide. Often this takes considerable learning on the part of the student. Situated Learning is a learning theory that fits well with immersing students into computer rich problem solving environments in a manner that will facilitate student learning.


References


Retrospective Comments 11/8/01
There is a huge amount of edutainment software that has a combination of entertainment and educational objectives. For the most part, this software has not been adequately researched. Many students use such software at school and at home for entertainment; relatively few use it with clear content area learning goals in mind. Many teachers facilitate such use—"You can use the computer (to play these games) after you get your assignment done." This approach to IT in
education is strongly entrenched. In some sense it is supported by both students and teachers. Thus, it resists change.

The section on Non-CAI Interactivity in the editorial remains central to the future of IT in education. It reflects use of IT in higher-order thinking and problem solving. There is increasing research evidence to support Situated Learning, and IT can be a valuable component of many different Situated Learning environments. I strongly support this approach to use of IT in education.

Situated Learning is one of 50 learning theories that are briefly defined and discussed in Explorations in Learning & Instruction: The Theory Into Practice Database [Online]. Accessed 11/8/01: http://tip.psychology.org/index.html. See also:

Brown, John Seely; Collins, Allan; and Duguid, Paul. Situated Cognition and the Culture of Learning [Online]. Accessed 11/8/01: http://www.ilt.columbia.edu/ilt/papers/JohnBrown.html. [Note added 5/8/02: This site is no longer available. However, Brown and Duguid have a book Balancing Act: How to Capture Knowledge Without Killing It that covers some of the same ideas.] Quoting from this Website:

The breach between learning and use, which is captured by the folk categories "know what" and "know how" may well be a product of the structure and practices of our education system. Many methods of didactic education assume a separation between knowing and doing, treating knowledge as an integral, self-sufficient substance, theoretically independent of the situations in which it is learned and used. The primary concern of schools often seems to be the transfer of this substance, which comprises abstract, decontextualized formal concepts. The activity and context in which learning takes place are thus regarded as merely ancillary to learning—pedagogically useful, of course, but fundamentally distinct and even neutral with respect to what is learned.

Recent investigations of learning, however, challenge this separating of what is learned from how it is learned and used. The activity in which knowledge is developed and deployed, it is not argued, is not separable from or ancillary to learning and cognition. Nor is it neutral. Rather, it is an integral part of what is learned. Situations might be said to co-produce knowledge through activity. Learning and cognition, it is now possible to argue, are fundamentally situated.