THE NEXT DECADE
The next decade will see a gradual moving away from an experimental phase where the use of computers and related technology in education has been in a trial form to one in which the computer will become a very important component of the educational system. The change will continue in the following decade, and by the year 2010 we can expect that the computer will be one of the dominant educational delivery systems in many parts of the world.

Many developing countries will find that it is easy for them to move into this area, perhaps even easier than for countries that have already been pursuing it for some time. This is because of the nature of the technology, with its rapidly declining costs. Countries that already have an investment will often have a disadvantage because of the older equipment that does not meet modern standards.

A number of factors are very important:

- New materials concerning the computer and education, intended for learning at all levels, must be developed on the basis of the current problems within educational systems. In most countries in the world these problems are severe, and are increasing. While they differ from country to country many simply represent the fact that the lecture/textbook system, on which many of our schools are based, has reached the point where it is no longer improvable.

- Much existing material for using the new technologies, with computer, videodisc, CD-ROM, etc. is not based on any clear understanding of the current problems of educational systems. Indeed many of the speeches and papers about such new material never mention that there are any existing problems!

- New developments involving technology in education should be student-centred, rather than administrative-centred or teacher-centred. These new developments should not make life more complicated for the other stakeholders in education, even though they focus on students. We need to have a clear priority often missing in current education, as to who our major clients are in education. This applies at all levels of education.

- Education is one of the most important activities in the world. We must never lose sight of the fact that it is important not only for countries, but for the well-being and happy life of individuals. Often education is treated as a step-child in society. We should not allow this to happen.

- New developments should concentrate on higher order thinking skills.

- We badly need additional research as to how the computer and associated technology affects the learning process. There is relatively little known about many of these aspects. Often it is assumed that information from non-computer environments applies, but our studies at Irvine, in such areas as reading from computer screens, suggests that this environment is so different that older research is often inadequate.

- Another area that will need additional emphasis in the next decade will be that of the development of effective production systems. Many of the materials that have been produced so far have been produced by strategies other than the best modern curriculum development strategies. Understanding how to develop highly interactive material involving computers is only gradually coming to us. We need to develop much more experience and conduct more research in this area. A good production system is the key to the future.

- We also need more exemplary materials at the full course or segment level. There are few full courses devoted to any aspect of the computer in education at the present time, but many fragments. Development at the full course level is essential to show teachers and administrators the inherent possibilities.

ADVANTAGES AND RISKS
Education will be facing a series of continued crises during the next twenty years. These crises will be quite independent of the use of the computer. The computer will give us a possibility for beginning to solve some of these crises. The greatest risk will be that the computer may be used in ways that do not improve the educational system, but lead to its further deterioration.

Hence the greatest risk is emphasis on simplistic ways of using the
computer in this period of time, ways that will be appealing to some simply because they are easy or inexpensive to do. They may well lead to the opposite of what good computer material can lead to, a dehumanization of the educational process. I stress that this is not necessary, but only a possible outcome if no steps are taken to prevent it from happening.

The current situation with regard to computer material is not at all rosy. In spite of what purports to be research in this area, much of the existing computer material or material using other new interactive technologies, is inadequate for a new educational system. If we are to avoid the simplistic ways already mentioned we must go far beyond the types of things which have been created already. Very little has been done so far with adequate budgets, and with adequate planning.

DEMOCRATIZATION OF EDUCATION
One of the key issues to be considered is that of making our educational system more democratic. The issue of whether a country is democratic or not is simply a question of whether officials are elected or not. Rather the access to education is an important issue, often neglected, in the democratic process. Several aspects of this are of particular importance concerning computers.

Equity of computer availability
The question that must be faced is availability of computers, both learning materials and hardware. If computers, including associated highly effective learning materials, are available only to the privileged few, then computers will have a negative influence on bringing education to a greater number of people and in aiding the democratic process. If on the other hand steps are taken to insure computer access for everyone in our world society, then the democracy can be aided.

The key factor in making computers available to all is that schools can provide them, without cost, to those who are unable, for economic reasons, to access home computers. Another possibility is to have far more computers in public locations, such as libraries and shopping centres. Like all other inequalities in our modern societies, the inequalities can be solved if governments are willing to spend reasonable sums.

Learning for all
A second important factor in assuring that society is democratic, so far as education is concerned, is that education should not only be available to all students, but all students should learn. This means that each student must learn to that student's full ability. This is by no means the case in our current educational system as reflected in the grading systems. These systems show that not all students are learning. Yet the mastery learning theorists, particularly Benjamin Bloom, have argued for a long time that all students can learn, given the appropriate learning environments. Thus all students can master everything currently taught in schools, and probably everything taught in universities. This is not to say that all students will require exactly the same time, or that a single set of learning materials will be satisfactory for all students. Rather the learning materials must be versatile, taking into account the differences between students.

I emphasize that I am not speaking simply of learning factual information. Our current educational systems put far too much stress on this, both because it is the easiest thing to do, and because the national and international exams tend to stress rote memory of fact, or memory of simple processes. Higher cognitive skills are almost ignored in this widespread testing procedure. Yet these too can be attained by all students.

Lifelong learning
Another key to the democratic process is that learning must take place throughout the person's life; we do not put people in niches at the beginning of life, such as was done in Aldous Huxley's novel, Brave New World. We expect people to learn at all ages, and to learn enjoyably. This is a rapidly changing world. If citizens are to perform effectively in a democracy their educational strategies must reflect this change, and so must be present at all ages.

RELATIONSHIP BETWEEN EDUCATION AND INFORMATION
History has shown little relationship between educational experts, and experts in informatics. Hence attempting to change the situation regarding technology in education is a difficult one, because many of the people involved in this area do not have the expertise from one direction or the other. Several aspects of this need to be considered.

Schools of education
One important issue for schools of education concerns the use of computer and other related technologies. Again the issue differs from country to country. I consider mainly the United States.

Studies conducted in the United States indicate that very few schools of education currently have any notion about the computer in the educational process. Only a few schools are offering adequate programs in this direction.

Schools of education have many other problems, complicating the difficulty of working with them. Serious concerted effort is needed on a worldwide basis. While I am not as familiar with the situation in other countries, I believe that there are many where similar serious problems exist.

This issue seems to be a very difficult one. The traditional educators all come from a period where computers played no role in learning. Furthermore, they are naturally a conservative group; they tend to favor the methods that they themselves were brought up on. To introduce radically new ideas in education requires a serious change in thinking patterns.

The best hope is to use the computer itself as the learning vehicle for the teachers, as well as for the students. That is in developing new courses, in particular, areas in the development of interactive materials for teachers shall be considered an integral part of the course development. Almost no materials of this kind have been developed to this point. But that is not too surprising, since very little in the way of full-scale development involving the computer has taken place either. I will argue that such sizable development is essential if we are to do more than change education cosmetically. An international organization could take the lead in such a process.

Learning and information
The difficulties just talked about in school have to do with the fact that the educators are not very attuned to computers. But an entirely different set of difficulties comes when one starts looking at what computer scientists do when they do things in education. Here the situation is equally bad. Although these people often know their own discipline, and are usually well intentioned, they know little about learning. Indeed they seem to think that computer science itself is the key to understanding learning, a dubious proposition.

One typical note of this confusion is to mistake the presentation of information, from the question of learning. The naive view often seen here is that if students have access to very large amounts of information, in versatile forms (hypertext and hypermedia are...
often stressed), then they will learn. But most teachers know that simply presenting information to students does not guarantee that anything will be learned. If we know anything about learning we know that it is a very difficult process, and that it differs greatly from student to student.

I am afraid that so far much of the work in artificial intelligence in education is in this same direction. Well-intentioned people often proceed with little knowledge of what the problems are in actual learning. Much of the material produced this way tends to be elitist, usable for only a few students, and defeating the aims of democracy as discussed above.

INTERACTIVE TECHNOLOGY AND EDUCATIONAL PROBLEMS

I have referred several times to the fact that the use of technology, or any new innovation in education, cannot proceed in a vacuum. It must work in the context of the known situation in education, and the known difficulties that are occurring with that situation. In this section these difficulties are considered, and the ability of interactive technology to be of assistance is brought forward.

Individualization

In the current educational situation, although there is a general belief that students differ, almost all students are given the same educational situation. Very seldom do we take into account differences from one student to another.

The main villain is the standard lecture-textbook class usually having between twenty and forty students. University classes are often larger. In some countries classes are also larger. Again one is speaking of statistical averages. There are certainly small rural schools in many countries that have far fewer students working together, but the typical class in almost all parts of the world fits into the range just suggested.

Given a class of that size very few teachers will be able to individualize the learning experience. This is reflected in the grading system too. The grading system shows that the goals of mastery learning are not attained at all in current educational systems. Indeed when one talks about improvement it is often a very small fractional improvement, far short of the goal of mastery.

The computer provides the key to enabling us to individualize the learning process. The computer can be playing close attention, at any moment, to what the student knows and does not know through questioning the student, and can be very selective in determining the precise difficulties the student is having. All this assumes the existence of very high quality material, to be discussed briefly later. It is no longer necessary for each student to have the same learning experience. Rather the learning experiences can be tailored to the needs and problems of the individual.

Interaction

Most learning theorists, from a wide variety of different backgrounds, agree that learning should be an active process. If the student can play a major role in creating knowledge, it is much more likely that this knowledge will be retained, and it is likely that it will be held at a deeper level. For example there is a great difference between a student being told the laws of genetics, and a student, perhaps with considerable aid and assistance, discovering the laws of genetics. Yet in almost all existing school systems, when genetics is studied, the laws are presented, sometimes within an historical basis, sometimes not. Often too they are presented with little motivation for the student.

The interactive capabilities of the computer make an entirely different approach possible. The student can be constantly queried, or given assistance as needed. So the process of learning for each student can be an active process. The student does not have to listen to sizable chunks of lecture, or read material in books; the learning process can be discovery-based, unique for each student, and providing an active learning experience for each student. Again the possibility of this is dependent on large amounts of learning material not in existence at the present time.

Motivation

In many countries of the world the student’s view of school is a dim one. In the United States many students use words like ‘prison’ to describe the school environment. Indeed many schools are prisons, particularly in inner-city areas in the United States. The doors may be locked, opened only by guards. All visitors to schools are escorted by guards. Students are not permitted to leave the school grounds at any time during the day. This situation is not unique, but it is certainly common.

We also see the student’s view of schools by the fact that teachers in many areas motivate students primarily through threats. These threats are often based on grading. Indeed if there were no grades in schools many teachers would have little idea of how to keep students motivated at difficult tasks. The threat of grades is coupled with the threat of parental reaction, and the ‘false’ threat that one’s whole life will be ruined if one does not make a good grade in a given course.

Studies with computers show that interaction and individualization go a long way toward keeping material motivating for students. If the student is an active participant in the learning process he or she tends to stay on the task for longer periods of time. Furthermore we can, by placing such materials in public libraries, completely unattended and with no threats, determine empirically where the motivationally weak points are in technology-based learning material.

Technology and new courses

To attain a more individualized, interactive, and motivational educational system than we have at present, is possible through much more extensive use of computer, videotdisc, CD-ROMs, and other interactive technologies. But this cannot be done piecemeal, with a small amount of addition to existing courses. Small additions do not fundamentally change the courses, because most of the student time is still taken up in the older non-individualized, passive strategies that are the basis of the older courses. It is only through the creation of full new courses that we can attain the goals that we desire for the future of education.

Amazingly few courses based on interactive technology are in existence. One can label them almost on the fingers
of one hand, although one might quibble in a few cases. The most recently developed course of this kind is the Writing to Read course, for five-year-olds, marketed by IBM and developed by John Henry Martin.

The relatively small amounts of money that are going into developing highly interactive technology-based courses should be compared to the vast sums of money that have been spent, in almost all levels of education, on primarily video-based non-interactive courses. Massive government programs, such as Star Schools, have gone in this direction. Whole foundations have devoted very sizable amounts of money, such as Annenberg/CPB. States such as Oklahoma have poured large amounts of money into this direction. Yet the results are primarily still the non-interactive, non-individualized courses that exist. Before these courses were developed, I see no prospect that linear video will ever produce courses that will overcome the major problems of education. But on the other hand it would appear that interactive technologies offer us major possibilities.

There are many problems associated with the creation of these newer courses, problems far beyond the scope of this paper. Many of them are discussed in other papers by the author. They include the following:

- An important issue in generating new technology-based courses, using a wide variety of different media, is a question of how these courses are to be produced. Very few strategies for developing highly interactive material, and material that makes full use of media, are in existence so far. Extensive experimental work is needed in this direction.
- Production of large amounts of high quality learning material of the type necessary is not an inexpensive process. The major sources for doing this are likely to be the governments of the world, the international organizations such as UNESCO and the World Bank, and very large corporations. In the last case there must be a possibility of successful marketing to encourage sizable development.
- To encourage extensive development we need a trial period, one that will not only convince the funding sources just mentioned that the activity is likely to lead to major improvements in education, but also one that enables us to gather further knowledge of how such materials can be more effective.
- These new courses will differ in many ways from existing courses. Content is perhaps the first place to start. It is generally agreed that in many countries of the world current content in education is inadequate, yet there is not agreement on what the new content should be. Nevertheless there are several areas that seem promising, such as the emphasis on integrated courses to be found in many countries at the present time.
- Courses will also differ as to the overall organizational strategy of the course, the role of teachers, the question of where the course is to be conducted, and even in leading to different architecture of schools. Again there are many interesting possibilities to be considered here, beyond the range of the current paper.
- There are some major advantages in international development. This would seem to be particularly the case in science courses, where, as far as I have been able to ascertain, there is little difference in courses from country to country. What differences there are could all be incorporated in a computer-based version of the course, leading to a superior course than that available in any one country.

International development would also have economic advantages, since developing in several countries together is far less expensive than developing individually in each of those countries. But international development has not been tried on any extensive scale, and so again, as with many of the aspects here, more experimental work is needed to determine feasibility.

**Difficulties to be overcome**

I regard these as principal difficulties:

- The lack of much suitable highly effective demonstration material, particularly at a full course level.
- Our incomplete research knowledge in education, particularly relating to computers.
- Inexperience with full-scale production systems for producing materials.
- Inadequacy of funding for full-course development.
- Insufficient consideration of the quality of materials.
- Problems associated with the effective training of large numbers of teachers.

---

**LEGO Dacta presents a series of Computer Technology courses:**

'Chips and the Old Block, Computers with LEGO!'

**What?** Courses for Primary, Secondary and Tertiary levels of interest.

- Topic areas include, Maths, Science, Technology, Writing, Computing and Cross Curricular studies.

**How long?** Course runs for 2 consecutive days.:

- First day: beginners. Second day: advanced.

**How much?** $30 per day. $60 for whole course.

**Where?** Brisbane, Toowoomba, Gold Coast

**When?** At a time to suit you.

**What now?** Contact Geoff Johnston, your LEGO Dacta Consultant.

Phone: (07) 282 1585 or Fax: (07) 816 1142 and leave a message with your phone number.

---

**LEGO Dacta**

**MINDBLOWING FUN FOR TEACHERS AND PARENTS**

Build maths games, control singing robots, design and build an automatic house, write interactive adventure stories, design lightshows, write music, build scientific apparatus, industrial robots, CAM equipment and monitoring systems.....

You think it...we help you make it!

TOTAL BEGINNERS WELCOME