Synthesis of Research on Electronic Learning

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Much of what we know about electronic learning—learning via electronic sources such as television, computer, videodisc, teletext, videotext—is anecdotal and word-of-mouth. It would seem that, compared to print learning, electronic learning calls on more sensory interactions based on the ability of electronic technology to produce images, sound, simulation, and radically new dynamic graphics that can enhance learning.

To date there has been little systematic research about electronic learning. This is to be expected in any new field; we must simply remember that many so-called findings at this stage may be reversed as we learn more about electronic learning.

Parents and educators commonly ask a number of questions about computers:

• Do computers help learning? This is one of the few questions that can be answered with systematic research. A long-term study of computer-assisted instruction (CAI) conducted by the Educational Testing Service found that computers do indeed assist learning.[1] Pupils learned more quickly when they were exposed to computer-assisted instruction than they did in traditional classroom instruction. The computer-assisted instruction included a good deal of drill and practice, which is the form most of the early software has taken. And drill and practice, according to the ETS study, is effective, partly because it improves motivation and attention.[2]

• Doesn't electronic learning take away from reading? Educators worry that children will spend a lot of time in front of computers, in which they are obviously interested, and as a result will neglect reading. A better question would be not whether children will read less, but whether children will learn more. If children are going to learn more, does it matter whether they learn from a computer or from a book? Most educators, including myself, are print oriented; we believe that learning from reading is the best possible way to learn. We are simply going to have to open our minds to the other possible ways to learn, and accept that learning from an electronic source may be just as effective, and maybe more, than learning from print.

Books are not going to go away. They are still a very efficient way to transfer information. But it is likely that school-age children are going to learn more and more from electronic sources. The question will then be are they learning more from an electronic source than they are from a print source? If they are, isn't learning going to increase, and isn't that what we all want?

• Do computers motivate pupils to learn? There are no systematic studies so far, but there are hundreds of anecdotal and observational reports that children, when exposed to learning from computers, take to it like ducks to water. Almost all children seem to enjoy contact with computers and software. A pilot study in the Electronic Learning Laboratory at Teachers College shows that student attention, defined as time-on-task, was higher with computers than it was in the classroom.[3] This was true even in a school where computers were no novelty. Colleagues have reported that children receiving remedial reading showed a marked increase in attention when they were exposed to software on the computer for the same remedial reading session. It is possible that this is a novelty effect, although in independent schools around New York City, where computers have been in use for ten years, the effect has not worn off.

• Will computer games affect learn-

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ing? Because the game format used in much of the software now being written is usually attractive to children, it can be used to bring about learning. Many people worry that children's exposure to exciting video games means that they will, by comparison, be bored with traditional classroom instruction. This may be true. While it is too soon to tell, it seems likely that if computer software continues to become more and more attractive, it will be a very hard act to follow—just as television was a hard act for classroom teachers to follow. As educators, we are probably going to have to take games much more into our thinking in organizing instruction.

• What is so attractive about interactive technology? Nobody has the answer to this, but we have some clues and many people are working at it.[4] There have been a few studies in which the software has been changed, characteristic by characteristic, to see what attracted children.[5] Some of the characteristics that seem to be important are the idea of a challenge, the involvement of fantasy, and the game format. The level of challenge especially appears to be important. Software should not start off too difficult or too easy, and must move along at the right rate of increase to keep the pupil involved. Well-written software keeps the pupil alert in order to answer the questions and problems being presented in a variety of technological formats. An alert student tends to be a learning student.

A pilot study at the Electronic Learning Laboratory found that pupils involved with the computer ask more questions than they do in the traditional classroom. This goes against the notion that children just sit in front of the computer like little robots. Far from it. They are very active and full of questions, which seems to be an educationally desirable characteristic of computer learning.

• What about this technology itself attracts pupils? Nobody seems to have an answer to that one yet, but it does seem that the technology itself is alluring. A colleague reported this anecdote: Children were visiting an excellent museum display, which began with interaction on a computer and ended up with some computer games. The children who came into the museum started enthusiastically at the computer, skipped the exhibits, and, like lemmings, went to the video games. They paid not one bit of attention to any of the exhibits between these two technology points. This suggests that there is something about the technology that is inherently attractive to this generation of children and that we had better pay attention to it.

Some think that because children can make the machine do what they want, they gain a sense of control. Some think that interacting with computers is attractive.[6] Others say that technology is the glamour aspect of our current society and has the appeal of being contemporary and future oriented. It may be these characteristics or some others that we have not yet identified; but one thing is clear—children will make a beeline to the technology, given the opportunity. We never want to throw away what is attractive to children if we can use it in education.

• Does learning a computer language help other learning? The results of research on this are not in agreement. Some people have claimed, as has Seymour Papert, that learning a computer language like LOGO will teach a child to think logically and sequentially.[7] That is an appealing notion. Others have claimed that learning BASIC or PASCAL will do the same thing since learning how to program requires one to put things in a logical and precise order. This is not a new argument; it was said many years ago that learning Latin and Greek was a good discipline for the mind. Neither Greek nor Latin has been demonstrated to have such a transfer effect on other learning, and it is an open question whether or not computer languages will show a tranfer of this magnitude. (In fact, it is very hard to

Highlights from Research on Electronic Learning

Electronic learning is how we learn from the new electronic sources—computers, videodiscs, television, and so on. There has been very little research on the effects of electronic learning; most of what we know is based on anecdotal reports. So far, we know that:

- **Computers can improve learning.**
- **More learning in the future will be electronically based, less will be in print or lecture form.**
- **Electronic learning motivates children.**
- **The attraction of computer games will probably force us to use game formats more in educational materials.**
- **Electronic learning is attractive to students partly because it is interactive and partly because of the allure of the technology.**
- **Learning to program may teach logical thinking, but it is not known if this will transfer to other subjects.**
- **Children who are excellent at programming are also likely to be good at mathematics or science.**
- **Computers increase, rather than decrease, socialization among children.**
- **"Good" software depends on who judges it. Some "bad" software is rated "good" by children.**
- **Software is viewable and, consequently, judged critically. How would we rate classroom teaching if we could have it assembled and rated in the same way?**
- **Future electronic learning will benefit from technological advancement.**
- **A large part of electronic learning will be in imagery.**
- **As a result of the electronic learning revolution, education will never be the same!**

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show that there is transfer of learning from one subject to another.) Whether learning a computer language will teach a child to be logical and sequential in some other endeavor is an open question.

• What kind of pupil does best at learning a computer language? Again there has been some research in this area, and again the results are not consistent, largely because the investigators have looked at different characteristics of pupils. The common perception is that a "computer freak" is a child who has not done well in school before and has not been very popular, but who has a special gift with computers and becomes the local computer guru. The stereotype is of a boy who is poorly coordinated, anything but a jock, who wears glasses, and sits pale and wan in front of his computer until all hours (shades of "Pinball Wizard"). This is not very accurate. The evidence to date suggests that people who are good at computers are also good in allied skills such as mathematics and science. They might not have been outstanding students, but neither were they poor students.

Being good at programming probably takes a certain type of linear thinking that not everyone is good at,[8] but that remains to be demonstrated.

• Don't computers isolate children socially? An Electronic Learning Laboratory study suggests the opposite is true; namely, that children who work around computers tend to talk to each other more than they do in the classroom and to talk about what is to be learned rather than talking about out-of-classroom matters. It is possible that this higher level of social interaction around a computer is a function of a shortage of the machines themselves. As we get more computers in the classrooms and children are more likely to have a computer or terminal to work on by themselves, then possibly the interaction will drop. But at present we are seeing increased socialization around the computer. And the level of socialization around the computer is greater than in the classroom.

• Why isn't there good software? We are in the infancy of the development of software for microcomputers, and it is hardly surprising that what we have is not very sophisticated. Much of the first software was a translation of existing textbooks and workbooks to the computer screen. This is what print publishers knew how to do and thought best because it had worked in the classroom. Unfortunately, print does not translate to good software. They are two very different mediums and they require two kinds of treatment of the material. This is something we are just discovering, and very few people have a real appreciation of what the technology can do.

Nevertheless, exciting new software is being developed.[9] What may be overlooked is that what software teachers think is poor may not be poor in the eyes of the pupil. In fact, children in the Computer-Assisted Tutoring System at Teachers College have worked eagerly on a software program that adult evaluators said was quite awful. To the pupils, it was exciting and fun and they were learning. So it might be wise to reserve opinion about software until one sees it being used by the consumer, which in this case is the pupil. (It is also true that just as there is some very poor software out there, there is some poor teaching around. Not every teacher, if videotaped, would look superb as a pedagogue.)

At the moment even bad software seems to be capable of teaching. Perhaps the proof of the pudding will be in what children learn from it. The secret is that it keeps them *attending*, and the result is that they get more practice in their drill than they do in the classroom. Skills have to be practiced to be learned, and one advantage of this software is that the practice *does* happen.

• What can the computer technology really do? Nobody, but nobody, has the answer to this one. We are just beginning, in a most primitive way, to understand what this technology can do for learning and for teaching.[10] What we predict is that the technology will make different demands on the learner.[11] One of these will be in imagery.[12] Children will be relying more and more on imagery comprehension than on word comprehension. Children will be learning more from graphics than they will from the alphabet.

• What will the new technology bring? Again, nobody knows what the impact of the newer technology such as teletext, videotext, and videodisc will be. All we know is that experiments are going on now to see what combinations of the computer and television can bring in the form of information and entertainment.[13] Videodisc is a different kind of technology that has enormous capacity to store images—some 54,000 on one side of a videodisc. Clearly this would be an appropriate form of technology for highly visual fields of knowledge.

What the new technology can do and what form it will take is anyone's guess at this point, but we do know that it is exciting, it is happening, and it is going to change.[14] Schools will never be the same; learning will never be the same; teaching will never be the same.□

[1]M. Ragosta, *Educational Testing Service Bulletin* (Spring 1982).

[2]D. Forman, "Search of the Literature," *The Computing Teacher* (January 1982): 37–51; J. A. Kulik, R. L. Bangert, and G. W. Williams, "Effects of Computer-Based Teaching on Secondary School Students" (The Center for Research on Learning and Teaching, University of Michigan, Ann Arbor, January 11, 1982).

[3]Electronic Learning Laboratory, "On Task Behavior of Students During Computer Instruction vs. Classroom Instruction" (Teachers College, Columbia University, New York, January 1982).

[4]A. Bork, "Interactive Learning" in *The Computer in the School: Tutor, Tool, Tutee*. Edited by R. P. Taylor (New York: Teachers College Press, 1980).

[5]T. W. Malone, "Toward a Theory of Intrinsically Motivating Instruction," *Cognitive Science* 4 (1981): 333–369.

[6]Malone, ibid.

[7]S. Papert, *Mindstorms: Children, Computers and Powerful Ideas* (New York: Basic Books, 1980).

[8]K. B. McKeithen, J. S. Reitmen, H. H. Rueter, and S. C. Hirtle, "Knowledge Organization and Skill Differences in Computer Programmers," *Cognitive Psychology* 13 (1981): 307–325.

[9]D. Watt, "Informal Learning: Software that Teaches and Entertains," *Popular Computing* (March 1983): 60–64.

[10]L. P. Grayson, "New Technologies in Education," in the *Encyclopedia of Educational Research* (Washington, D.C.: NIE, 1982).

[11]R. R. Burton and J. S. Brown, "An Investigation of Computer Coaching for Informal Learning Activities," *International Journal of Man-Machine Studies* 11 (1979): 5–24.

[12]M. A. White, "Toward a Psychology of Electronic Learning," in *The Future of Electronic Learning*. Edited by M. A. White (Hillsdale, N.J.: Erlbaum, in press).

[13]"The Innovative Japanese," *The Economist* (June 19, 1982); "Tokyo Looks to the '90s," *Datamation* (January 1982).

[14]A. R. Molnar, "The Search for New Intellectual Technologies" (Washington, D.C.: National Science Foundation, 1982); Office of Technology Assessment, Congress of the United States, *Informational Technology and Its Impact on American Education* (Washington, D.C.: U.S. Government Printing Office, 1982).