Education in the Information Age: Promises and Frustrations

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Information technology can be used to compensate for the limitations of conventional teaching methods and systems and reach students who would otherwise have little or no education access at all. The developed world uses instructional technologies to offer a better quality education. The situation in the developing world is different. Resources are scarce, and so are trained teachers. In these countries, instructional technology can be used to compensate for the lack of resources, trained teachers and lack of access to education. Distance education through TV has proven to be successful in countries like Mexico and Brazil.

The Key Argument

Information technology can be used to compensate for what conventional systems cannot afford to offer. If this is done, the reach of serious education can be extended to populations who otherwise would have much poorer-quality instruction or none at all. Alternatively, information technology can be used in conjunction with factors that are scarce and expensive, such as highly trained and motivated teachers. This combination might lead to levels of learning that would not be possible without it; but it will reach only as far as these other factors do—not very far in the case of developing countries.

Used in classrooms in a constructivist approach, computers have tremendous potential to develop students' higher-order cognitive skills. (*The premise of constructivism is that knowledge is constructed by the learner rather than imparted by the teacher. Its tools are those that extend students' capacities to explore and experiment.*) However, computers require exactly the kind of teachers who are scarce everywhere in the world. They also require considerable capital outlays and infrastructure. By contrast, high-quality broadcast television programs benefit from pre-existing investment in hardware, economize on high quality teachers by having them serve as support to less than superbly trained instructors and have strong economies of scale. Whether the levels of learning are comparable with those from conventional modes of delivery is an open question. But what TV programs do is to allow the skills and imagination of the best available teachers to reach a clientele that otherwise could never dream of access to that level of education.

If this reasoning is correct, the policy implications are very significant. Poorer countries should not focus their efforts on uses of technology that try to reach beyond what is possible with good quality conventional education. Instead, they should focus on reaching the poor through cost-effective technology that compensates for the limitations of conventional education.

The Path from Technology to Education

All major developments in the transmission of images and in the development of computers, videotape, CD-ROMs, interactive TV and the Internet took place in the industrialized countries. Therefore, it should be no surprise that the first educational uses of these technologies took place in the industrialized countries, and in particular in the United States. From the first uses of broadcast TV in Michigan during the 1950s, to the early experiments in using mainframe computers in tutorial programs such as Plato, most seminal innovations took place in the United States.

When these developments took place in the United States and Europe, these countries had mature systems of education compared to Third World countries. Children had access to properly qualified teachers and countries could afford high quality education.

The first uses of both computers and TV tended to mimic teachers. The initial batch of tutorial software and the more widespread use of "drill and practice" programs used machines to repeat what teachers do in conventional classrooms. They taught simple skills or trained students in them, such as spelling and multiplication tables. Educational TV had teachers in front of the camera teaching the same classes they would in more conventional classroom situations.

But soon computers were being upgraded to more imaginative uses. The turtle, which moved around on the screen, was seen as a means to teach programming algorithms. LOGO became a landmark in the use of computers to develop higher-order cognitive skills. Simulations and animations offer endless potential to make students understand theoretical principles. From graphic models of the solar system to a vast range of chapters in physics or inference statistics or the Electronic Workbench, a computer can show what scientific abstractions are about. Word processors offered a new path to writing. Spell-checkers changed the rules in the art of spelling words. None of this was planned, yet word processors have become one of the most robust uses of computers in education.

Following the approach recently christened as constructivism, computers are being proposed as tools to explore the world. This may be via computers equipped with sensors as data gathering devices, or via databases. Whatever the tool, students are urged to research, explore and express themselves in ways which are not possible, practical or powerful with more conventional means.

The emergence of the Internet brought another wave of innovations and enthusiasm for the use of computers. From early experiments in connecting schools to Dow Jones databases to the exploding use of present day web sites, the possibilities are mind boggling.

The Economics of Teaching with Machines

It is the expected scale of utilization that should determine the mode of instruction. With few students, one hires a teacher; with thousands of students, technology-intensive alternatives may be less expensive. It is assumed that for every hour of classroom contact, a teacher has to invest another hour of preparation. For every hour of class, it takes five hours to prepare written materials. But every hour of instruction using an interactive CD-ROM requires at least 300 hours of preparation. Hence, in order to justify the use of more complex instructional technologies, it is necessary to have a much broader clientele.

These considerations are important because developing countries cannot afford to ignore the costs of education in its different modalities. They cannot afford the same technologies being used in the industrialized nations. In many cases, the alternatives are either to have expensive technologies for a privileged few, or to have more economical alternatives for a larger share of the school-aged population.

However, television and other forms of distance education cost less than computers in schools. A computer (plus indirect expenditures) costs at least 3,000 dollars. Assuming a useful life of five years and another 300 dollars of maintenance per year, we have 600 dollars per computer per year. Taking the rate of 1 computer to every ten students, this amounts to $60 per year. Assuming an average cost of $300 per student for basic education, using computers will increase educational expenditures by 20 percent. This is not a politically feasible increase in educational budgets. The Brazilian Telecurso 2000 costs about 10 dollars per student (not including instructor time) and a very successful interactive radio program in Bolivia costs one dollar per student.

The Theory and the Theory of the Practice in Using Technology

Many studies indicate that new instructional technologies may bring strong and positive improvements in learning. Scaling up is another matter, however. Cognitive theory says that such-and-such technology works fine in improving learning. But the theory of the practice is another matter, as scaling up to larger audiences is much harder than expected. It may indeed be true that if applied to everybody, the effects would amount to a small educational revolution. The problem is that what works under a controlled and protected atmosphere may fail when scaled up.

Educational experiments create a total environment that is designed to shelter the project. In scaling up, however, the innovation has to face a real world that is far less hospitable. Schools are conservative organizations and their incentive structures are very hard to change. Very often, they welcome small experiments that do not threaten conventional operations. But scaling up affects the rules of the game and may conflict with school values, practices and incentives. Hence, it is resisted, boycotted, sabotaged or discretely abandoned.

Another consequence is that costs are not as low as expected because of waste, breakdowns, underutilization and misuse. Therefore, not only are the results a pale image of what the pilot projects promised, but the costs per student tend to be much higher.

The results of this lack of effectiveness of scaled-up activities and the cost overruns are far more serious for developing countries, because they are less capable of affording such waste. In rich countries, the costs of technology are a much smaller fraction of education costs. Notice that a computer in an American school costs, at most, just half of the student/year cost while in developing countries it costs 10 times more than to keep one student in school during the same period.

"What Is Good for the United States ..."

It was once said that what was good for the United States was also good for developing countries. Whether this is true in particular situations is irrelevant. But in the case of instructional technologies, this is certainly not the case. The United States, like other rich countries, can afford most, if not all, of these technologies, even if they do not work too well.

It stands to reason that they choose and scale up the technologies that respond to their needs. And their needs are the needs of countries that have already put into their schools just about everything that has been dreamed up by educators and administrators. There are as many properly trained and certified teachers as there are subjects being offered.

Therefore, instructional technologies are used to take the additional step, to improve learning beyond the levels previously reached—levels already vastly superior to those reached by developing countries. In other words, they are used not to save resources or to reach a broader clientele but to raise the quality of education even further.

In developing countries, the problem with the use of instructional technology is that too often its champions studied in the United States or Europe, following the meandering intellectual fashions of these regions. No matter how poor the country, very often those struggling to introduce instructional technology are closely following the latest paper published in computer journals. When the latest fashion meant drill and practice programs for computers, this was a relatively easy technology to apply. However, the state of the art has evolved from that to LOGO, to simulations, to the introduction of computers in regular disciplines, to the Internet and to the World Wide Web.

Even so, copying these styles of utilization constitutes a capital sin in less affluent countries. These styles require exactly the factors that are particularly scarce in poor countries—namely, resources and well-

trained teachers. If poor countries had a vast supply of the teachers needed for LOGO or constructivist approaches to computer utilization, they would not have the miserable education they do. By the same token, where telephone lines are rare and expensive, the Internet is doomed to remain an elitist resource, available only to a small number of students. No less important, these remain expensive technologies for developing countries, even with falling costs over the last several decades.

The bottom line, therefore, is obvious enough. What is good for the United States is not necessarily good for developing countries. Developing countries should resist the temptation to mimic the use of instructional technologies of the Northern countries because it is not compatible with its present factor endowments. We have neither the abundant financial resources nor the supply of well-trained teachers necessary to scale up the most creative use of computers in the classroom.

Surely, the above statement is not meant to deny the right to pursue state-of-the-art technology. In fact, as technologies evolve and costs go down, countries are well advised not to wait. They should hone their skills in the use of these technologies, no matter how arcane or expensive they may be at present. But we should make a strong distinction between a policy of encouraging small experiments in all directions and the thrust of a massive policy to use new instructional technologies in our countries.

What Is—Indeed—Good for Developing Countries

What is good for developing countries is what is affordable for the masses and what compensates for the chronic scarcity of quality teachers. Fortunately, the quest for "teacher-proof teaching methods" is past and the fear that computers will create mass unemployment of teachers has abated. Certainly this article is not proposing a reinstatement of those goals.

What this article proposes is that instructional technologies should compensate for the shortcomings of existing teachers or for their complete absence in very poor regions. Just as rich countries have used technology to respond to their needs, we are suggesting that in developing countries technology should respond to their needs.

In the case of computers in schools, software must be easy to use and non-threatening to the teachers. Unavoidably, this means that the most interesting and enriching uses of computers will have to wait. Can we use the expression "appropriate technology" without insulting everybody?

Another suggested line is to privilege those institutions that have less fear of computers, such as technical and vocational schools or educational institutions. An alternate approach is to favor those institutions created expressly to use new technologies—a trend that began with the creation of the United Kingdom's Open University. It has been noted again and again that K-12 schools are the ones that most resist the use of technologies, making waste higher and results less impressive.

Probably the starkest contrast is between the modest or, in some cases, outright disappointing results of computers in academic schools and the impressive use of broadcast TV for education. While developing countries, at best, play second fiddle in the area of computers in schools, the experiments in using television for mass education in Latin America are nothing short of spectacular and as good as anything done anywhere else in the world.

Rich countries have used television in education in very modest ways. The British Broadcasting Corporation (BBC) in the U.K. may be an illustrious exception. Programs for preschoolers, such as "Sesame Street" and others associated with the Public Broadcasting System (PBS) in the United States, cater to populations not served by regular schools and have also fared quite well. But by and large, educational TV in rich countries does not amount to very much. All one needs to do to verify this proposition is to surf the cable channels and contrast the quality, tempo, color, and wealth of images on commercial net-

works with the "talking heads" lecturing on standard school subjects on the local educational TV channels.

By contrast, Mexico has been operating its Telesecundaria for many years, with millions of students having gone through its courses. Also in Mexico are the impressive achievements of the Tecnológico de Monterrey with its technical courses beamed to students in many states and now reaching several other countries with its technical and management courses.

Brazil, a country of modest achievements in education, has become a leader in the area of distance education, bringing forth many interesting innovations. Particularly impressive have been the achievements of Globo network. Recently, it retired the old Telecurso, just short of its twentieth anniversary. It is safe to say that it has been watched or carefully followed by many millions of poor Brazilians. This program was replaced by the new Telecurso 2000, which also offers a "second-chance" program for young adults, with separate primary and secondary programs.

One interesting feature of this program is all the classes are filmed in environments that look like factories, offices, tourism agencies (for English language), newspaper stands and so on. All materials are contextualized in real life situations. Young adults learn by watching scenes that are close to their worlds, rather than the stale classroom with a teacher and students. In fact, the program uses professional actors for all scenes except for some quick interviews.

Along the same lines, TV also offers privately funded programs of agricultural extension and small business development. The audience for these programs is extraordinarily high, reaching millions. Recently, the Brazilian Federation of Transports, representing private business in the area, rented satellite time and started offering 10 hours per day of training in transport-related trades. There are already 1,200 classrooms spread around the country, mostly in transportation firms, with enrollment that reaches 300,000.

What all these experiments have in common is that they reach the masses, which the conventional educational systems cannot always do. They also compensate for the inadequate preparation of teachers. Telecurso 2000 and Telesecundaria use classrooms with learning facilitators to help the students. But if these instructors were to teach the students, they could never deliver anything comparable to what can be done with professional actors and scripts prepared by the best teachers in the country. Last but not least, these programs have low costs per student. Any cost divided over millions of students becomes small.

Some Lessons

To conclude, what this article is saying is that technology today offers many exciting alternative paths for improving education, but each of these alternatives is not equally good or appropriate for all countries. Rich countries have used technology to make their good education even better. If developing countries were to follow the same path, they would be choosing alternatives that, in addition to being very expensive, require high-quality teachers who are not available and cannot be made available. These experiments are, therefore, doomed to remain enclaves, catering to local elite but incapable of being scaled up to reach the number of people who are in dire need of better instruction.

Instead, then, developing countries need to focus on those technologies that compensate for the factors that are lacking—namely, well-trained teachers and the resources to pay for expensive equipment. Developing countries should concentrate on those technological alternatives that, at low costs, bring to the students the imagination and creativity of a few excellent teachers.
While the use of computers in classrooms is not to be denigrated, a much greater potential can be found in distance education. The fact of the matter is that despite considerable efforts to bring computers into academic classrooms, developing countries remain marginal players in this area. This contrasts with the superlative and world-class performance of several mass education programs using radio, broadcast TV and video.