

Q. I am planning to make a presentation to our school board. What are some really good arguments that computers make a difference in education?

I am currently involved in a research project designed to investigate this issue and find some answers to this frequently asked question. This column is the third in a five-part series of columns summarizing some of what my research group is finding and explaining my own current thinking on this question.

**Lifelong Learners**

One of the widely accepted goals of education is that all students should make significant progress toward becoming independent, self-sufficient, lifelong learners. This is important because the totality of human knowledge is growing so rapidly. To become responsible adult citizens, young people will need to acquire a combination of knowledge and skills that do not yet exist.

This means that our educational system needs to place increased emphasis on learning how to learn. Research tells us that learning is a constructive process—that learners build on their previous knowledge and skills. Each learner has individual differences in learning styles and learning abilities, background knowledge, and experiences. Thus, learners can benefit by learning more about their own specific learning characteristics and how to improve their knowledge and skills as learners.

Traditional education helps students learn how to learn in a formal school environment. However, this is not the learning environment adults experience as they become lifelong learners. The learning environments adults face at home, at work, and at play tend to be quite different than the structured classroom settings of our formal educational system.

**Technology-Enhanced Learning**

In recent years we have seen great strides in the development of a number of powerful new technology-based aids to learning. Five key examples include:

1. **Computer-Assisted, Instruction (CAI).** This includes drill and practice, tutorials, simulations, and microworlds. Increasingly, CAI is available in a hypermedia environment that includes text, sound, graphics, and video. CAI uses research-based principles of cognitive learning theories and includes the use of built-in generic tools such as word processors and computer-based calculators.

2. **Computer-Managed Instruction (CMI).** This system uses record keeping, self-assessment, and feedback to provide guidance in a learning task. The
learning itself may take place via a variety of learning aids, such as CAI, distance education, and books.

3. Distance Education. This may involve real-time interaction, perhaps including both two-way audio and two-way video; it may be time-delayed to fit the time convenience of the learner and/or the instructor. Interaction between the learner and the instructor, as well as among learners, may be by e-mail, telephone, or audio or video conferencing. Both the learners and the instructor may routinely use desktop presentation facilities.

4. Electronic Interaction. Electronic interaction involves access to and interaction with individual people and groups of people. The interaction may be in real time or it may be time-delayed.

5. Electronic Information-Gathering. Electronic access to information and computer tools, which now routinely contain built-in, context-sensitive help features and tutorials, help process information. That is, computer tools and CAI are merging. A type of "just in time" learning occurs in environments where computer tools are used.

The combination of all of these electronic aids to learning is called technology-enhanced learning (TEL).

The Future of TEL

TEL is in its infancy. It is growing and changing, and ever increasing in the services it offers. Increasingly TEL will provide:

- Learning that can occur at a time and place that fits the needs of the learner, whether this is at home, at work, or at school.
- Learning aids that account for individual differences among learners. For example, materials will be available in different languages; at various reading, listening and viewing levels; and in formats based on different prerequisite assumptions.
- Learning that covers a broad range of topics-in essence, whatever a person wants to learn.
- Interaction among learners from all parts of the world rather than from a limited geographical area. Participants in this type of interactivity will be learners, but they will also help each other to learn. The knowledge and skills of multiple learners will be valuable to everyone.

Students spend many years in our formal education system trying to learn how to learn in a formal setting. We now need to broaden the system's "learning how to learn" goals to include teaching students how to learn in a TEL environment. We can do this by actually giving them the experience of learning in this environment. They need instruction in how to use TEL effectively and how to tailor their own learning environments to best fit their individual learning needs and strengths.

Schools currently have widely varying levels of access to the components of TEL. However, almost all have sufficient access to provide students with training and experience in using TEL. For example, individuals and/or small teams of students could assume responsibility for researching and learning a topic such as how to use a particular piece of software. In the process students become learning facilitators—they help other students to learn the material. This type of
learning/teaching activity can be used over and over again, at all grade levels and in all subject areas. It is an excellent way to help students become independent, self-sufficient, lifelong learners and teachers.

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Note: The National Foundation for the Improvement of Education (NFIE) has received funding from Microsoft founder and CEO William Gates III to carry out a project titled "The Road Ahead." NFIE is a non-profit educational foundation created by the National Educational Association in 1969. NFIE has subcontracted with the International Society for Technology in Education (ISTE) to do research and evaluation on this project. Some of the ideas in this series of columns on computers and effective practices are based on this research.