Adapting technology for school improvement:
a global perspective

Adapting technology for school improvement: a global perspective

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Chapter 1

The role of technology in school improvement

David W. Chapman, Amy Garrett, Lars O. Mählck

The rapid spread of electronic communications has the capacity to affect the quality and efficiency of basic education throughout the world in dramatic ways – both positively and negatively. The ease with which teachers and students can gather information over the Internet on virtually any topic has the potential to transform instructional content and pedagogical practice. Moreover, courses developed by the best teachers in one country can be made available to students across many countries. This international export of courses is already commonplace in higher education (e.g. British Open University, University of Phoenix) and is increasingly available in secondary schools in more industrialized countries. It is only a matter of time before this application spreads widely across the developing world. While the use of electronic communication technology as a medium of instruction is just beginning in basic education, it is already clear that it will be a dominant trend over the next decade.

Purpose

The premise of this book is that the move to advanced technology use in primary and secondary schools offers great hope for improving the access, quality, and efficiency of basic education. In the view of many, this move is inevitable. So far, however, these strategies have not yet lived up to their promise. If education systems are to reap a meaningful return on their investment, educators will need to better understand the key issues and formulate more sensible strategies for integrating technology in classroom instruction.

A key concern is that the implementation of technology in the schools will be uneven, and that unevenness will lead to inequities in school quality and student learning. This will fuel political debates and policy decisions that may curtail the effective use of technology at the K-12 levels. Only as education leaders understand the issues associated with the effective use of technology in instruction can they effectively guide the process. However, educators and government officials lack clear models of successful technology use at the primary and secondary levels. Part of the reason for this deficit is that the international experience that has accumulated has not been adequately shared. It is to this end that the present book is devoted.

The purpose of this book is to identify and examine how information technologies can be (and are being) used to strengthen the quality of primary and secondary education. The book takes a global focus, drawing on examples from a wide range of countries. However, the goal is to distil lessons that have particular relevance to countries that are at an early stage of technology use in primary and secondary education. The book examines the variety of ways technology is now being used in primary and secondary school instruction, analyzes the challenges that teachers and education planners face as they make this move, and shares how those challenges are being met in some of the countries now engaged in this effort.

Audience

This book is intended for educational policy-makers, administrators, planners, and curriculum development specialists concerned with how technology can be used to extend access and raise the quality of education in their countries. It is also intended for international organizations, development assistance agencies and NGOs that are often most responsible for advocating and promoting the use of technology as a solution to education problems in low and middle-income countries. If successful, the use of technology can provide a cost-effective means of improving education. If, however, it is designed or implemented inadequately, it can undercut the quality of education, as resources are wasted that might be better used in other ways.

This study is intended as a resource book that captures current international experience in technology use in education. It will also be useful in orientation and training programmes aimed at educational and government leaders concerned with the effective use of technology in education.

Sponsorship

The preparation of this book was sponsored by the International Institute for Educational Planning (IIEP) in Paris. IIEP was established in 1963 by UNESCO to promote training and research on education and planning in relation to economic and social development. The Institute conducts an annual Advanced Training Programme in Educational Planning and Management at its Paris headquarters for educators and government officials from around the world. Additionally, it offers workshops, seminars, and training programmes at a variety of regional and national locations throughout the year, and maintains an active programme of research focused on improving the design and delivery of education. IIEP's sponsorship of this project reflects its ongoing commitment to bring new ideas and technologies to education planning, management, and the delivery of instruction.

Theoretical framework

This volume is based on two particular theoretical perspectives. At the organizational level, the book employs a systems perspective, in which a nation's education system is understood as a complex organization composed of multiple, interconnected sub-systems (Weick, 1976; Nagel and Snyder, 1989; Chapman and Austin, 2002). Changes affecting any particular subsystem have implications which impact other subsystems, sometimes in unanticipated ways.

The move to advanced technology use in the classroom has enormous implications on teacher training, the pedagogical strategies they use, how the curriculum is structured, and how schools utilize their budgets. Some of the implications that ripple through a system are subtle. For example, the move to greater instructional use of technology may create 'digital divides', i.e. unintentional disparities in learning among those with different levels of access to the technology that may, in turn, undercut a country's commitment to equity. Similarly, adopting technology-based delivery options may broaden access, but, simultaneously, may raise questions about who is controlling the instructional content.

A tenet of good national planning is that planners need to anticipate and provide for the cross-impacts of the interventions they advocate. Only as governments and education leaders understand the interwoven nature of the problems now facing schools in their adoption and use of technology in instruction and the interconnections among the intended solutions they seek to implement, can they offer effective leadership in charting a course that strengthens the quality and improves the relevance of education in their countries (Chapman and Austin, 2002). Planning at both the central government and school levels will only be effective as these relationships are identified and the interconnectedness and wider consequences of their actions actively anticipated. It is to this end that the authors of this book are committed.

At the level of individual users, this book draws on the innovation dissemination theory, particularly as formulated in the work of Fullan (2001). He argues that adoption of an innovation (in this case, the adoption of technology in education) is shaped by the characteristics of the innovation and its implementation. Six characteristics help shape the extent to which new ideas are adopted: clarity, observation, complexity, comparative advantage, trial, and cost. *Clarity* concerns the extent that the innovation, in this case the technology being introduced into the classroom setting, is understandable to those being asked to implement it (or to support its implementation by others). *Observation* refers to the extent that would-be adopters can clearly see the key features of an innovation.

Complexity refers to the extent that would-be adopters can quickly learn to use the technology. *Comparative advantage* concerns the extent that technology-based instruction offers clear advantages over alternative instructional strategies, either in terms of greater student achievement or in teachers' ease of use. *Trial* refers to the extent that would-be adopters can try an innovation in small increments as opposed to making a major commitment. For example, in the Iceland case study later in this book, instructors were able to teach an online course before needing to commit to a heavier involvement in an online programme. Finally, *cost* is always a concern. Given innovations that yield similar results, the lower cost options generally have the advantage. The country experiences described in this book highlight methods that technology advocates have tried, to reduce complexity, highlight comparative advantage, and provide opportunities for teachers to evaluate new techniques in supportive, low threat situations.

Technology use in education

Educators virtually everywhere have long looked to the emerging technologies of their time to improve the delivery of instruction in the classroom and to help them reach students (and teachers) in remote locations. In the early days of technology use, the focus was on the delivery of direct instruction (e.g., radio, interactive radio, instructional television). Instructional technologies widely used for this purpose in low-income countries include the use of programmed instruction, the distribution of lessons on audiotape, the use of duplicating and photocopy machines to prepare learning aids, and television broadcasts of lessons at times that coincide with the school teaching schedule.

Newer technology-based instructional strategies, incorporating the Internet and the World Wide Web (WWW), are used more to expand communication and increase access to resources. These newer technologies represent a significant change in the teacher's role in the instructional process. Whereas earlier technologies provided teachers primarily with a tool for continuing to teach in the manner they were already teaching (though presumably more efficiently), technologies such as e-mail and Internet tend to push teachers toward fundamentally different ways of teaching. Depending on how they are used, these techniques shift more responsibility to the students to seek out information and interact with people at other locations. For the most part, they tend to encourage more student-centred learning. This, in turn, is putting pressure on teachers to modify their approach to classroom teaching. The notion that students can search for and assemble information on their own is very consistent with the constructivist philosophy of teaching. However, that approach is at odds with the pedagogical practices of many schools around the world.

Online resources are used within education system primarily in seven ways.

1. The most common use is in *direct instruction*. Lessons developed in one location can be broadcast via radio or television or made available through e-mail or the World Wide Web for use by students (individually or in groups) in other locations. Excellent teaching can be made widely available. This is especially important in countries in which large segments of the teaching force are under-qualified for the grades they are expected to teach. Well-designed instruction in

the form of lessons delivered by radio, television, or online may be able to offset weak teacher preparation.

2. Similarly, teachers can use online searches to *find and access resource materials* that are then used in the teachers' own lesson preparation. For example, teachers might locate maps and fact sheets about countries being studied in social studies class.

3. A variation on this approach is that teachers can use the web to *access curriculum and instructional guides* for their own use. For example, teachers may access instructions on how to lead a class in the dissection of a frog in biology.

4. Students can use the web to *find and retrieve information* they can use in their own class research projects. In some schools, allowing students to use school computers for independent study is used as a way to motivate and reward good students. However, this approach tends to be limited to classrooms that have sufficient technology to allow students to use the equipment for independent study.

5. Some teachers use web-based chat rooms and online communications technology to *connect two or more classrooms* in different parts of the world. Students at different locations can ask and answer questions from those at the other locations.

6. Teachers can have their *lessons broadcast to multiple classrooms* simultaneously. This is already widely used in higher education as a means of offering courses in low-enrolment subject areas. In secondary education this allows students in remote locations to have direct interaction with teachers at a central location.

7. Finally, technology-based instruction is used in many countries as a means of delivering *in-service teacher education*. Teachers need not leave their teaching posts to participate in professional development activities.

A common element across all these innovations is that, in order to effectively use such technologies, teachers sometimes have to learn new knowledge and skills, spend more time in lesson preparation, and engage in different types of conversation with students (Hernes, 2002; UNESCO, 2002). One consequence is that teachers sometimes resist – not because the educational benefits of these new technologies are not clear, but because they lack sufficient incentives to undertake the increased workload, do not understand what is expected of them, or do not know how to cope with new demands imposed by the technology (Fullan, 2001).

Resistance to the use of newer technologies

Online instruction is widely used in higher education worldwide, though less so at the primary and secondary levels. One reason is the scale of demand at the lower levels. Many governments view the cost of providing computers to individual schools as unaffordable. Not only are the initial equipment and the necessary teacher training expensive, but equipment upkeep, repair, replacement and software costs involve a substantial recurrent expenditure.

Limitations of infrastructure and finances effectively bar some countries from participating in this electronic revolution. In other countries, education and government leaders have legitimate concerns about the cost, the efficacy, and the feasibility of using communication technologies in their education systems. More specifically, developing countries face four main problems:

1. **Access is expensive**. While the cost of Internet access is low by world standards, it still represents a high (often prohibitively so) cost for many developing countries. Making Internet connections available at the school or school cluster level will be a central problem for many countries in educational planning over the next decade. Moreover, hidden costs are substantial. Internet use shifts a significant cost from the information provider to the information recipient. It is the recipient who usually pays for the telephone line, paper, printer cartridges, software upgrades, and equipment repair. Moreover, meaningful use of the Internet in the instructional process will require new curriculum and new training for teachers.

2. **Ensuring equity of access is difficult**. If access to electronic communication were limited to schools serving the rich and influential, the social and economic disparities among those who could obtain quality education would widen. Such differences can erode the social fabric of a country and lead to serious social and educational rifts.

Ensuring that the benefits of easy access to world information and to electronic instruction are widely available to students of all social and economic backgrounds will be a challenge for educational planners in the next decade.

3. **Retraining teachers to use the new technology is complicated and costly**. Even if they had access to the Internet, most teachers in the developing world lack the technical skills, the content background, and the language capacity to effectively utilize the World Wide Web including in classroom instruction. Most web-based resource material is in an international language, with the preponderance in English. Notwithstanding language skills, teachers often lack the pedagogical skills to know how to most effectively use this powerful information tool in their classroom. At times, the use of the Internet may conflict with the prevalent instructional strategy of the teacher.

4. **Inappropriate content poses a problem**. Some countries resist introducing widespread Internet access from a fear that it will have a negative impact on local culture or be used in ways that undermine national authority. A central concern is childrens' access to pornography. Some governments are also concerned about political and social content. They observe that people from some industrialized countries place content on the Internet that may convey unacceptable ideological positions.

The introduction of computers into classrooms can also pose subtler problems. Technology-assisted instruction can inadvertently embarrass teachers. For example, there may be instances when students know more about computer operation than their teachers, when the imported lessons raise questions the classroom teacher is unable to answer, or when lessons adopted from elsewhere employ instructional strategies that undercut teacher-centred approaches that may be favoured by the classroom teacher.

These specific issues can be overcome. But there is a more central requirement: To be effective, online instruction has to be good. The mere use of technology in the delivery of instruction does not necessarily improve the quality of that instruction. Technology may only allow the faster and wider dissemination of mediocrity.

While research confirms that technology-based instruction can be effective in promoting higher levels of student learning, it also suggests that those gains are not necessarily a function of the technology *per se*. Rather, they occur because instruction delivered by radio, television, e-mail, and the World Wide Web tends to be developed through a systematic process of instructional design that gives thoughtful attention to selection, sequencing and pacing of content (Clark, 1983). When technology-based instruction is effective, it is often because it incorporates the best practices of instructional design. If regular classroom lectures were as carefully constructed and delivered, it is likely they would yield the same learning gains. Nonetheless, experience suggests that teachers often either are unable or unwilling to achieve this standard in their day-to-day lesson preparation. The use of technology provides a means of ensuring greater consistency and quality in instruction.

Chapter framework

The chapters composing the book combine issue papers and case studies that capture current knowledge and practical experience in introducing and implementing information technologies in support of widening access and strengthening education quality, with all the surprising consequences and cross-impacts that actual implementation often produces. Issue papers emphasize the cross-cutting concerns – those that affect virtually every country's efforts to integrate the use of information technology in public schools. The case studies, in turn, describe and analyze particular countries' efforts to utilize information technologies to improve the quality of education.

Chapters are organized around seven themes:

- the role of technology in school improvement;
- top-down versus bottom-up approaches;
- interactive radio instruction in the schools;
- computers in the classroom;
- technology in teacher education;
- issues in adoption of technology;
- where does it lead?

The role and value of technology in education

Two chapters help establish the global context for the growing interest in the practical applications of information technology in education and analyze key policy issues associated with its use within education systems in low and middle-income countries. Claudio de Moura Castro, in *Chapter 2*, argues that information technologies can be used to compensate for what conventional systems cannot afford to offer. For example, high quality teachers are scarce yet, through technology, the benefits of good teaching can be made widely available. He argues that poor countries should not try to use technologies to provide what students and teachers are already able to get through conventional education. Rather they should concentrate on the use of cost-effective strategies that compensate for weaknesses in conventional education. He emphasizes the value of using technology to compensate for weak education rather than investing in technology merely to enhance what is already good education. In particular, he cautions against being swept up in the excitement of new, high-technology efforts to improve education and overlook lower technologies, such as radio and television, around which there is already considerable history and experience on which to draw. In particular, the author describes two success stories from Brazil and Mexico: TV and video-taped programmes using professional actors, and followed up in classrooms by regular teachers. These programmes provide a livelier, more interesting and varied instruction than conventional and ICT education, and at a much lower unit cost.

The increased use of technology in education has generated considerable innovation and debate over benefits and disadvantages. One pervasive tension is between the perception that investments in education technology yield a high payoff in student learning and the competing perception that resources are wasted. The debate is fueled, in part, by a difference of opinion over whether some cultures are more amenable to technology than others. Is it true that culture affects technology adaptation? If so, does culture affect the degree to which education technology is generalizable across countries and cultures? Drawing on examples of technology use in the classroom from Mexico, Brazil, Chile, and Costa Rica, Stephen Heyneman and Katherine Taylor Haynes, in *Chapter 3*, explore ways in which new forms of technology use in schools may be altering the teaching and learning process, particularly in middle and lower income countries. They explore the threats and opportunities associated with cross-border sharing of education in an increasingly globalized world.

A common theme across the de Moura Castro and the Heyneman and Taylor Haynes chapters is that, when thinking of new technological solutions for education, the best ones for less affluent countries are not necessarily to be found in the rich countries.

Top-down versus bottom-up approaches for introducing technology to schools

Often the introduction of technology is undertaken as a top-down innovation in which the Ministry of Education initiates the effort and then tries to persuade teachers to use the new instructional strategies. Many argue that this is the Ministry's role and responsibility, especially when the technology being introduced is expensive and beyond the ability of individual schools to undertake on their own. A case study of the Republic of Palau, a small nation in the Pacific, offers a recent example of this approach. An important feature of the Palau experience was the considerable care and attention demonstrated by the Ministry of Education to ensure adequate computers, software, teacher training, and technical expertise in virtually every school.

In *Chapter 4*, Gregory Sales and Masa-Aki Emesiochl examine dilemmas that teachers face in integrating technology into classroom instruction, with special attention to the experience of the Republic of Palau, which may have the highest concentration of computer technology in public schools of any less industrialized country in the world – about one computer for every 12 students. Virtually all teachers and students in the country (from grade 1 to 12) have access to computers and educational software. Nonetheless, teachers' utilization of this technology in the delivery of instruction remain low, largely for two reasons.

First, in the late-1990s, to encourage fresh thinking in the civil service, Palau mandated retirement of all civil servants after 30 years of service. There was an turnover of over one-quarter of the teaching force in the country in a two-year period. As a result, despite initial teacher training aimed at technology use, fully half of the teachers now in the schools never received computer training. Second, integrating computer-based materials in their lessons requires extra work on the part of teachers to find the materials and build them into their lesson plans. Lacking clear incentives, many teachers chose not to undertake this extra work. The authors highlight the interwoven nature of the issues that influence teachers' willingness to utilize the technology that is already available in their schools. The basic premise of their paper is that, even in well-designed efforts to introduce technology into the schools, inadequate attention is often given to teacher incentives for actual utilization.

A case study set in Jamaica illustrates the bottom-up approach in which the adoption of technology in the classroom occurred almost despite ministry efforts to the contrary. The Jamaican Computer Society (JCS), a local non-governmental organization concerned with the workforce preparation of secondary students, promoted the introduction of computer technology in the schools. They sought public and private funding to provide secondary schools with computers and teacher training in the instructional use of computers. While the Ministry of Education was benignly supportive, it believed there were more pressing needs within the education system and offered little tangible support for the efforts of the JCS. Largely on its own, the JCS was able to mobilize local businesses to provide equipment and training to schools. As grassroots support was mobilized, government eventually found new interest in joining as a collaborator. Errol Miller, in *Chapter 5*, recounts this experience and draws a series of conclusions that have implications for other countries.

Interactive radio instruction in the schools

After 25 years of use, interactive radio instruction (IRI) continues to demand the attention of educational planners and researchers around the world as an effective tool for improving the quality, equity and access of education for students in poorer countries. Two concerns dominate the consideration of radio in classroom instruction. First, is instruction delivered via radio effective in promoting student learning? Second, are radio projects sustainable over time or do they die when the external funding ends? These issues are addressed in *Chapters 6* and *7*, respectively.

In *Chapter 6*, Teshome Nekatibeb and Thomas Tilson present a case study of the use and effectiveness of distance education programmes using radio in Ethiopia. One programme offers interactive radio instruction to 13,000 secondary students; another programme offers in-service upgrading courses to over 21,000 primary school teachers. Both programmes integrate the use of and print materials. They found that (a) students who were taught using interactive radio instruction out-performed other students in the Ethiopian School Leaving Examination and (b) teachers who received in-service teacher preparation via radio performed better than teachers enrolled in more conventional alternatives. While demonstrating the effectiveness of radio in the delivery of instruction, the authors also offer a realistic assessment of the challenges Ethiopia faced in establishing and maintaining relevant content and an effective delivery system.

Andrea Bosch, in *Chapter 7*, presents an extensive review of international experience with the long-term sustainability of IRI. She traces the fate of 30 significant IRI projects that have been undertaken over the last 25 years in Africa, Asia, and Latin America. Of these, 21 were sustained, either in their original form or with some modifications, for at least a decade. Yet some projects were not continued even when there was ample evidence of student learning gains. Bosch reviews these cases to offer a series of conclusions as to why some efforts lasted and others did not.

Computers in the classroom

Advocates of technology in classroom instruction argue that modern computers and Internet connectivity offer more than just faster access to more information. Rather, these features provide an opportunity to fundamentally change the way children learn. In particular, they allow teachers to employ a more constructivist learning environment. Constructivism is a theory of learning that emphasizes the learners' need to organize information and construct meaning for them. It stands in contrast to the transmission model of education, in which the emphasis is on conveying facts. Constructivist learning emphasizes student-centred learning, learning from experience, collaborative discussion, critical thinking, and reflection.

Many contemporary educators argue the value of a constructivist approach to teaching. Advocates argue that constructivist learning better equips learners to successfully master new and novel situations (than does the transmission model) (Clark, 1983). It emphasizes problem solving over the mere accumulation of facts. One of the central arguments for the use of Web-based resources in the classroom is that it gives learners access to information resources in ways that allow them to search for relevant data, synthesize that information, and draw their own conclusions.

The role of constructivism in learning and the role of technology in supporting constructivist pedagogy are the key issues addressed in *Chapter 8* by Jeffry Coupe and associates. Drawing on teacher training programmes in Morocco and Namibia, they argue that technology offers an effective strategy for teachers to participate actively in their own training in ways that yield subsequent benefits to students.

In *Chapter 9*, Cecilia Braslavsky and Laura Fumagalli draw on the experience of the Schools Network Project in the town of Campana, Argentina, to illustrate how technology can help break down the isolation of classrooms and schools and, eventually, contribute to improved quality of learning. At the same time, they point out the challenges that this type of initiative must overcome, with particular attention to issues of access, distribution, quality, equipment availability, and teacher investment in the reform.

More specifically, the authors analyze how the introduction of new information and communication technologies can become part of a comprehensive process of change to promote the development of a locally-based curriculum, instructional materials and in-service teacher training. They demonstrate that the direct involvement and participation of local actors, especially teachers, school principals and the local community in this process was a major condition for adopting an innovation such as ICT in the schools of Campana.

Vera Suguri and associates, in *Chapter 10*, describe one of the most advanced uses of computer technology in the classroom – the use of chat rooms to connect students from different schools with each other for real-time conversations and, in another case, to connect students in a classroom with a professor at a university. Chat, using the Internet, is a form of synchronous online communication that uses software to allow two or more people to engage in real-time discussions by typing. Unlike many Internet chat applications commonly used today, the chat software used in this pilot activity allows users to chat without having to download and install any special software. Through a case study of the use of Web-based chat with teachers and students in four schools in Brazil, Suguri *et al.* document the impact on students of being able to communicate directly with students in other locations about topics being studied in their respective classrooms.

Technology in teacher education

Teacher training has long been viewed as one of the most promising uses of technology. The ability of upgrading teacher preparation without pulling teachers out of their classrooms has economic benefits to both education ministries and to the teachers themselves. Ingólfur Ásgeir Jóhannesson and Anna Thóra Baldursdóttir, in *Chapter 11*, describe the use of distance education in a teacher certification programme in Iceland. The programme addresses the need in Iceland to allow currently employed teachers to work toward their teaching certificate at a university without removing them from their classrooms. These teacher certification students are widely scattered across a sparsely populated area of the country. If they were to leave their schools for an on-site programme at the university, the schools would experience a teacher shortage in the rural areas that would be very difficult to address. The programme uses a multi-mode approach to distance education that combines online instruction, the use of web pages for course lecture notes, and telephone conferencing with occasional face-to-face contact. Students combined individual study with group projects. The Iceland experience illustrates one approach to distance education and offers observations about elements that were important in its success.

Irrespective of country, the educators and instructors at teacher training colleges are assumed to be the key actors as regards the adoption of ITCs in curriculum and teaching practices. Unfortunately, they are often insufficiently prepared for this task and lack practical experience. In this respect the design and results of the Morocco and Namibia case studies reported by Coupe and associates in *Chapter 8* are indeed encouraging. In both projects, the emphasis was put on the development of communication networks among teacher training colleges and achieving a critical mass of local education technology capacity (by training of 'master teachers'). Both are part of a broader national education reform programme, and thus are good examples of efforts aiming at sustainable quality improvement.

Issues in adopting technology

People and institutions often resist the adoption of new approaches. Country studies of technology use in schools in high and medium-income countries help illustrate both effective strategies and continuing challenges that face those seeking to implement instructional technologies. In *Chapter 12*, Bozena Mannova analyzes current national policy in the Czech Republic regarding the use of information and communication technology in the schools. She argues that, in order to maximize the benefits of technology in the classroom, teachers and students must clearly see its relevance and benefits. Only as the benefits of technology use in instruction are clear to all key stakeholders can a country expect to create the motivation and overcome the challenges associated with the integration of technology into classroom instruction. Mannova stresses the need for increased support of teachers through in- and pre-service teacher education that stresses the value of technology use.

Insights from the efforts of more industrialized countries to encourage greater computer use in schools can offer useful insights into the challenges that await countries with fewer resources. Renate Schulz-Zander, in *Chapter 13*, reports on the impact of the *Schools Online* initiative in Germany, aimed at supporting the development of technical infrastructure in the schools. A central goal was to connect schools to the Internet and promote its use to students in their learning.

Across German schools, there has been a rapid increase in the availability of computers and of Internet connectivity over the last five years. Nonetheless, there is considerable variation in students' access to technology from school to school. The location of computers in schools differs immensely in the way they are used. For example, in most schools, computers are located in laboratories rather than in classrooms. This limits teachers' ability to use the computers in different locations or with various-sized workgroups. Moreover, many teachers are reluctant to use the computers for their own work because they lack confidence in their own computer skills and do not want to work where others could observe them.

Despite generally widespread availability of equipment, actual use of computers in instruction tends to be limited to a relatively few enthusiastic advocates – only about 10 per cent of the teachers. Even then, computers tend to be used mostly in courses directly related to information science. While teachers and students assign considerable importance to computer use in instruction, their classroom practice tells a different story. Their actual use does not reflect their stated enthusiasm. The use of computers in instruction is seen mostly as motivational; their primary use is to make learning more interesting for students. Teachers do not necessarily see computers as fundamentally changing the learning process itself. At the same time, there are few incentives for teachers to use this technology in instruction, that is, to do the extra work necessary to effectively utilize computers in their teaching.

The German study also showed consistent gender differences: female teachers and students were less self-confident in handling the new technologies and tended to use computers less frequently than their male counterparts. However, a subsequent assessment several years later indicated that, with adequate opportunities to practice their skills and with teachers giving them the same attention and support as the boys, the girls had significantly reduced the initial differences.

In *Chapter 14*, Lars Mählck and David Chapman summarize implications from the earlier chapters to discuss wider implications for improving technology use in school instruction. They offer a set of cross-cutting themes and observations that capture some of the more generalizable lessons. One example of such a central theme concerns the pros and cons of cross-national sharing of (a) training and support of teachers and administrators and (b) development of curriculum and instructional materials. Another example is the need for new partnerships (public-private, central-local) to make the continued developments in technology accessible to all and to ensure sustainability.

Conclusion

Advocates for the greater and more varied use of technology in education offer strong arguments. There is clear and compelling evidence that technology-based instruction can improve the consistency and quality of instruction, make learning more motivating for students, and extend access to hard-to-reach learners (Haddad and Draxler, 2002; UNESCO, 2002; Phipps and Merisotis, 2000; Institute for Higher Education Policy, 1999, Adkins, 1999, Bosch, 1997). If used wisely, technology can lower the unit cost of instruction (Goldstein, 1996; Tilson, Jamison, Fryer, Godoy-Kain and Imhoof, 1991). Moreover, the growing demand in the labour market for computer literate graduates is creating pressure on education systems to ensure that graduates have these skills. Finally, technology use is widely seen as a symbol of modernization and, as such, tends to have widespread political support.

Many technology-based instructional strategies have yet to live up to their promise. Educators and planners are discovering that the anticipated benefits are not automatic or assured. Indeed, the move toward greater use of technology in classroom instruction has often bred frustration and waste. The use of technology in instruction is expensive. If it does not result in better teaching and more student learning, then not only is the investment lost, but the expenditure may actually undercut education quality as it diverts resources from higher payoff alternatives. Moreover, unequal access to technology across communities can contribute to inequities in school quality that have both educational and political repercussions. Only with sensible planning that takes into consideration the concerns and interests of those directly affected can instructional technologies be implemented in ways that promote, rather than undermine, access and quality of education. This volume is dedicated to improving technology use in school instruction in ways that are practical, sensible, and cost-effective.

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Chapter 2

Are new technologies better technologies? For whom?

Claudio de Moura Castro

Can technology help developing countries? Are the advanced countries the only source of inspiration in the use of technologies in education? Are the most advanced technologies the ones with the greatest promise for the developing countries? Can new technologies be cost effective? Has education been shaken by the use of computers? Are 'old' technologies such as video and television obsolete?

This chapter explores the successes and failures of information technologies in education, with special attention to comparing its use in developed and developing countries. It points to the great potential offered by these technologies to bring serious education to a vast number of people. But it also points to the difficulties of fulfilling this potential due to the failure to adapt these technologies to developing country contexts.

The key argument can be summarized as follows: 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 reach 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 could lead to significant levels of learning, decreasing in the case of developing countries.

This discussion will point to the limitations of computers presently used, and will examine the differences in choice of technology between rich and poor countries. Finally, it will show how television and video have been used very effectively in Brazil and Mexico, reaching larger and less prosperous clienteles at very modest costs. The paragraph below summarizes the main line of argument.

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, such use of computers requires exactly the kind of teachers who are scarce everywhere in the world. They also require considerable capital outlay and infrastructure. By contrast, high-quality broadcast television programmes benefit from pre-existing investment in hardware, economize on high quality teachers by using them as support to less than superbly trained instructors and have strong economies of scale. Whether the levels of learning are comparable to those from conventional modes of delivery is an open question. What TV programmes can do is to allow the skills and imagination of the best teachers and technicians available to reach a clientele that otherwise could never dream of access to that quality of education.

If this reasoning is correct, the policy implications are very significant. Poorer countries should not focus their efforts on using technologies that try to go 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 industrialized countries. Therefore, it should be no surprise that the first educational uses of these technologies also 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 programmes, such as Plato, most seminal innovations took place in the USA.

At the point these developments occurred in the US and Europe, these countries had mature systems of education, compared to Third World countries. Children in these countries had long had access to properly qualified teachers and these countries were already spending lavish amounts of money on high-cost 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' programmes used machines to repeat what teachers did in conventional classrooms. They taught simple skills and concepts, such as spelling and multiplication tables. Educational TV used teachers in front of the camera, teaching classes just as they would in conventional classroom situations.

Soon computers were being put to more imaginative use. The turtle that 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 learning. Simulations and animation offer endless potential to make students understand theoretical principles. From graphic models of the solar system to a vast range of chapters on physics, inference statistics, or the Electronic Workbench, a computer can explain scientific abstractions. Word processors offer a new path to writing. Spell-checkers have changed the rules in the art of spelling words. None of this was planned. At first disdained by computer analysts, and against all expectations, word processing has become the number one use of computers in education.

As time went by and machines grew in performance, the use of computers has become increasingly sophisticated. Following the approach recently termed *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 that are not as practical or powerful using more conventional means.

The emergence of the Internet brought another wave of innovation and enthusiasm in computer use. From early experiments in connecting schools to the Dow Jones databases, to the cacophony of present day web sites, the possibilities are mind-boggling. As the apostles for such uses increase, some are now becoming the teachers of those who come from less affluent countries and return to them after graduation.

The economics of teaching with machines

No matter how lofty the dreams and plans, ultimately, costs have to be faced. And costs are far more critical in poorer countries. In practice, cost limitations have deflated many an ambitious plan.

From what we know about the nature of teaching with machines, fixed costs are much higher. Therefore, it is the expected scale of utilization that should determine the mode of instruction. If students are few, 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. However, 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. More often than not, they cannot afford the same technologies used in industrialized nations. In many cases, the alternatives are either to have expensive technologies for a privileged few, or more Spartan alternatives for the majority of the school-age population.

This is where television may have a greater role to play. Television and other forms of distance education cost less than computers in schools. A computer (plus wiring, software and indirect expenditures) costs around US $3,000.[1] Assuming a useful life of five years and another US $300 of maintenance per year, that brings the total to US $600 per computer per year. Taking the rate of one computer to every ten students, this amounts to US $60 per year. In a typical developing country, we can assume an average cost of US $300 per student for basic education. Therefore, using computers will increase educational expenditures by 20 per cent.

Even if we were half this number – by considering cases of more expensive education or savings in the use of computers – this is not a politically feasible increase in educational budgets. Let us not forget that when a cost of around 2 billion dollars was mentioned as the required amount to wire all American schools – a proposal by then Vice-President Gore – it was considered as too expensive, even though it amounts to less than 1 per cent of the total budget for primary and secondary education in

1 . The cost of machines is going down steadily. However, rewiring a school easily researches the cost of buying machines. Protecting the computer or the room that houses it from pilferage is quite expensive. Microsoft Office costs more than 500 United States dollars and a school needs more than that in software. The computers usually have to be networked and that needs wiring and troubleshooting. In addition, maintenance is expensive.

the United States. By contrast, the Brazilian Telecurso 2000, considering a 10 year lifespan for the programme, will cost as little as US $3 per student (not including instructor time) and a very successful interactive radio programme in Bolivia costs US $1 per student – all inclusive.

These tentative figures show that from the point of view of cost only, computers are still very expensive compared to other alternatives. This finding should not be a criterion for deciding on choice of technology. Neither can it be ignored.

The theory and the practice in using technology

Many studies based on controlled experiments indicate that new instructional technologies may bring strong and positive improvements in learning. Cognitive theory may say that such-and-such technology works fine in improving learning. And all of us are impressed by the results. But scaling up to reach larger audiences is harder than expected. It may indeed be true that this experimental use, if replicated to all students, would amount to a serious educational revolution. The problem is that something which works under a controlled and protected atmosphere may fail when implemented on a larger scale.

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 hard to change. Very often, they welcome small experiments that do not threaten conventional operations. But scaling up may require changing drastically 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, under-utilization 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.

Lack of effectiveness and cost overruns of scaled-up activities are far more serious for developing (than more developed) 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 less than half of the student/year cost while in developing countries it may cost 10 times the student/year cost.

Technology to enhance good education or to compensate for weak education?

Can we say that the best technologies in rich countries should also be the most appropriate for poorer countries? It is the contention of this chapter that this is not a warranted inference. The rich countries can afford most if not all of these technologies, even if they do not work well. The best alternatives for rich countries are not necessarily the same for less affluent countries.

It stands to reason that richer countries choose and scale up the technologies that respond to their needs. And their needs are the same as those 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. Schools have libraries and laboratories. Despite the domestic controversies surrounding the inadequacy of teachers and teacher training in OECD countries, the nature of the limitations is not at all the same. The shortcomings of poorer countries are much more basic and the lack of preparation of teachers has a different order of magnitude.

In rich countries, instructional technologies are used to take an 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 not used to save resources or to reach a broader clientele but to raise the quality of education even further. In fact, just about all young people are attending school well endowed with teachers and resources.

The sad predicament of developing countries is that people who studied in the United States or Europe often propose the use of instructional technology. When they return to their countries, no matter how poor, they often struggle to introduce instructional technology that closely follows the latest paper published in the computer-in-education journals.

When the latest fashion meant drill and practice programmes for computers, this was a relatively easy technology to apply. However, the state of the art has evolved to LOGO, then to simulations, to the introduction of computers in regular disciplines, to the Internet and to the World Wide Web. It went from simple, mechanical uses to open-ended constructivism, where teachers had to develop their own solutions and strategies.

Efforts to keep up with the evolution in complexity and sophistication in the use of computers in less affluent countries led some to commit grave errors. The technologies they advocate require the factors that are particularly scarce in poor countries – namely, technological resources and well-trained teachers. If poor countries had the vast supply of teachers needed for using LOGO or constructivist approaches to computer utilization, they would not have the substandard education they do. By the same token, with about 10 (bad quality) telephone lines to each 100 inhabitants, the Internet is doomed to remain an elitist resource, available only to a small number of students. It also remains an expensive technology for developing countries, even with falling costs over the last several decades.

The bottom line, therefore, is that what is good for affluent countries 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 they are not compatible with their current financial capacities. They have neither the abundant financial resources nor the supply of well-trained teachers necessary to implement the most creative use of computers in the classroom in any large scale.

Let us take as an example the use of LOGO, a seductive use of computers. The amount of time in front of a computer required to improve cognitive fluency and the preparation of a teacher to handle LOGO effectively cannot be reproduced in developing countries with significant numbers of teachers and students. The countries that took this path more than 10 years ago are still stuck with very modest numbers of students following this line. Neither the budget for computers nor the number of teachers is sufficient. Even if money were not a constraint, to teach LOGO takes the kind of teachers that are unavailable in significant numbers.

Urged to introduce computers into schools and to do something with them, a standard solution seems to become dominant. Computers are entering into the workplace, with a vengeance. Firms with few computers are either way behind the competition or are going to be forced to buy more. And of course, someone has to operate them. The old argument on why it is appropriate to have computers in schools before all students have textbooks and basic supplies is being overshadowed by the counter argument that all the rich children have computers at home. If the poor do not find them at school, they will be even further handicapped. Therefore, the conclusion is simple. Computers should be in schools, in order to prepare students to use them at the workplace. This leads to the conventional courses on word processing, spreadsheets, data-banks, PowerPoint etc. The positive side is that there are now computer courses in schools. There is a clear roadmap: teach the programmes students will need when they get to work. The negative side of this is that the idea that computers can be a marvelous tool for education is gradually receding. Computers are in schools because they are in the offices, by the same token that a woodworking course has to teach how to use the tools that are used by industry. This is a pity.

The scepticism of the comments above is in no way meant as a denial of developing countries' 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 it is important to 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 less affluent countries.

The logic of technological choice in 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 gone. This was a hostile and needless position. Also, the fear that computers will create mass unemployment for teachers has abated. If anything, experience has shown that computers result in the need for more teachers, not less. Certainly this chapter is not proposing a reinstatement of those goals.

What is being proposed is that instructional technologies should compensate for the shortcomings of existing teachers and for their complete absence in very poor regions. Just as rich countries have used technology to respond to their own needs, developing countries must use technology to respond to their own (but different) needs.

In the case of computers in schools, software must be easy to use and non-threatening to the teachers, at least in the initial phases of implementation. Unavoidably, this means that the most interesting and enriching uses of computers will have to wait. The expression 'appropriate technology' may have acquired a very derogatory tone. However, what is proposed here amounts to using a technology that best responds to local needs, rather than another that is the latest, the most sophisticated or the most appropriate to another set of countries.

A second suggested policy is to focus initially on those institutions that have less fear of computers, such as technical and vocational schools. An alternative approach is to favour those institutions created especially to use new technologies – a trend that began with the creation of the United Kingdom's Open University – as a result of the refusal of the traditional universities to engage in distance education. 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.

Education by TV: the top players are not in the developed world

Education by television? Turn on a cable television set in the United States and surf the many education channels. Contrast the quality, tempo, colour, and wealth of images on commercial networks with the 'talking heads' lecturing on standard school subjects on the local educational TV channels. What do we see? Grainy images. Blackboards and stiff teachers, talking heads, with no life, no punch and agonizingly slow rhythm. This is definitely not an uplifting sign and not the highest level of education technology.

There are also television programmes for middle and high schools in the United States. The Kentucky Educational Television is a live classroom linked by TV to other schools that lack teachers in that subject. But it is strictly conventional education using television. Korea also has a similar programme for high school drop-outs but it is not particularly innovative. It could be said that both are effective programmes and get the job done. But those looking for technological innovations or high quality television will not find them inspiring. However, it would be premature to write off television as an exciting media of instruction, just because the most aggressive country in the use of technology for education has little to offer along those lines.

When we turn our attention to the rich countries, none of them have enough primary or high-school drop-outs to deserve much of an effort to offer alternative solutions for them. The drop-outs are few and the existing conventional schools can take care of them. This is certainly not the case with poorer countries. They have an ample stock of youth who do not finish either intermediate or high schools. In fact, in most of these countries, less than half of the corresponding cohort finishes the secondary level. Yet, most of these countries are neither able to afford conventional schools of quality nor to use technology creatively.

There are, however, two countries in the world which are sufficiently poor and large to have millions of students out of regular schools and sufficiently rich to do something different about it. What distinguishes them from the others is that both have high quality commercial television. In fact, both are major exporters of soap operas, probably the largest producers and exporters in the world. These countries are Mexico and Brazil.

Not surprisingly, these countries have made a serious breakthrough in educational television. To put it succinctly, they have applied to education the costs and approaches of world-class commercial television. Production alone in the Brazilian programme (Telecurso 2000) runs at the same cost as commercial spots (from US $1,000 to $1,500 per minute). Being large countries, they can easily afford the fixed costs, since the programmes are going to be used by millions of students. Production of the Brazilian Telecurso was funded by a US $30 million grant from the Federation of Industries of the State of São Paulo. Considering that enrolment is already above half a million and assuming a shelf-life of ten years for the programme, the cost per student per year will be just a few dollars. In other words, spending heavily in television production generates only very modest costs per student, considering the huge numbers involved.

Telesecundaria in Mexico

Eight o'clock. The parabolic antenna is beamed to a satellite. All seventh grade students are already seated in a rural Mexican classroom. The teacher gets up and turns on the television set. The class begins. The TV programme focuses on a given subject, say, the study of the acceleration of bodies falling. The TV shows masons dropping bricks from a construction site and a stopwatch measuring the time it takes to reach the ground. The programme is lively, emulating the style of commercial TV. There are workers and teachers in front of the cameras, as well as students and many different people in several environments. The conventional TV setups and backgrounds are often displayed. Video clips are used to illustrate the class. At 8.20 a.m. the class finishes and the TV is turned off (at the same time as it is turned on in the eighth grade classroom). The teacher tells the students to open their book at the corresponding page and to start to follow its instructions. What takes place is a discussion of what was presented on TV, followed by drills and further discussion. The class ends with a review. All this takes place following a rhythm and sequence paced by the broadcast book.

Notice that this is not distance education. It is face-to-face education in a classroom, with the presence of a teacher. It is not conventional education either, because the teacher has a different role. The TV totally replaces the lectures. It offers, instead, lectures of a quality level that is beyond the capabilities of all but the most talented and dedicated teachers.

The Mexican Telesecundaria presently enrols close to a million students and it is expected to continue to grow. In addition, neighbouring countries are beginning to use it. The InterAmerican Development Bank is actively helping other Latin American countries to benefit from this programme. It is a strictly public programme, produced by the Ministry of Education and operating mostly in rural schools. The teachers must have higher education diplomas but most are not career teachers. They receive a short training course before being placed in charge of classes. In order to have a Telesecundaria school, the local community has to organize itself, request the creation of one, and provide the physical space.

Recent evaluation shows very positive results for the Telesecundaria, in terms of higher promotion rates, lower drop-out rates, and respectable student achievement test results. Students scored only slightly lower than those of regular schools, even though they were in rural schools and, on average, came from poorer families. It seems reasonable to assume that these students are better off than most other rural students who, as a group, perform much worse than their urban counterparts. The expenditure is not too different from that of regular education, because after all, the cost of hiring teachers is always greater. What we get in this formula is a package that delivers a quality of education that would not be possible with the teachers recruited to teach in rural communities.

The Brazilian Telecurso 2000

Telecurso is a completely different story. It is produced by the Roberto Marinho Foundation, which is part of the Globo Network, the fourth largest TV network in the world. The Network is one hundred per cent private, as is the funding for the programme.

At 6.15 a.m., Globo broadcasts Telecurso 2000. Some households watch the programme as children get dressed and have breakfast. But for those who take the course as a preparation for the public examination that yields a primary or a secondary school diploma, this is just an opportunity for teachers to tape the programme for use at a later, more convenient time. In addition, education channels and cable TV re-beam the programme during the day for workers located in factory and office classrooms. But increasingly, firms are buying the tapes directly from the producer. Those involved in the use of Telecurso claim that one way or another, users obtain a tape with the requisite classes. There are no practical impediments to coping and distributing the tapes in an informal market, in addition to the official sales by the producer.

At some time during the day, more than 40,000 workers walk to a 'distance classroom' to watch the Telecurso tapes. A teacher's aid is present to hold discussions, troubleshoot and support the students. The formula is not much different from the Mexican initiative. There are also classes in labour unions, civic centres, prisons, ships, buses and many other environments. At the end of the year, students must pass a public examination in the subjects they took.

In recent years, public schools have discovered the programme. Even though it is targeted to young adult drop-outs, regular schools have taken a keen interest. The data are not reliable but it seems that more than 400,000 students in regular public schools are using the Telecurso materials and techniques. Initial evaluation has shown the results to be very impressive, and in particular, much better than regular forms of education. The cost and time required to offer Telecurso and for students to pass a public examination is considerably less than what the government spends in public schools to yield an equivalent accomplishment – without the quality control imposed by an outside examination. Although there are no rigorous evaluations, indirect evidence of student achievement in Telecurso, compared to regular education, suggests that the results are at least as good as that of regular schools. Moreover, Telecurso operates where regular schools do not reach or, if they do, the quality of teaching is so abysmally low that Telecurso is almost a luxury for those students.

There are around 300,000 Brazilians of Japanese descent who are living and working in Japan. Their children have had chronic problems in adjusting to the strict and inflexible Japanese schools. As a result, Telecurso has become a major source of schooling for them. Through the Brazilian Embassy, they can sit the final examinations and receive the official diplomas in Japan.

Telecurso has three strong and well-defined features. First, it is contextualized learning. Everything is presented in a context familiar to the student. The sessions take place in the street, in offices, factories, small enterprises, newspaper stands etc. By contrast to the Mexican programme, there are no classrooms, students, teachers and chalkboards to be seen on the screen – because it was conceived to be used only with young adults who have a negative image of school life. The idea is to present all school subjects, concepts and theories in an environment familiar and friendly to students. Contextualization is truly taken seriously. For instance, the English language classes take place in a travel agency that receives English-speaking tourists and also in the São Paulo apartment of an American family with a Brazilian maid. The second feature is the emphasis on basic skills. The classes focus on skills that are important in life – instead of following the Byzantine meanders of official curricula. Third, the production is expected to reach the quality level of Globo TV. There are no real teachers or students. All participants are professional actors, some of them known to the students for their roles in soap operas or commercials.

The rhythm is fast, very fast. And the production is slick. Images mimic the styles of commercial TV. The programme shows many interviews in the street, to elicit responses to problems proposed in the class. The closest comparison would be to think of the sophistication of the best Discovery Channel or TLC programmes but targeting regular school subjects. Education is marketed much like pizza or any other product, creating a demand that – much like the soap operas – stirs an interest in tuning into the next instalment.

Essentially, the producers have come up with a programme that is eminently fun, funny, fast and entertaining. At the same time, it is dead serious education. After all, it has to follow the regular curricula of junior high and high schools. Phone polls have shown the audience of the programme to be predominantly those who watch it "because they like educational programmes" and not those who are preparing to take the examination. The latter do not watch the programme on TV but on video at the scheduled classes at work. There are over six million people watching the programme, just because they like it. In fact, the author has recently met a highly respected Brazilian ambassador, a former rector of the premier Brazilian University, and a well-known journalist who watch the programme regularly.

If a rector, a journalist and an ambassador watch what is supposed to be a high school class, something is right, something is quite remarkable. The television media allow a stellar team to produce a class that is vastly superior to any live class in the world. No real teacher can match the resources of TV or approach the refinement, structure, variety of images and humor that is conveyed in such a class. The computer and the Internet media may be interactive but they remain poor and primitive media compared to the shine and punch of high quality television. And let us not forget, that while the videotape is not interactive, the entire package is fully interactive, since there is a live teacher present in the classroom.

It is pertinent to notice that Telecurso is not a lone exception in using television to teach. The Ministry of Education is using television to train thousands of rural teachers. The Brazilian Federation of Transports, representing private business in the area, rents satellite time and offers

10 hours per day of training in transport-related trades. There are already several thousand classrooms spread around the country, mostly in transportation firms, with enrolment that reaches over 300,000 workers. The same Globo Network that produces Telecurso has a rural extension programme (Globo Rural) and another programme to help small business enterprises. Each of them reaches several million viewers every week.

Some lessons in the choice of technology

In conclusion, this chapter has offered arguments in support of seven propositions:

1. Technology today offers many exciting alternative paths for improving education, but each of these alternatives is not equally good or appropriate for all countries.
2. Rich countries have used technology to make their good education even better.
3. When thinking of new technological solutions for education, the best solutions for less affluent countries are not necessarily to be found in the rich countries. 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 elites but incapable of being scaled up to reach the number of people who are in dire need of better instruction.
4. While the use of computers in classrooms is not to be denigrated, despite considerable efforts and after many years, developing countries need to understand that computers have not yet lived up to their educational potential, even in rich countries.
5. 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. They should concentrate on those technological alternatives which, at low costs, bring to the students the imagination and creativity of a few excellent teachers.
6. Television is not a dead or an obsolete media for education. It is alive and doing a lot of good. And the leaders in the creative revival of the media are not in the developed countries but in two large developing

countries – Mexico and Brazil – both with poor regular education systems and world-class commercial television.

7. Teachers will not be replaced by technology; they are just to be combined differently. Much more effort should be focused on their training and selection as these remain as critical as ever. But technology brings to the classroom the talent of other teachers and scientists which add to the skills we expect from the average teacher.

Chapter 3

International uses of education technology: threats and opportunities

Stephen P. Heyneman, Katherine Taylor Haynes

Introduction

A decade ago, Stewart Brand (1987) of the MIT Media Lab noted that communications media are so fundamental to a society that when their structure changes, everything is affected. While this is true, it is also true that the culture must be ready to change. For changes to occur in education, shifts must take place at the classroom level, in the way teachers teach, and at the school and district levels in the priorities assigned by educators, government officials and other decision-makers. These changes have proven to be neither swift nor inevitable.

One illustration of these technological pressures concerns the adoption of information and communication technology (ICT). Since the proliferation of the Internet in the public domain in OECD countries in 1992, increasing discussion about educational applications of telematics has ensued. Nonetheless, education technology has existed for a number of decades. Radio was first introduced into schools in New York City in 1923 and was followed by radio instruction in accounting, mathematics and history. Television was introduced into the classroom in Los Angeles in 1939 and rose in popularity as a panacea for overcrowded classrooms in the 1950s and 1960s (PBS, 2001). The introduction of interactive radio instruction and television to the classroom increased the level of content-area knowledge. Prior to this, the area-content level was determined by the teacher's education. Radio and television permitted classrooms to affordably tap into outside expertise. While these technologies are still in use, the rapid evolution of newer technologies, often using old methods, has revolutionized the use of technology in some classrooms.

Today the computer is the fastest growing technology in public schools in the USA and in many other countries. In 1984 there was one computer for every 92 students (PBS, 2001). By 2001, there was a computer for every five students (NCES, 2002). In many contexts, the reach of the Internet is altering, indeed, redefining education. Access to the World Wide Web is changing both the cultures of learning and teaching.

What makes the changes in ICT more profound than many previous technologies, has less to do with the revolutionary nature of the technology itself and more to do with an equally profound shift in the purposes and priorities in education. Economic shifts away from agriculture, manufacturing, and manual labour toward information and communication skills have changed the nature of the expectations for schooling. There has been a shift away from the acquisition of factual information towards the skills of interpretation and evaluation of factual information.

Rather than being a repository of information, students are asked to find information, and then think critically about what they find. They must be able to decipher the data that they find in remote sites and databases in order to locate, identify, assess, synthesize and apply information. Teachers are now able to use school-to-home communications to pursue professional development, online courses, and peer support groups.

Although these shifts in labour markets have not been limited to high-income countries, there remains a significant difference among countries in the degree to which schools and schooling are able to shift in response. Crucial differences exist in the extent to which schools are able to teach new skills. First there is diversity in the skills and experience of teachers. Second is the availability of technical equipment and resources.

The 'digital divide' or gap in access to information and communications technology is significant between developed and developing regions. The high-speed information networks and computers that drive the global information economy are remote possibilities for most people in the developing world where only a select few have access to phones. Access to the Internet, one measure of the 'digital divide', demonstrates the regional disparities and differences according to the level of development (see *Table 1*).

In the middle of the 1990s, a growing trend toward linking schools electronically and the replacement of typewriters with word processors escalated the investment in computers in schools in many parts of the world. School links exist both within school districts and counties or provinces, within nations and even transnationally. They are linked through the exchange of educational projects and, in some cases, by shared, common curricula. Students use e-mail, the Internet, and often software created specifically for collaborative projects or what are termed 'learning networks' (Harasim, 1995).

Little analysis has been done on the impact of education technology on culture or on the impact of culture on the adoption of education technology. How are different countries advantageously positioned to use or even develop education technologies? Are southern countries able only to capitalize on the advances already made in the north? Does culture affect the adoption of technology in education or does the adoption of education technology affect culture? Is it true that culture affects technology adaptation? If so, does this affect the degree to which education technology is generalizable?

Table 1. Internet users by region (in thousands)

Region	1995	2000	2005 – projected
Worldwide total	44,324	353,254	765,776
Africa	—	4,000	—
Middle East	508	8,160	29,481
Latin America	410	19,629	56,051
Asia/Pacific	3,547	72,066	189,651
Eastern Europe	375	10,806	45,472
Western Europe/Scandinavia	8,713	87,743	213,670
North America	30,771	150,850	231,451

Source: Adapted from the Computer Industry Almanac, Inc. http://www.c-i-a.com/199908iu.htm

Some answers to these questions reside in the issue of the digital divide. Still others pertain more to issues of cultural suitability. ICT offers cost-effective mechanisms to people in areas of the world that lag behind in terms of economic development. In education, once reliable access is established, the capacity for education technologies to compensate for the gaps in conventional education exists (Lockheed, Middleton, and Nettleton, 1991).

Opportunities

Access for the poor and for those who have previously not had the ability to use information and communications technology, whether in educational settings or elsewhere, increases as bandwidth becomes more readily available. As a general rule, the deployment of technologies declines with population density (US Department of Commerce; US Department of Agriculture, 2000). However, using radio, television and, in some cases, computers and distance education may narrow the digital divide. The expansion of bandwidth and incremental adoption of new technologies offer opportunities for low and middle-income nations to leapfrog into the information age and to realize some of the opportunities of the twenty-first century. It is possible for a student in Shanghai to enrol in a business school with international access to sources of information that, only a few years ago, could not have been imagined. There is a digital divide, but ICT also provides new opportunities.

The role of culture

Should more vulnerable cultures be 'protected'? The question arises: What about cultures that are inexperienced with new technologies? Should certain portions of the world be protected from technological advancements?

Are some cultures pre-disposed to technology? Is it the case that certain cultures are pre-disposed to thinking in certain ways and that some are advantaged in performing particular tasks? With work on multiple intelligences,[2] one might well reach this conclusion. If humans are associated with specialized and differentiated skills, then perhaps some are more adaptable to new technologies than others. If this were true,

2. Howard Gardner (1983), in *Frames of mind: the theory of multiple intelligences*, elucidated work that he and colleagues at Harvard's Project Zero have been conducting for the past 15 years. His theory of multiple intelligences critiques the notion of a single human intelligence that can be assessed by standard psychometric instruments (e.g. the 'intelligence quotient' or IQ test). Rather, he proffers that there exist at least seven types of intelligence including musical intelligence and kinesthetic intelligence, to name just two.

then even if technologies were uniformly available, some parts of the world would be more likely to make use of them than others.

But what is culture other than a category of prior experience? According to the American Heritage Dictionary, the standard definition of culture is the "totality of socially transmitted behaviour patterns, arts, beliefs, institutions, and all other products of human work and thought". The field of social anthropology regards culture as 'shared norms and values'. New experience may lead to an amalgamation of cultures. A migrant from one country to another may change behaviour in response to new experience. The offspring of the original migrant may change over time so radically that it may be difficult to identify them with the original culture.

Throughout history, culture has been loosely associated with geographical proximity. Those who share a common experience live close to one another. If post-industrialized society reduces opportunities to share experiences, the opportunity to develop a common culture may decline. Robert Putnam (2000) for instance, in *Bowling alone,* argues that participation in group activities has been on the decline as a result of stress and time pressures of two family incomes, divorce, and the exigencies of commuting.

But new cultures have recently emerged which are not dependent on geographical proximity. Increasingly, new definitions arise which incorporate societal changes such as 'youth culture', that is, the culture of 'special interests'. In the past these may have used correspondence clubs associated with specialized magazines, CB or HAM radios – gardening, exploration, antiques, etc. With the widespread use of the Internet approximately 10 years ago, there has been an explosion in new linkages. Thomas Friedman (2000) describes this information revolution as one of the most important in the modern era. People are able to connect with one another in an unlimited number and variety of specialized interests, with multiple languages, without regard to national borders.

These new opportunities have scrambled traditional patterns of economic and social opportunity. While it is true that the distribution of opportunity to experience technology is imbalanced, it is also true that the opportunities themselves have forged new and highly specialized cultures. People can follow jazz, debate political issues, and support social causes from their homes in France, Japan, and Mexico. Not only does globalization affect profit-making firms, but it is also now deeply embedded within organizational culture in widely diverse non-profit organizations too, advocating widely diverse fields of environment, protection of wildlife, civil liberties, and freedom for political prisoners.

While it was once true that geographical proximity largely determined culture, it is less so today. To the question of whether technology exacerbates the division among peoples on the basis of culture, independent of economic opportunity, the answer is in part, no. In fact, it is possible to speculate that the growth of global or transnational cultures of many kinds, often highly specialized, is one of the most important outgrowths of the trends in technology. It cannot be said so easily that there is something we all understand as 'Western technology'. Nor would it be quite so easy to identify what we might all agree on as 'appropriate technology'. What is appropriate may have multiple definitions within as well as between parts of the world.

It may be true to suggest that different cultures have different propensities to adapt to technology, but it is certainly not easy to predict which ones do and which do not. Major software firms have contracted work to entrepreneurs in St Petersburg, Bucharest, and Bangladore. Could one have anticipated this trend? Could one have anticipated the growth in local equity markets, and their technological underpinnings, in the Russian Federation, South Africa, and the People's Republic of China? It certainly is not the case that everyone has the same access to technology, but it is unquestionably not the case that culture is among the principal barriers to its distribution.

The adoption of new technologies requires the adaptation of ICT to educational settings as well as cultural changes in the role of teachers and other stakeholders in the educational process. Education technology may be altering schooling in developing areas, including both the teaching and learning processes. ICT can offer what conventional education cannot (Crawford, 1997; Hawkridge, Jaworski, and McMahon, 1991). It presents opportunities for greater access.

For example, television education offers access to a higher quality educational material that would otherwise be available. Television education often is not synonymous with distance education when for instance, it complements the regular instruction in the classroom. It can be used effectively to increase the reach of an education system. Two cases exemplify this in *Boxes 1* and *2* below.

Box 1. Telesecundaria – in Mexico

Produced by the Mexican Ministry of Education, *Telesecundaria* provides quality education through nationally televised programming to rural schools. The programme uses teachers who have higher education diplomas but are not necessarily career teachers. They receive some short training before being put in charge of classrooms. *Telesecundaria* schools are established on a demand basis; the community must request the creation of one with the proviso that they will provide the physical space. As of 2000, the programme had enrolled close to a million students and countries in Central America began to use it as well. In Mexico evaluations have revealed higher promotion rates, fewer drop-outs, and respectable results in student achievement tests (Castro, 1998; also chapter 8 by Coupe *et al.* in this book).

At a given time, a teacher in a classroom turns on the TV to receive the *Telesecundaria* broadcast via satellite. A twenty minute televised session is transmitted. After the programme, the teacher instructs the students to open their workbooks to a given page. A discussion ensues about what was presented on TV, followed by drills and more discussion. The presence of a classroom teacher means that this is not distance education, but rather education aided by the use of television that broadcasts programming.

Box 2. Telecurso 2000 – in Brazil

Telecurso is the antithesis of *Telesecundaria*. It is produced by The Roberto Marinho Foundation, part of the Globo Network, and the fourth largest TV network in the world. Funding is completely private for both the Network and the programme.

Each morning at 6.15 a.m., Globo broadcasts *Telecurso 2000* for people to either view from home or tape for later use. Educational channels and cable TV re-beam the programme during the day for workers. Tapes are also available for purchase – a practice adopted increasingly by firms.

Over 200,000 workers in distance classrooms throughout the country watch the programme. A teacher's aide is available is available in person for discussions, support and troubleshooting. The target audience includes high school drop-outs, labour union workers, civic centre participants, prisoners, and people in the transportation industries. At the end of the year, students must pass a public examination (that resembles the Graduate Equivalency Degree or GED exam) for the subjects that they have taken (Castro, 1998).

Despite the fact that the programme targets young adult high school drop-outs, regular public schools are increasingly using the *Telecurso* materials and techniques. Initial evaluations show that the results are more favorable than regular forms of education.

The programme's strongest features include: (i) contextualized learning in which the lessons are presented in a context familiar to the target students such as factories, the street and small businesses; (ii) the pace of the programme is fast and the production, slick; (iii) the programme provides serious content in an entertaining and compelling manner. Even people who do not fit the profile of the target audience watch the programme because they value the educational programming that it provides.

In both Brazil and Mexico, a culture of high school drop-outs combined with a culture of television soap operas exists without which the countries' respective successes in television education would not have been possible. Both possess high quality commercial television industries, which are major exporters of soap operas (Castro, 1998). This notion of using the television medium has expanded to include using television for educational programming. In turn, the programmes that are produced in Mexico for example, are exported to Russia. This example shows that it is not a uniformly 'north' to 'south' or 'south' to 'north' phenomenon; the export occurs in all manners including south to south. In each instance both *Telesecundaria* in Mexico and *Telecurso 2000* in Brazil leverage their access to media sources to produce instructional materials that are vastly superior to what any one teacher could produce on a daily basis in one classroom (Potashnik, 1996).

Learning networks that connect students in different schools, sometimes in different countries, offer another example of how technologies can be adapted for educational purposes. The cases of *Red Enlaces* in Chile and *Computers in Education Network* in Costa Rica present examples of programmes begun as pilot projects that introduced computers into schools (*Boxes 3* and *4*). Ten and 13 years later, respectively, both programmes have been taken to a larger scale.

These cases suggest that opportunities exist to use technology to improve the way in which students are educated. While the Chilean and Brazilian examples complement the otherwise traditional teacher routines, the Chilean and Costa Rican programmes offer innovative mechanisms for promoting national connectivity and exploration of topics. Further on the cutting edge are GLOBE and iEARN (*Boxes 5* and *6*) that foster learning relationships across national boundaries and across age groups. These last two programmes successfully focus on developing the conceptual thinking, as well as critical and creative thinking, of their participants. In such instances, culture, as traditionally defined, does not dictate the use of technology. Rather, culture is often considered and incorporated into the projects. Such efforts, as exemplified by the cases previously described, demonstrate opportunities for cross-border sharing in education at the classroom level.

Box 3. Red Enlaces – Chile

The *Red Enlaces* (Spanish for 'links network') project began in 1992 as a pilot project in the Ministry of Education with the goal of linking 100 Chilean schools together in 4 years. It sought to identify the roles, impact, costs, and benefits of the use of computers and telecommunications in Chilean schools. In 1995, having surpassed the goal of connecting 100 schools within the first 2 years, the pilot was deemed successful. It expanded to the national level for both basic and secondary education. By 1998, the programme fulfilled another goal of achieving 100 per cent access for middle schools and 50 per cent access in elementary schools. By the end of 2001, the programme involved 4,974 primary schools, 1,288 secondary schools, and totaled 6,262 educational institutions. A total of 70,000 teachers have been trained through the university network. For each new school that is added to *Enlaces*, an average of 13 additional teachers are trained. Each school has its own educational project, which is adapted to its cultural, social and geographic reality.[3] Enlaces promotes cultural change in the sense that it forces improvements in communication and collaboration.

3. The main applications used are: e-mail, storytellers, word processing (ClarisWorks), and Kid Pix (a drawing/sketching application). Several types of specialized educational software are available, all in Spanish.

Box 4. *Red Telemática Educativa* (or Computers in Education Network) – Costa Rica

Created in 1988 as a campaign promise of former president Oscar Arias, the Costa Rican Computers in Education Network programme was established to help improve the quality of Costa Rican education and promote greater access to technology in rural and marginal urban areas. A joint effort between the Ministry of Education and the Omar Dengo Foundation, it strives to promote the development of logic, problem-solving skills, a broader, deeper understanding of curricular content, creativity, self-esteem, the exploration of technological environments, and the development of positive attitudes toward collaborative learning.

The target population includes children in rural areas who are socially vulnerable and otherwise would not have access to such technology and learning opportunities. A total of 434 public schools (or over 30 per cent of the public elementary students) in Costa Rica are served, 362 of which have a computer lab and the remaining 72 of which have only one teacher, but use computers in the classroom. As of 1998, over a million Costa Rican children, teachers and adults had been reached since the inception of the programme (Potashnik, 1996). In 2000, there were 225,113 students served by the programme.

The programme uses a constructivist methodology for using computers and employs LOGO as a programming tool. Regular teacher training, follow-up and support are integral components of the programme. A Costa Rican team and a team lead by Seymour Papert of the Learning and Epistemology Group of MIT jointly developed the initial programme design.

Box 5. The GLOBE Initiative (Global Learning and Observations to Benefit the Environment)

Similar programmes exist which draw on cross-cultural, cross-national exposure for e-mail collaborations, Web-based projects and intercultural classroom connections. One example is the GLOBE Initiative (Global Learning and Observations to Benefit the Environment). Started by then Vice President Al Gore, the GLOBE Initiative is a programme of national and international scope, with primary sponsorship by National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF) and the National Oceanic and Atmospheric Association (NOAA). It is intended to train teachers to engage students in the collection of weather and environmental data at their schools. GLOBE functions as a consortium of public and private groups, and brings teachers, elementary and secondary students and scientists together by Internet to monitor the worldwide environment. Students who have Internet access can share data sets about the environment. The programme instils a sense of stewardship of the environment in students and advances the broader understanding of global environmental science.

Box 6. iEARN

Another example of a cross-national and cross-cultural learning network is iEARN, a non-profit programme that permits students to use the Internet to engage in collaborative educational projects that enhance learning and have an effect in the world. Participants help determine the content of the network and the nature of their respective projects. Projects are adapted to fit a particular curriculum, classroom needs and academic schedules. When a school joins iEARN, all students and teachers have access to the network, with resources available for locating appropriate iEARN projects for different age levels and academic disciplines. The option exists for students to join existing online projects or to work with other students internationally to create and produce their own projects according to their needs and interests. The culmination of an iEARN project is the development of a final project or exhibition of the learning that has taken place during the collaboration. This includes magazines, creative writing, anthologies, web sites, letter-writing campaigns, reports to government officials, art exhibits, workshops, performances and charity fundraising.

Threats and dilemmas

Within each country there is a trade-off of resources. This trade-off is felt more acutely by developing countries in which fewer resources must stretch in more directions. Poor people lack access to information technology. Information communications technology drives current economic development in the developing world and comprises the source of power and control, especially where individuals and governments use ICT to gain political and economic advantage. Yet, should governments, which already spend valuable resources providing traditional textbooks, spend precious resources on computers for educational purposes? In a poor country with many people who are illiterate, low skilled and unemployed, should scarce foreign exchange money be spent on ICT rather than on addressing other priorities? It is true that in many countries education is second only to defense spending, yet as greater access to education is achieved, the education budget must be stretched for more purposes. The result is a never-fulfilled demand for education budget dollars. Why then should one consider investing in education technology given these circumstances?

At the other end of the spectrum is the concern that those countries that fail to adopt information technology suffer from the chronically widening technological gap between industrial and developing countries. For example, China lagged behind the USA in microcomputer design until the Great Wall PC-compatible appeared in 1985. Developing countries cannot escape such broad trends. If developing countries fail to prepare for the information age, the technology gap may become a chasm.

Economies of scale of new technologies raise the possibility of a reduction in the digital gap. As the supply increases, the price of technologies drops. Technological advances make computers, radios, telephones and televisions increasingly affordable. The latest cell phone technology permits many who live in sub-Saharan Africa to overcome the lack of infrastructure for landlines and have access to technical flexibility which can be used at home, at work and when traveling. The same trends are possible for microwave and Internet technologies. Developing countries stand to benefit from the gains already achieved by the developed world in acquiring, perfecting and maximizing the use of certain technologies. They have comparatively low overhead costs and young workforces that may use them to their advantage, compared to other parts of the world where the workforces are older and the infrastructures more inflexible.

But who decides whether a country will adopt technological innovations for its schools? In the developing world this choice often resides at the highest levels of government where budget allocations and educational policy are formulated. Research has shown that ministries of education, together with ministries of industry, trade and finance, develop questions about education technology policy because of the commercial and technological interests at hand (Carnoy, Daley and Loop, 1987). Decisions may be influenced by political and commercial factors. If a minister elects to pursue a policy of education technology, an apt justification follows as well as decisions about the level of introduction, hardware and software, the innovation strategy, the organizational structure including human resources issues such as teacher training and technical support staff and country-specific issues. Providing further justification are the ideological rationales for adopting education technology. For example, in China, education policy is couched in utilitarian terms in which it serves goals of modernization and reconstruction (Hawkridge, Jaworski and McMahon, 1991).

Financial resources

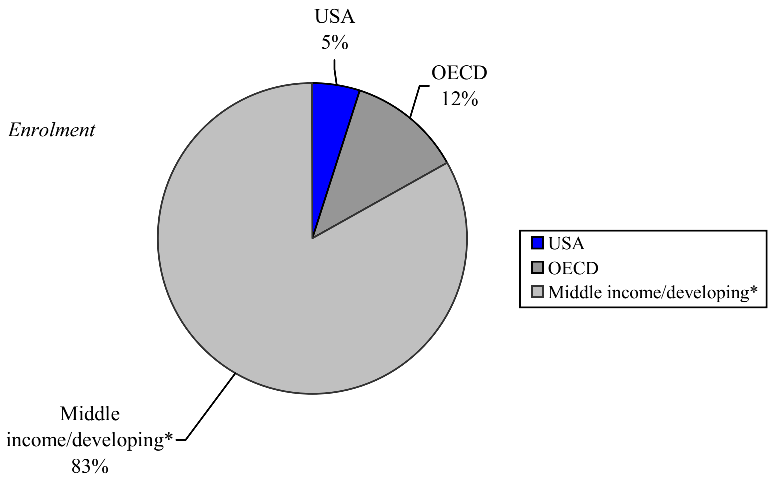
In terms of size the US educational system accounts for about 5 per cent of the world's enrolments (and about 3 per cent of the world's relevant school age group). Industrialized countries in Europe and Asia, together with the USA account for about 17 per cent. Eighty-three per cent of the world's enrolments are located in the middle-income and developing countries, with 57 per cent enrolled in East and South Asia (*Table 2*).

Education systems in all countries are changing rapidly and as economies grow, more is spent on students. Unit expenditures across the world doubled between 1980 and 1994, but different regions showed different rates of growth (*Tables 3a* and *3b*) Expenditures doubled in the USA, but they increased by 135 per cent in Europe and by 200 per cent in East Asia. This presents two challenges.

The first challenge is the gap in educational expenditures between low-income countries and others. Educational expenditures were only US $9 per inhabitant in poor countries, but US $110 per inhabitant in the Arab states, and US $982 per inhabitant in Western Europe. In some parts of the world, the gap in educational expenditures between the wealthy and other economies may be narrowing. Expenditures per inhabitant grew by 200 per cent in East Asia and the Pacific between 1980 and 1994, but by 100 per cent in North America. But in sub-Saharan Africa the trend has been in the other direction. There, educational expenditures declined by 22 per cent over that period.

Even within industrialized countries there is a range of educational expenditures. The United States spent US $4,950 per student in 1992. This compared to US $5,855 in Switzerland, US $5,289 in Sweden, and US $1,613 in Hungary (NCES, 1996). Some countries clearly make more of an 'effort' to provide educational opportunity. For instance, this is evident in the United Kingdom and Canada with respect to public expenditures per student on higher education relative to GDP per capital (*Figure 1*).

Table 2. Distribution of elementary and secondary students* – by category of economic development



* World total = 1 billion children enrolled of the 1 .5 billion in the 5-18 age group.

Table 3a. As economies grow, more is spent on goods and services per student

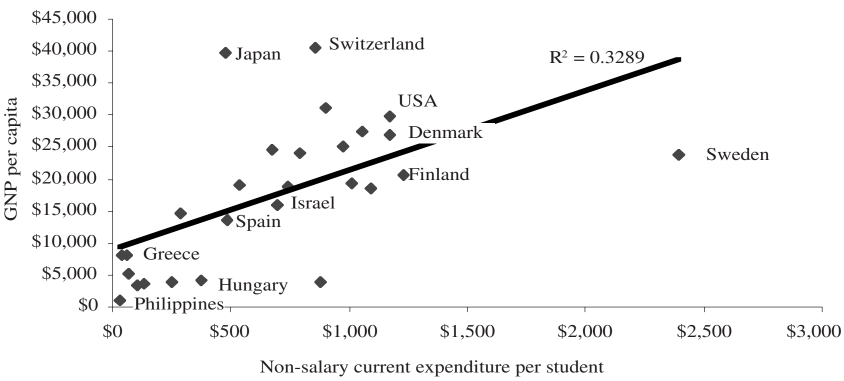


Table 3b. Large growth of education expenditures per region

Continents, major areas and groups of countries	Public expenditure on education per inhabitant (US $)				Percent change 1980-1994
	1980	1985	1990	1994	
World total	126	124	202	252	100
Africa (North and SSA)	48	40	41	41	-15
America	307	375	521	623	103
Asia	37	39	66	93	151
Europe	418	340	741	982	135
Oceania	467	439	715	878	88
Industrializing Countries	31	28	40	48	55
SS Africa	41	26	29	32	-22
Arab States	109	122	110	110	1
LAC	93	70	102	153	65
EAP	12	14	20	36	200
S. Asia	13	14	30	14	1
Poorest Countries	9	7	9	9	0
Industrialized Countries	487	520	914	1211	149

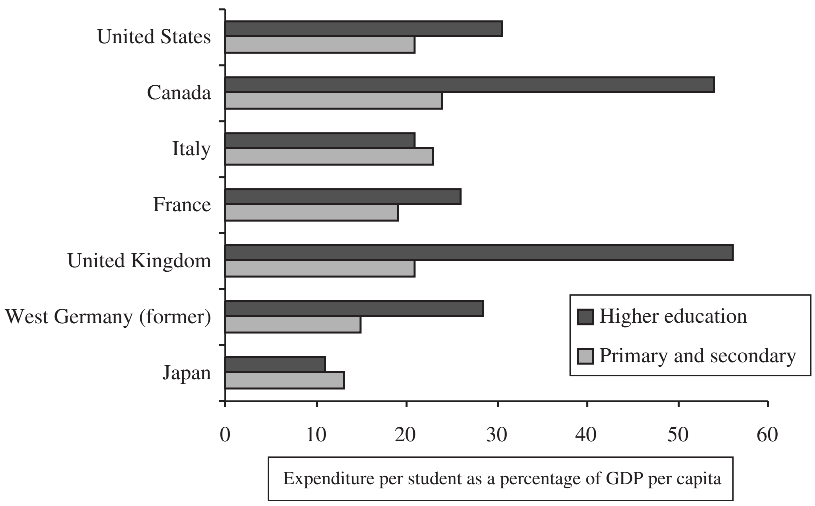
Source: UNESCO statistical yearbook, 1998

Do more resources translate into more opportunity to use technology, and hence to better results? The answer is somewhat complicated. More resources allow a nation to invest more heavily in technology. The pupil to computer ratio in secondary education was 18:1 in the USA, 26:1 in the Netherlands, and 29:1 in Austria (NCES:157) (Table 4). The proportion of students using calculators in school ranges from 3.7 per cent in Korea to 54 per cent in the USA to 94 per cent in France (NCES: 154) (*Table 5*). In the use of science experiments, there is also a wider range – the percentage of students who never conduct a science experiment in school ranged from 25 per cent in the USA, 36 per cent in Switzerland, to 51 per cent in Spain (NCES:151) (*Table 6*).

One can say that the opportunity to experience technology is of great assistance in the acquisition of knowledge, but it is not necessarily a linear connection. In fact many parts of the world with modest levels of education technology seem to perform well or at times better than parts of the world with higher levels of technology (*Table 7*).

In the Third International Mathematics and Science Study (TIMSS) it is obvious that some countries were able to invest more than others in the quality of schooling. Norway, for instance, spends $1,111/capita (of adults in the population) on schooling. The USA spends $1,040; the Republic of Korea spends $362, and Romania spends $55. These figures can be found in Column A (*Table 7*). It is also clear that the results of mathematics achievement differ by country. In Norway, for instance, 46 per cent of the students performed on the TIMSS at the international median level for all countries in the sample. In the USA, 45 per cent of the students performed at the level of the international median. In Korea, 82 per cent of the students performed at that level, and in Romania, 36 per cent of the students performed at that level. These figures can be found in column B.

Figure 1. Current public expenditure per student (in constant 1991-1992 US dollars) and relative to GDP per capita, by education level and G-7 country*, 1992 – continued



* Countries are sorted in descending order by current public expenditure per student in constant 1991-1992 US dollars (primary and secondary).

Source: Organization for Economic Co-operation and Development, Center for Educational Research and Innovation, International Indicators Project, 1995. Reprinted from National Center for Education Statistics Educational Indicators: An International Perspective. Table 43, Washington, DC, Nov. 1996: 219.

Table 4. Percentage of schools using computers for instructional purposes and median student/computer ratio, by level of education[1] and by country, 1989

	Percentage of schools using computers			Student/computer ratio		
Country	Primary	Lower secondary	Upper secondary	Primary	Lower secondary	Upper secondary
G-7						
France	92	99	99	23	31	26
West Germany (former)	—	94	100	—	47	48
Italy	43	58	80	116	90	36
Japan	12	35	94	14	143	32
United States	**100**	**100**	**100**	**23**	**18**	**15**
Other						
Austria	—	50	100	—	29	46
Belgium (Flemish)	—	78	98	—	28	35
Belgium (French)	54	93	93	28	34	38
British Columbia (Canada)	99	100	100	—	—	—-
China	—	—	64	—	—	43
Greece	—	5	4	—	52	44
Hungary	—	—	100	—	—	27
India	—	—	8	—	—	95
Israel	62	—	81	25	—	29
Luxembourg	—	100	—	—	45	—-
Netherlands	53	68	68	63	26	34
New Zealand	78	100	100	62	34	38
Poland	—	75	75	—	—	53
Portugal	29	72	72	301	287	289
Slovenia	—	94	94	—	—	50
Switzerland	—	98	98	—	21	21

— Not available.

(1) For the purposes of this study, primary refers to grades 4-6, lower secondary refers to grades 7-9, and upper secondary refers to the final year of secondary education.

(2) Median student/computer ratio in computer-using schools. Computer-using schools refers to all schools in which computers are used for teaching and learning purposes in a grade in which the modal age of students is 9, 10, and 11 for primary, and 12, 13, and 14 for lower secondary; and in the final and penultimate secondary grade for upper secondary.

(3) No data available for Canada or the United Kingdom.

Note: There is substantial variation across countries in the population of schools and students covered by the study.

Source: W.J. Pelgrum and T. Plomp, Ed. 'The IEA Study of Computers in Education: Implementation of an Innovation in 21 Education Systems', (New York: Pergamon Press, 1993). Reprinted from National Center for Education Statistics Educational Indicators: An International Perspective. Table 43, Washington, DC, Nov. 1996: 157.

Table 5. Percentage of 13-year-old students who have a calculator and who have used calculators in school,[1] by country: 1991

Country	Have calculators	Have used calculators in school
G-7[2]		
Canada	91.1 (0.5)	74.7 (1.3)
France	97.9 (0.3)	94.2 (0.5)
United States	**88.5 (0.9)**	**53.6 (3.5)**
Other		
Hungary	86.7 (1.0)	71.0 (1.6)
Ireland	57.5 (1.6)	25.3 (2.2)
Israel	93.6 (0.7)	48.5 (2.3)
Jordan	52.7 (1.9)	5.4 (0.8)
Korea (Rep. of)	20.3 (1.1)	3.7 (0.5)
Slovenia	85.6 (1.1)	46.1 (2.5)
Soviet Union (former)	46.6 (5.0)	19.2 (2.1)
Spain	85.9 (1.3)	45.0 (2.8)
Switzerland	84.9 (1.2)	51.3 (3.1)
Taiwan	57.7 (1.3)	62.2 (1.0)

— Not available.
1 Standard errors are in parentheses.
2 Data are not available for Germany, Italy, Japan, and the United Kingdom.

Source: Educational Testing Service, International Assessment of Educational Progress, Report 13, Background Questions and Proficiency Scores for all Populations, 1992. Reprinted from National Center for Education Statistics Educational Indicators: An International Perspective. Table 28, Washington, DC, Nov. 1996: 154

Table 6. Percentage of students who never[1] conduct science experiments,[2] by age and country: 1991

Country	9-year-old	13-year-old
G-7[3]		
Canada	26.6 (1.0)	13.1 (0.7)
France	—	20.1 (1.7)
United States	**21.7 (1.3)**	**25.5 (1.9)**
Other		
Hungary	40.2 (1.3)	30.6 (1.7)
Ireland	50.1 (2.0)	26.8 (2.1)
Israel	14.1 (1.1)	34.5 (1.4)
Jordan	—	26.3 (1.4)
Korea (Rep. of)	18.6 (1.1)	34.9 (1.7)
Slovenia	21.4 (1.1)	22.0 (1.5)

Soviet Union (former)	43.7 (1.2)	12.7 (0.8)
Spain	40.3 (2.2)	51.0 (2.3)
Switzerland	—	35.8 (1.7)
Taiwan	10.4 (0.8)	25.1 (1.3)

— Not available.
1 'Never' means not during the most recent school year.
2 Jackknifed standard errors are in parentheses.
3 No data available for Germany, Italy, Japan, and the United Kingdom.

Source: Educational Testing Service, International Assessment of Educational Progress, Report 12, Background Questions and Proficiency Scores for all Populations, 1992; Report 13, Background Questions and Proficiency Scores for all Populations, 1992. Reprinted from National Center for Education Statistics Educational Indicators: An International Perspective. Table 27, Washington, DC, Nov. 1996: 151

Table 7. Educational expenditure and mathematics achievement (in order of expenditure)

Country	Public expenditure on education/capita* (A) in dollars	Proportion of students over the international median in 8th grade mathematics (B) as a percentage	Ratio A/B
Norway	1,111	46	24
United States	1,040	45	23
Kuwait	848	3	287
Singapore	724	94	7
United Kingdom, England	649	48	14
Japan	602	83	7
Israel	584	56	10
Korea (Rep. of)	362	82	4
Hong Kong	309	80	4
Czech Republic	297	70	4
Hungary	272	60	4
Thailand	206	54	4
Islamic Republic of Iran	183	9	20
Latvia	147	20	3
Lithuania	71	34	2
Romania	55	36	2

* Calculated by multiplying the GNP/capita (in international dollars) by public expenditures on primary and secondary education

Source: Beaton *et al.*, 1996.

Clearly the gross amount of technology and available resources do not necessarily determine the level of mathematics learning. But what are the implications of these differences? One way to approach this question is to take the ratio of column A and column B. These figures can be found in column C.

These figures represent the amount of money in each country that would be required to get an additional 1 per cent of the student population over the international median of achievement. In Norway for instance, it would require an additional expenditure of US$24 for each adult in the population. In the USA it would require an additional expenditure of US$45/capita. In the Republic of Korea it would require an additional expenditure of US$4, and in Romania it would require an additional expenditure of only US$2. This suggests that if technology could be improved in Romanian classrooms the impact would be considerably greater than it would be in Norway or in the United States.

Distance education: limitations on quality

It is sometimes suggested that distance education can overcome the traditional requirement that high-quality education requires face-to-face instructional experience. Is it possible, for instance, to deliver a University of Chicago programme anywhere with the same quality and price? We believe it is not possible.

Education cannot be delivered free of cost. The more well-known the 'brand', the higher the cost. The private cost (the cost to the individual student) has been slowly reaching the public cost. This means that individuals will increasingly have to shoulder higher costs and a higher percentage of the costs. This is particularly true of distance education.

It is said that much of the value of an education programme is semi-autonomous from the curriculum. The business curriculum at the Wharton School may differ only slightly from the business curriculum at the University of London. What does differ is the quality of the professional staff. Better educational institutions have higher quality professional staff. Students pay to have access to them. And the key to understanding the economics of distance education is that there is no known way to give students the equivalent level of access to individual professors that they would have had in person. Only a small number of distance education students would be willing to pay the full cost ($30,000 per year) for a programme that gives them only a teleconference. Some might be willing to pay, but not enough to justify the capital and infrastructure investment. Since the level of access is not identical to face-to-face instruction, many brand name universities are unwilling to label the distance education degree as equivalent. They worry about devaluing their overall brand.

Thus in the field of distance education we may have seen a hiatus of sorts. The current scene includes: few name brand participants, a plethora of medium- and low-quality participants interested in mass audiences and sizeable market shares, and a cluster of institutions all within the same small number of curricular areas including business, economics, management, accounting, etc.

Culture, education and entertainment: the blurring of the lines

One explanation for the difficulty experienced by curriculum authorities in capturing the minds and interests of students has to do with the significant change in young people's leisure habits. At one time, students were unexposed to professional electronic entertainment. Once access to television and film became universal, and once these were overtaken by video and computer games, the standards for capturing teenager attention shifted. Access to their attention has become a competitive game in itself, with challenges built into it.

The expertise of entertainment is generally segregated from that of the formal curriculum. Films and video games are developed with considerable success, but these are generally divorced from mathematics and science. A few private companies, such as Lightspan, have developed curricula based on the expertise of the entertainment industry, but to merge these fields well requires considerable capital investment.

Should it be necessary to entertain, in order to educate? Or would merging entertainment with formal curriculum be an indication of a breakdown in standards and a pandering to teenage whim?

There will always be important exceptions but, in general, the new demands for information and the instantaneous merging of text with graphics and sounds will probably become the future standard in education.

There seems little escape from the requirement of having intellectual and cultural challenges merged with the cultural standards outside of the classroom.

The international trade in education goods and services: conflict between human rights and the nation state

An educational provider may be foreign, or commercial, or just non-governmental. Does a government have the right to restrict access of citizens to the education of their choice? If the Internet provider is shut out of a market, some users will feel that they have been denied an essential service. In these instances, the client may not be the traditional student already in a university, but a potential student who may not have an opportunity otherwise to attend at all.[4]

A citizen of Greece may wish to take a course at the British Open University. In a democracy, does the state have the right to prevent a citizen from privately financing what s/he may wish to learn? If individuals have been 'protected', not on grounds of health or safety, or on grounds of likely damage to the environment, but on grounds that private or foreign education represents a danger to the culture, then one might ask whether a human right has been abrogated.

What about cultures said to be threatened by the private provision of education? There are many with strong views about this. A former prime minister of France, for instance, once pointed out that the suppleness and adaptability of capitalism make it a dynamic force. But it is a force that of itself has no sense of direction, no ideals or meaning – none of the elements vital to a society. 'Capitalism is a force that moves but does not know where it is going ... The financial crisis of 1997 and 1998 in Asia and Russia ... shattered the claims of neo-liberalism ... so we must seek to create a regulatory system for the world capitalist economy' (Jospin, 1999: 8-9).

4. The nature of the client's concerns may differ from one kind of country to another. Bray points out that the drivers of private education differ between low and high-income countries. In high-income countries they tend to reflect the movement toward accountability, choice, and efficiency. In low-income countries, they reflect concerns over shortages of public resources and inefficiency. Mark Bray, *Privatization of secondary education: issues and policy implications* (Paris, UNESCO, International Commission for Education in the Twenty-First Century, April, 1996: 1).

It is true that some cultures find it difficult to combat influences from elsewhere. But this is certainly not limited to education. It is also true with fashionable clothing, medical practice, religious belief, language, technologies, transportation, music, film, art, literature and many other fields. While many countries find it difficult to 'control' these influences through traditional mechanisms of regulation,[5] it is also true that some influences on hindsight have been positive and welcome. One can think of examples in the fields of medicine, music and literature. How can one know ahead of time if the influence will have constructive or adverse consequences? And what about recipient cultures? What future is there for a 'protected culture'? Will it exist like an endangered species in a nature preserve?

Conclusions

There has been some confusion over the morality of international trade in education technology due to the lack of distinction between arguments which apply to compulsory education and those that may apply to post-compulsory education. While it may be the case that all nations have a right to 'protect' their cultures with respect to minors, it is less compelling in the case of adults. Whether they seek vocational skills training or exposure to more general higher education, adults should have the right to pursue their education free of constraints.

In the case of culture and technologies, it is quite probable that ICT needs to be treated differently from previous technological breakthroughs. ICT has precipitated a rise of new kinds of cultures, which span international borders and, in general, this should be welcomed.

Are there limits to these new cultures? Styles of dress in one part of the world may offend others in another part. There may be extremist views of race or religion. If information is offensive, should all have access to it? Again, the answer in part derives from whether the target audience consists of minors or adults. All nations have the right to protect against

5. It is curious too that dominant world actors are not always prominent in terms of curriculum. Frank *et al.* point out that both Western Europe and classical Western civilization have declined in importance over the same time as Western capitalism expanded. (David John Frank, Suk-Ying Wong, John W. Meyer, and Francisco O. Ramirez), 'What Counts as History: A Cross-National and Longitudinal Study of University Curricula', *Comparative Education Review* 44 No. 1 (February, 2000: 43).

what they fear is offensive. However, all nations must be prepared for new standards and styles of learning which have been influenced by the entry of ICT into both education and young people's lives more generally.

There is a digital divide between rich and poor nations, but it cannot be said that ICT is therefore limiting. In fact, the opportunities to acquire new education and global sources of information make educational opportunity more possible than at any time in modern history.

ICT may also influence the role of international organizations. In the past, international organizations have tried to 'bridge the gap' in funding and technical assistance. These efforts have long been futile. Markets and choice are the predominant method by which technologies spread.

But international organizations now have a new and more important responsibility. What is needed today are neutral professional organizations which can help adjudicate the dilemmas and problems arising with the new technologies. Under what circumstances should a nation 'protect' a culture? Under what circumstances should an individual have the right to purchase education on the open market? These are not simple issues of right or wrong. Answers can only be found through a considered discussion, and international organizations now need to step up and assure that this discussion, fair to all sides, can occur.

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Chapter 4

Using instructional technology as a bridge to the future: Palau's story

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This chapter examines dilemmas that teachers face in integrating technology into classroom instruction, paying special attention to the recent experience of the Republic of Palau. The basic premise of this case study is that even in well-designed efforts to introduce technology into the schools, inadequate attention is often given to teacher incentives for actual utilization.

This is illustrated in the case of Palau. On a per capita basis, Palau may have the highest concentration of computer technology in public schools of any developing country in the world. Virtually all teachers and students in the country (from grade 1 to 12) have access to computers and educational software. Across Palau, the ratio of students to computers is less than 12 to 1. Nonetheless, teachers' utilization of this technology in the delivery of instruction is low, largely for two reasons.

First, in the late 1990s, to encourage fresh thinking in the civil service, Palau mandated retirement of all civil servants after 30 years of service. Over one-quarter of the teaching force in the country turned over in the last two-years. As a result, fully half of the teachers now in the schools never received computer training. These new teachers could participate in the additional training opportunities offered each year, but teachers have to pay for their own transportation and lodging while attending this training. This poses some burden on those who live outside the capital city (where the training is offered).

Second, integrating computer-based materials in their lessons requires extra work on the part of teachers to find the materials and build them into their lesson plans. The low utilization rates of the technology suggest that Palau will need to identify stronger incentives to encourage teachers to commit the extra time and work needed to effectively integrate technology into instruction.

The case study suggests that (1) there is a need for pre-developed computer-based lesson materials that are easier for teachers to use; and (2) that such computer-based lesson materials might be developed on a regional basis. The regional preparation of these plans could do much to improve instructional quality, encourage utilization, and lower per-country costs for curriculum development.

Background

The Republic of Palau, an island republic in Micronesia with a population of approximately 20,000, is located in the North Pacific Ocean approximately 600 kilometres southeast of the Philippines. In 1978, after three decades as part of the UN Trust Territory of the Pacific under the administration of the United States, Palau opted for independent status rather than joining the Federated States of Micronesia. A Compact of Free Association with the USA was ratified in 1993, and in October 1994 Palau gained independence (www.cia.gov/cia/publications/factbook/geos/ps.html).

The public education system of the country consists of 19 elementary schools distributed across the archipelago, and one high school located in the capital city of Koror. In addition a pre-school Head Start programme, a number of private schools, and Palau Community College offer educational opportunities to residents.

Within Palau, students are required to attend school through grade 12 or until they reach the age of 17. Annually, approximately 95 per cent of the students completing grade 8 actually go on to attend high school in Koror and approximately 80 per cent of the students complete high school. The average daily enrolment in the school system is approximately 2,300 (Ministry of Education, 2001). Palau’s effort to adopt and integrate educational technology into the public schools began in the late 1980s and continues to this day.

Why integrate educational technology?

With the aid of technology, Palau education officials believed students could learn more and faster, retain more, and access information that hitherto had been beyond their reach. In addition, the speed, capabilities, and capacity of modern educational technology led them to believe that many of the record-keeping and reporting tasks associated with education should be simplified and automated, resulting in more accurate records and easier information retrieval. At the same time educators would be freed to devote more time and energy to the interpersonal aspects of the education process.

The expectations for the role of technology were ambitious, optimistic and naïve. Education officials believed that, as a result of the decreasing hardware prices and increasing capabilities (Landefeld and Grimm, 2000), technology in education would become ubiquitous. They thought that all learners, teachers, and administrators would have access to the educational advantages offered through technology and that high quality learning opportunities would be freely available. Through these opportunities, barriers to education would fall and equity would be achieved. Educational technology would become a great equalizer.

As outrageous as these expectations might seem, some would argue that technology has helped countries realize a number of these outcomes and bring others within reach. Research has shown that learning time is reduced and retention is increased through the use of technology-based instruction. Learners indicate that using the computer as an educational tool is easy, enjoyable and rewarding. The Internet provides access to information and opportunities previously unavailable to many (PBS, online). Unfortunately, these findings have been limited largely to populations in the economically advantaged areas of the more developed countries of the world. This situation is creating an even larger, and expanding gap in the educational experiences and achievements of those with and without access to technology. In addition to the obvious loss of basic educational opportunities, there is the related concern that those with technology skills will have access to greater higher education and employment opportunities than those with little or no experience working with technology. This educational inequity and the differentiation in associated benefits have come to be known as the 'digital divide' (Digital

Divide Network, online; National Telecommunications and Information Administration (NTIA), online, online).

A digital divide can exist within a developed country or between developed and developing countries. Efforts to 'close' or 'bridge' such a divide are often undertaken as a means of limiting the negative impacts that might otherwise befall a population that remains technologically disadvantaged. However, exactly what efforts should be undertaken and what impacts might result are matters still under investigation. The following case study examines the Republic of Palau's efforts to integrate technology into public education in an attempt to realize the hopes and promises of technology and to mitigate the further development of a digital divide between the students of Palau and those in the developed countries of the world.

The chapter begins with an historical overview of the decisions that led Palau's Ministry of Education (MOE) to adopt the approach they have. Next, the authors review the current status of the educational technology integration initiative. The final section of the chapter looks to the future of educational technology in Palau as it relates to improving the educational benefits, sustainability, and scalability of the programme. Throughout this chapter we examine the impact of outside forces (e.g. over a million dollars in funding from the USA, limited access to high bandwidth connections, regional technology and education initiatives) on Palau's educational technology planning and implementation.

Data were collected during 2001 as part of a republic-wide evaluation of the educational technology infrastructure (Sales and Chapman, 2001). Data sources included (a) inspection of the multimedia laboratories during site visits conducted to 13 of Palau's 20 public schools, (b) interviews with school principals and/or computer lab managers in those 13 schools, (c) interviews with MOE officials, (d) a review of relevant MOE documents, and (e) a review of international research.

Palau's technology integration plan

The concept of integrating educational technology into the curriculum and instruction offered by the Palau Ministry of Education began in the late 1980s when the Ministry's Director of Curriculum and Instruction attended a demonstration in Guam on the use of technology to enhance teaching and learning. He was impressed with the power of a laser disc player to present core instruction in mathematics, science, and social studies. The demonstration convinced him that technology would become one of the greatest tools available to teachers and students. Upon his return to Palau, he undertook aggressive efforts to integrate educational technologies into classroom instruction and to assist teachers to develop their skills in using these technologies.

The Ministry of Education determined that six stages of technology integration were required to achieve its goals:

1. establish a computer lab in every school;
2. equip each lab with appropriate hardware and software;
3. provide technology training to all teachers and principals;
4. connect all schools with video conferencing systems to allow training and meetings of teachers and principals to take place while they are in their school environment;
5. develop a computer-based management information system in every school connected to the MOE data system, so that information about students, teachers, and school in general would be readily available for use in decision making on education issues;
6. connect every school to the Internet so that students and teachers could access educational resources outside of Palau.

The integration of technology required a significant investment. The Director was able to secure several grants from the US Department of Education on behalf of the Ministry of Education. The goal of these funded projects was to ensure that all of the schools in Palau had access to appropriate technology resources, including hardware, software, and teacher training.

One of the initial and significant challenges Palau faced in the early years (i.e. the late 1980s) was that a majority of the schools did not have electrical power. Only schools located in Koror had regular and reliable electricity. Funds were sought to remedy this situation and, eventually, the US Department of Education supported the purchase and installation of generators. By the early 1990s almost every school had been equipped with a power source.

As soon as electrical power became available, the first shipments of equipment were made to the schools. The initial technology provided to schools included a laser disc player, a TV/monitor, and core programmes for mathematics, science, and social studies. In addition, a series of training programmes for teachers were implemented. This training focused on use of the laser disc player as a teaching tool. The core instructional laser discs available in the schools were used during the teacher training to help teachers become familiar with the content contained and strategies used.

Concurrent with the installation of the laser disc equipment, the Ministry began to explore the use of computers to enhance teaching and learning. At this time Palau was challenged with a major strategy decision (one that all educational organizations face as they consider the integration of technology): "Is it better to put 2 to 3 computers in every classroom or consolidate them by putting a computer lab in every school?" After researching the various pros and cons and considering factors such as costs, security, care and maintenance, the Ministry decided to have computer labs. The goal was to establish at least one lab in every school.

In 1992 Koror Elementary School became the site of the first computer lab. In addition to the laser disc hardware and software that was provided earlier, the lab contained 15 Macintosh LC computer workstations. It took nearly a decade to equip computer labs in 16 additional schools across the Republic.

The establishment of computer labs took place one school at a time. In many of the schools there was no space available or appropriate for a computer lab. Considerable effort was required to co-ordinate and represent the interests of both local school officials and the Ministry. Eventually the necessary facilities and configurations (e.g. appropriate electric lines, air conditioning, renovation, security screens on windows) for a formal computer lab were in place in most schools. As late as June of 2001 some of the electrical issues were still being worked out at the more remote schools.

Standardizing on a computer platform was less of a challenge. IBM and Macintosh, the two computer manufacturers with the largest shares of the education market, both had vendors located in Guam. As Palau began to explore placing computers in the schools, representatives of both companies were invited to Palau to make presentations to teachers and principals. The vendor representing Macintosh accepted the invitation. The vendor made a presentation and won the Ministry's contract to supply computers to all of Palau's educational needs. The number of computers to be placed in each lab was based on the number of students. The goal was to ensure that every student would have a computer to work on when his or her class was in the computer lab.

In the mid 1990s the Ministry explored the feasibility of video conferencing among schools. The geography of Palau was a deterrent to meetings and training and the MOE believed that video conferencing technology could facilitate training, meetings among administrators, and idea sharing among teachers separated by long distances and difficult terrain.

Video conferencing equipment was installed in two schools and the MOE offices. Efforts to use the equipment for a range of functions met with mixed success. At the end of the pilot efforts, the video conferencing efforts ended. Three factors were cited for the 'failure' of the experiment. (1) the high cost of the initial investment required to provide all of the schools with the technology; (2) the high cost of the lines needed for use of the equipment; and (3) frustration experienced during the operation and maintenance of the technology.

Today, as a result of the MOE's efforts, nearly every school in Palau has at least one computer lab. The exceptions are three small elementary schools located on remote islands, each with less than 10 students.

Implementing technology integration

In the early 1990s, as Palau progressed in its efforts to install technology in the schools, educational leaders began to seriously reflect on how technology could empower both students and teachers, influence the quality of their instruction, and engage students as active learners. Along with these new expectations came a new definition of literacy – that of technology literacy. Technology literacy requires the knowledge and skills to use advanced electronic hardware and software applications and the ability to electronically search for, organize, interpret, and display information. Through the development of technology literacy, teachers and learners gain new tools – tools that would empower them to "communicate, compute, collaborate, and connect."

With this new understanding of the power of technology in education, the Director of Curriculum and Instruction began to structure an educational technology programme that was in alignment with the MOE's ten-year master plan for education. That plan became known as 'Palau 2000: Master Plan for Educational Improvement'. Published in 1994, the plan presented a vision statement for education in the Republic that included using real-world tools and experiences and increasing the certification standards for teachers in both primary and secondary schools.

Technology training

The MOE embarked on a 'Teaching, Learning, Technology' project that was designed not only to bring technology to the students and teachers of Palau, but also to identify and develop new strategies for teaching and learning. Building on the 'Palau 2000: Master Plan for Education Improvement', the project used a curriculum integration model that encouraged student-to-student and student-to-teacher interactions; a model where the mimetic approach to education gave way to a constructivist approach. The expectation was that these changes would produce a learning environment that prepared students to deal with uncertainty, complexity, information resources, new technologies, and different cultures.

Under the 'Teaching, Learning, Technology' project, a framework for professional development for teachers and school principals was developed as a process intended to improve skills, attitudes, understanding and performance. The process was structured around a series of courses and institutes designed to help teachers to acquire, apply, and evaluate the skills needed in using a problem solving, sharing approach. The courses and institutes were used, and continue to be used, as opportunities for teachers to be able to discuss, think about, try out, and hone new practices.

The training was designed and conducted by a consultant from Guam who presented the training at least once a year. A significant commitment was required from those who enrolled in the training. Initially, participants took part in an intensive week-long programme in Koror. That was followed by monthly, day-long sessions over a period of six months or longer. Throughout the training, teachers were exposed to a broad overview of computer operation, maintenance and use in the classroom. Content addressed included the operation of specific software products (e.g. HyperStudio and KidPix) and various strategies related to integration (e.g. lesson planning and co-operative learning). This form of professional development was seen as a key to the successful use of technology in education for improved student achievement (Hunt and Bohlin, 1995). The overall goal was to produce a change in the way teachers teach and ultimately to improve student achievement in predetermined curricular areas.

Technology competencies identified as critical components of this professional development process included: technology awareness, technology identification and operation, applications, academic skill development, cognitive skill development, acquisition of information (research), presentation/production skills, interpretation skills, ethics, and technology in the community. These competencies were aligned with five stages of technology application (*Table 1*) through which it was hoped all of Palau's teachers would pass. The five stages of technology application were derived from work conducted as part of the Apple Classroom of Tomorrow (ACOT) research studies (Apple Classroom of Tomorrow, http://www.apple.com/education/k12/leadership/acot/). These studies provided a common vocabulary to identify levels of application for individual teachers and to track growth and development overtime.

Each of these stages was linked to curriculum integration so that teachers could select appropriate instructional activities relative to their existing skill set and professional growth plans. As professional development took place and teachers began integrating technology, they were expected to progress through each stage over an extended period. By phasing in professional development offerings at each stage of integration, the MOE expected the majority of teachers to attain the invention stage by the year 2000. However, during the republic-wide technology evaluation conducted in May and June of 2001, it appeared that only one or two teachers had reached that level of proficiency. The vast majority of teachers were on the entry or adoption stages; only a handful of teachers had reached the adaptation stage.

Table 1. Five stages of teacher development

1.	During the **entry stage** teachers struggle with the changes education technologies bring to the classroom environment. They are required to rethink teaching and learning styles, develop a new technology vocabulary, and investigate new tools for learning. Initial experiences with technology characterize this first stage of technology awareness.
2.	Throughout the **adoption stage** the struggle regarding acceptance of these new technologies is replaced by the struggle to master them at the most rudimentary levels. Fear is replaced by experimentation with electronic applications that closely imitate existing classroom activities, such as drill and practice and tutorial environments.
3.	The **adaptation stage** is characterized by teachers recognizing the potential and power of technology tools to the extent they use them for personal productivity and begin to advance student usage of these same tools. Examples include the usage of word processing in writing assignments; database in social studies research and data collection; and spreadsheet integration into the mathematics and science curriculum.
4.	The **appropriation stage** is distinguished by the mastery of specific technology applications and their seamless integration into daily instructional and management activities of the teacher within the school environment. Teachers at this stage are a valuable resource to their colleagues. They help implement the 'teacher-training-teacher' and mentoring models for professional development activities.
5.	The greatest strides seen during the **invention stage** may be realized by the technologically-proficient teachers who provide students with the necessary technological skills and access to these powerful resources. Persons at the invention stage can develop sharable courseware and materials that link technologies to current curriculum or education reform components while they teach technology to others.

Source: These stages are taken from the teacher training programme, 'Teaching, Learning, Technology' created by Dr. Naomi M. Wahl and used to train teachers in Palau.

Structured teacher training programmes continue to be regularly offered by the MOE and teachers are encouraged to enrol. While these training programmes filled quickly in the early years, today's teachers have not been as eager to enrol. There may be a number of causes for this. For example, there are many new teachers, some with limited formal preparation for teaching positions. They may be choosing to focus their efforts on staying ahead of the students or taking courses that apply to a degree programme rather than in-service courses. In addition, when interviewed, some of the teachers from the more remote locations indicated that participation in professional development programmes created hardships, such as having to arrange their own transportation and housing when attending school functions or classes in Koror. For many, this means traveling for hours over poorly developed roads in their personal vehicles, using the supply boat that occasionally services the rural communities, or utilizing their personal skiff to travel up to 50 miles into Koror. Since the courses require participation over an extended period of time, the expense and inconvenience is too great.

Impacts from government policies and practices

To understand the integration of educational technology into Palau schools, it is important to understand three additional forces affecting Palau education.

1. In 1998, Palau passed a civil service retirement act mandating that all civil servants, including public school teachers, retire after 30 years of service. The purpose was to create turnover in the civil service that would lead to the introduction of new ideas.

   One result of this legislation has been a dramatic turnover in the teaching force. In a two-year period, 1999-2001, 76 of Palau's 266 public school teachers left teaching. While many of those leaving teaching had participated in in-service training on the use of educational technology in the classroom, their replacements had not. The unusually high rate of retirements created a significant problem for the MOE. There was not a sufficient pool of adequately trained personnel to fill all of the new vacancies. As a result, the schools were forced to hire teachers who lacked formal teacher preparation. Table 2 shows the number of teachers, by level of education, serving in Palau's schools at the end of the 2000-2001 school year.

   Government is concerned about raising the quality of education. To that end, legislation is being considered that would raise the minimum education level necessary to be hired as a teacher to a bachelor's degree. While this requirement would be phased in over several years, the success of this initiative would require a large number of bachelor graduates who want to become teachers. Since it is unlikely that the government will be able to raise teacher salaries to a level that will attract sufficient numbers of bachelor's candidates, it may need to find a way to assist prospective teachers to meet this requirement. Educational technology training will need to be a part of such an effort if the new teachers are going to be prepared to use technology in their new positions. To be successful, however, this training will need to be designed in ways that provide sufficient support (e.g. covering travel costs) to make participation possible and attractive.

2. Palau, like virtually all other countries in the Pacific Basin region, is experiencing the pressures posed by globalization, e.g. the rapidly increasing economic interdependence among nations. Continued economic and social development increasingly depends on cross-national communication, information exchange and the effective use of technology. The continued economic competitiveness of Palau requires that the education system develop these skills in the workforce, thereby narrowing the digital divide.

Table 2. Number of public, primary and secondary school teachers by education

Highest degree	**Number of teachers**
High school graduate	93
Associate's degree	86
Bachelor's degree	81
Master's degree	6
Total	266

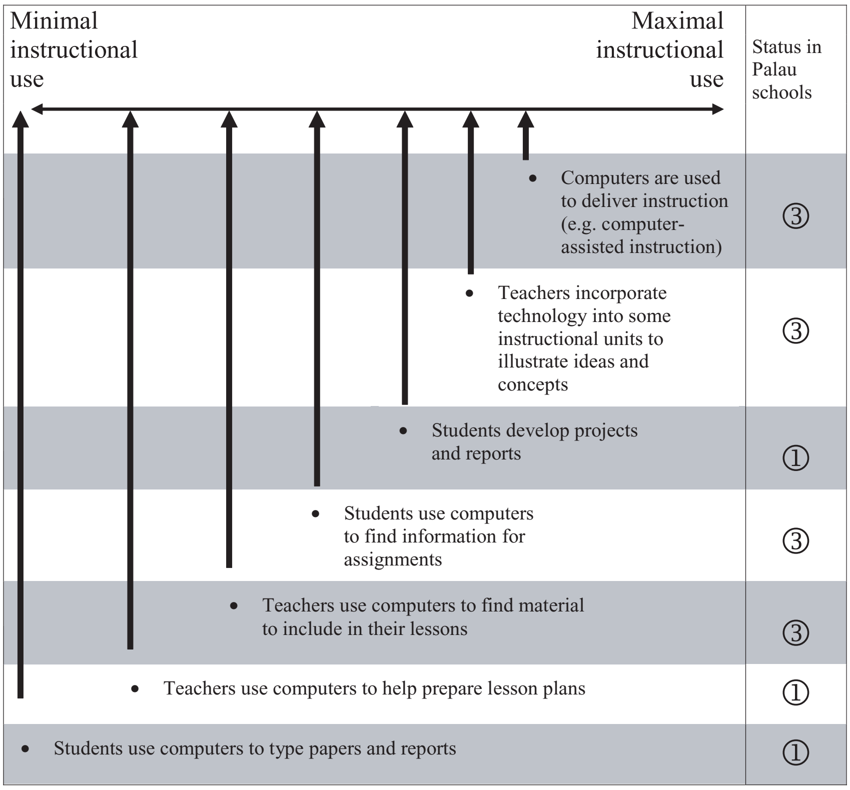
Technology use in the schools

The role of technology within the educational process can be viewed as a continuum. At the simplest level, technology is used to complete tasks that can be accomplished with other simpler devices (e.g. typewriter/ word processor, calculator, slide projector). At more complex levels, computers can be used to directly deliver interactive instruction (complete with record keeping and reporting features), compile and analyze data, or as a tool to simulate processes that promote problem solving. *Figure 1* illustrates the level of technology use in Palau schools in the 2000-2001 school year.

In the spring of 2001, across virtually all of Palau's schools, the utilization of technology for instruction appeared to be low. With notable exceptions, teachers were primarily using computers to type their lesson plans or to have students type reports and assignments after writing a draft with paper and pencil. There was relatively little use of the technology to actually deliver instructional content or illustrate concepts that were being taught in the lessons. There did not appear to be any use of technology to gather and analyze data or to assist in problem-solving tasks.

The degree of educational technology use varied from school to school. Not surprisingly, schools where the administration demonstrated an interest in technology were the schools where technology was being used. In some schools, for example, each classroom teacher was required by the principal to make use of the technology lab during one or two periods each week. Teachers were required to submit lesson plans to the lab co-ordinator prior to bringing students to the lab so that the appropriate preparations could be made. However, even in these schools there was little or no evidence of teachers integrating technology in other curriculum areas.

Figure 1. Continuum of school use of technology



Ratings of Paulau's progress: 1 = widely implemented
2 = in most schools on a limited basis
3 = seldom or never used in Palau schools
Assessment as of May 2001.

Instead, they treated technology as a separate content area or used the computers as word processors or graphics tools.

In schools where teachers were not required to use the multimedia laboratory, most of them did not use it. Some teachers reported they lacked the necessary training. Either they missed the training when it was offered, were hired after the last training occurred, or had not taken advantage of the opportunity when it was presented. However, many teachers with computer training still did not utilize the technology. They indicated that they lacked the confidence, experience, and time to adequately prepare lessons that incorporated technology. They viewed using the computers with their students as an additional course preparation.

The cultural relevance of commercially available software may also account for the limited integration of instructional software products into the curriculum framework in Palau. No commercial educational products have been available in Palauan, and programmes in English have not localized to the culture of Palau. Recently, efforts have been undertaken to provide regionally-focused technology-based resources to the Pacific Basin. CD-ROM based examples include, (1) the Art of the Pacific Islands, a searchable database of art artifacts from Micronesia, Melanesia and Polynesia (PREL, 2000*a*), and (2) a two-disc set of instructional support lessons entitled, *The Pacific Algebra Network* (PREL, in press).

The MOE has also identified the need for culturally-relevant materials. It has commissioned the development of both CD-ROM and Internet products. The CD-ROM, which combines, standardizes, and provides translations of a collection of grade-appropriate lessons developed in Palau, is aligned with the Cultural Profile curriculum in grades K-12 (MOE, in press *a*). The web site, hosted by the MOE, provides general information about education in Palau along with specific information such as reports and directories (MOE, in press *b*). In addition, another contractor working with teachers in Palau has developed a CD-ROM for use in schools entitled *'Learning about Palau'* (PREL, 2000*b*). This disc contains a wide range of information about the island nation and its people.

In spite of limited instructional use of technology, many of Palau's children are learning how to operate computers and are developing a basic understanding of what computers can do. The natural curiosity of the students, availability and accessibility of the technology in the schools, and the novelty of computers contribute to this incidental learning. There is little doubt that the knowledge gained through these experiences will be important to the post-secondary education options and future careers of many of these students. Another positive outcome is that students' current uses of technology have helped make learning fun and kept them interested in school.

Impact of technology on achievement

While one goal of introducing the multimedia technology laboratories into the schools was to increase student learning, no measurable changes in achievement have emerged. Palau Achievement Test (PAT) results indicate that achievement in core subject areas has been constant over the period 1997-2000 (MOE, 2001). Given the current limited use of educational technology, it is unlikely the computer labs will have a measurable impact on student learning for some time. To impact learning more, teachers must begin to effectively utilize technology in their delivery of instruction, and students must become more actively engaged in using computers for research and learning.

Accountability

At this time there is minimal accountability for the effective integration of technology in Palau's schools. However, the new government of Palau has indicated a strong interest in implementing performance-based budgeting across ministries. In response, the MOE is considering strategies for introducing a performance-based approach in its internal operations. One aspect of such a move may be the development of performance measures related to the use of technology in instruction.

Issues impacting integration

Computer lab managers, principals, and teachers express widespread praise for the technology training they have received. Participants found the summer intensive course followed by monthly training sessions to be helpful and interesting. When concerns about training were expressed, they tended to fall in three areas. First, the training concentrated on the use of instructional software rather than on the operation of the hardware. As a result, some teachers were unable to perform such basic functions as turning on the computer, although they often knew how to use particular software once the computer was turned on. Teachers needed more training in basic computer operations. Second, the computer lab managers asked for more training to improve their own technical skills. They felt they were stronger in software use than in basic equipment operations. For example, some computer lab managers were uncertain about how to plug in new peripheral devices or make simple repairs. As a result, at any point in time a significant number of computers might not have been functioning while waiting for a technician from Guam, under contract with the MOE, to arrive and make repairs. Third, educators outside Koror asked that at least some of the training be offered on-site outside of Koror. Teachers from the rural schools stated that they were sometimes intimidated by the Koror-based training and reluctant to ask questions when they did not understand the material. Some rural teachers might feel more confident in asking questions if the training were in their own work settings.

Teachers do not have clear incentives for using technology in instruction and some believe there are clear disincentives. In addition, teachers' attitudes toward technology use tend to be different within and outside Koror. In Koror, teachers think that preparing lessons that integrate technology takes extra time and work for which they are not rewarded and which competes with other uses of their time. Outside of Koror, principals report that teachers are more willing to experiment with computer use in instruction, but that the high personal cost of attending training is a serious constraint. Principals and teachers outside of Koror are expected to pay their own transportation, accommodation, and meal expenses to attend the monthly computer training sessions offered only in Koror. Depending on their location in the country, this can amount to a significant financial commitment for the individual teacher or principal. This pattern contributes to increased disparities between urban and rural schools. Schools farthest away from on-going technical assistance incur disproportionate costs to develop local expertise.

Teachers and principals in nearly all schools indicated considerable interest in having Internet connectivity. Many were attracted to the e-mail capacity, but some also saw the instructional opportunities posed by connectivity to a wider set of information resources. The current lack of connectivity for all but a few of the schools located in Koror is due to the limited bandwidth and high cost of Internet connections. This represents a national issue that goes well beyond the capacity of the MOE to resolve. Nonetheless, today, one of the greatest values of having technology available in the schools is to give students access to the worldwide resources and information available through the web. Only by accessing these information resources will Palau schools be able to narrow the digital divide that increasingly separates communities and nations.

Palau's teachers and principals regularly view computers as a separate, stand-alone curricular topic rather than as an instructional tool integrated into their teaching. Some teachers have reportedly neglected technology use, stating that they have enough to do preparing and teaching their other subjects. Consequently, when their students are given time to work on the computer, time is typically spent typing a report that had already been written by hand, or drawing pictures. Such activities add little to increasing students' subject matter knowledge.

Conclusion

The MOE's goal in introducing technology into Palau schools has been to improve the quality of instruction and, in turn, increase student learning. The MOE recognizes that for technology to result in increased student learning many components must operate together. Schools must have:

- adequate technology;
- software relevant to the curriculum;
- people trained to operate the hardware and the software;
- time within the school day allocated to its use;
- incentives that encourage teachers to use it;
- technical assistance to respond to questions and provide help when problems arise;
- means for efficiently repairing equipment when it breaks;
- a training plan for ensuring that new personnel receive training and that continuing personnel can increase their knowledge and skills; and
- an equipment upgrade plan to ensure that equipment is replaced before it wears out or becomes outdated.

Only when these elements work together can technology become a meaningful part of the educational experience of Palau's students. However, the Palau experience also demonstrates that, even when a country seemingly does everything right, other factors, both inside and outside the education system, can affect the country's ability to reap the full rewards of its investment.

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Chapter 5

The introduction of computers in secondary schools in Jamaica: a case of bottom-up reform

Errol Miller

In the 1980s a few Jamaican high schools – the equivalent of secondary schools in other developing countries – (for example Jordan and Costa Rica) began installing computers for use by selected students and grades, (El Hmaisat, 1990; Wolff, 1999). The vision at that time was quite restricted. In the 1990s the situation changed dramatically as computers became more powerful and more affordable, and as the Internet opened previously unknown vistas of communication. This chapter describes and discusses initiatives that made it possible for Jamaica to provide all secondary schools with at least one computer laboratory by the year 2000. This achievement represents a case of bottom-up educational reform that raises questions beyond the confines of information and communications technology applied to education.

Background

Jamaica is a small island with a population of about 2,600,000 people and is the largest of the English-speaking Caribbean countries. Jamaica was a British colony from 1655 to 1962, when it became an independent country. By the late 1960s Jamaica had achieved universal primary education and enrolled more than half of its early childhood population in some kind of pre-school. By the beginning of the 1980s Jamaica had expanded its secondary school system to enrol more than half the population aged between 12 to 17 years. Currently, nearly all children between ages 6 and 15 years are enrolled in school. About 65 per cent of students continue their education until the end of secondary schooling (Miller, 2000).

The Jamaican economy experienced strong and sustained economic growth in the post-World War II period until the first oil crisis in 1975 after which economic growth slowed considerably. Strong economic growth over a 30-year period allowed successive governments to embark on programmes to expand access to education and improve its quality. All levels of the Jamaican educational system were expanded and improved between 1945 and 1975 (Miller, 1999).

In the late 1970s the Jamaican economy went into recession from which it has not fully recovered. Beginning in the late 1970s and continuing into the early 1990s there were several structural adjustment programmes undertaken to strengthen the economy. In the early 1990s the Jamaican economy was deregulated and liberalized; privatization and market driven strategies were emphasized. Between 1998-2000, the financial sector, namely the bank and insurance industries, virtually collapsed, resulting in a huge government bailout in order to minimize the losses to policyholders and depositors. In 2001, 63 cents of every dollar of Government revenue went toward the repayment of local and international debt.

It is against this general background that moves to introduce the use of computers in secondary schools in Jamaica must be interpreted and understood.

The first efforts of schools

Prior to 1990, about ten of the 146 public secondary schools in Jamaica, acting on their own initiative, had established computer laboratories to support instruction. In fact, the Montego Bay High School not only constructed a lab, through the efforts of its PTA, but also was able to, with the support of the Ministry of Education, secure funding from UNDP to purchase equipment and train the teachers. The Ministry supported this initiative as a pilot study of the appropriate use of Computer Assisted Instruction (CAI). While the school made full use of this support, there is no evidence of any follow-up to this initiative or its extension to other schools.

The schools possessing computer labs were among the most affluent schools with strong support from their communities. Computer labs had also been established in two of the eight teachers' colleges and in the College of Arts, Science and Technology (CAST). The computer labs in the secondary schools were mainly used to teach computer science courses to prepare students for the Cambridge GCE Ordinary Level examinations. Computers were also used to support the teaching of business subjects where computers skills were deemed important (Miller, 1996). Approximately 30 other schools had acquired 1 to 4 computers of varied types, mainly as gifts from benefactors. In most instances the computers in this second set of schools were mainly used for administrative purposes.

The introduction of computers in these 40 schools, despite a lack of Ministry policy or provision of equipment, occurred largely as a result of the considerable autonomy that exists in the Jamaican school system. These schools were responding to local demand for computer training and were supported in varying degrees by the communities they served.

The intervention of the Jamaica Computer Society

The Jamaica Computer Society (JCS) is a private non-profit, professional society created in 1974 to promote professional competence, ethics and social responsibility in areas concerned with the application of computers to commercial, scientific and administrative endeavors in Jamaica. The JCS is modeled on the British Computer Society, to which it is affiliated. Membership is open to computer professionals and affiliates in the industry. Annually elected officers, who offer their services on a voluntary basis, manage the society.

In 1989 the JCS became concerned about the inadequate number of appropriately prepared students graduating from the Jamaican school system, relative to the growing demand for computer professionals (e.g. programmers, system analysts, engineers). The shortfall of new recruits was seen as a constraining factor in the desire of Jamaican computer professionals and businesses to keep pace with North America. The JCS came to the conclusion that intervention at the secondary level would be most effective in producing the number of appropriately prepared new recruits that were needed by their profession.

Meetings were convened with secondary teachers of computer science to identify the existing constraints and to formulate an intervention strategy. The first meetings were held in 1989 at CAST. The consultation between the JCS and secondary school teachers of computer science identified three following key constraints:

1. *inadequate pre-service and in-service training for the teachers*. Usually it was mathematics or business teachers who doubled as teachers of computer science. Even though these teachers had some background in computers, they often lacked any pedagogic training in teaching the subject;
2. *limited equipment in the teaching of the subject*. In many cases computer science was being taught in circumstances in which students had very limited hands-on experience given the number of students compared to the number of computers the schools had;
3. computer science was being offered in the Cambridge GCE, which was being phased out, and not in the Caribbean Examination Council, CXC, which was replacing it.

In these circumstances, the consultation concluded that it was not possible to substantially increase the numbers of students opting to take computer science as an area specialization without addressing the constraints identified. In addition, improvement in the quality of preparation of computer science students emerging from high schools required that attention be given to these constraints.

Following further deliberation within the JCS the following strategy was agreed upon and adopted:

1. To establish the Jamaica Computer Society Education Foundation (JCSEF), which would be a non-profit organization, and whose mission would be to support secondary schools in the teaching of computer science through the training of teachers and the provision of adequately equipped computer labs.
2. To approach the Caribbean Examination Council with a proposal to establish computer science as a subject within the complement and to offer technical assistance in its creation through the voluntary contribution of expertise by members of the JCS.
3. To mount in-service training for computer science teachers in secondary schools through the JCFEF and to approach the teachers' colleges concerning the establishment of appropriate pre-service training for teachers desirous of teaching this subject.
4. To promote and provide secondary schools with adequately equipped computer labs through the JCSEF.
5. To invite the public and private sectors to become partners in these endeavours.

Through contributions solicited from some members of the JCS, the JCSEF was launched in 1990. Its mission was the execution of the strategy outlined above. This mission was focused on the interest of the JCS to expand the number of new recruits graduating from secondary schools who could be drafted for further training, ultimately leading to a substantial increase in the number of computer professionals in Jamaica. This mission was totally consistent with the mission of the JCS to promote the interest of its profession, as would be expected of any professional group. Also the secondary school teachers with whom the JCS had had dialogue were interested in obtaining support in serving a need they had identified, but which could not be adequately addressed by their resources.

It should be noted that the JCSEF's first efforts were directed towards mounting in-service training for secondary school teachers of computer science. The first workshops were held in the summer of 1991. The Foundation also had almost instant success with the Caribbean Examination Council, which accepted its proposal for the establishment of computer science as a subject and its offer of technical assistance in developing the same. The Caribbean Examination now offers computer studies both at the General Proficiency and Technical Proficiency levels. Similar success was also experienced with the teachers' colleges. Several colleges training secondary school teachers now offer computer studies as one of the two subjects in which student teachers can specialize.

The provision of computer labs to secondary schools offering computer science proved a more difficult proposition. First, neither the JCS nor the JCSEF had the resources to place more than a few computers in schools already possessing some computer capacity. Indeed, the first donation of 36 computers to schools was done in 1991 to 11 schools that already had computer labs. Second, without the provision of computers in the secondary schools the success achieved in creating a computer science curriculum in CXC and the in-service and pre-service training of teachers in computer science would be undermined. Third, there was little support within the private sector at that time for putting computer labs in schools for the purpose of training students specializing in computers. As Miller (1996) pointed out, several of the firms approached did not themselves have computers in their operations, so could not justify the provision of computers for schools. Fourth, the Ministry of Education had not established this area as a priority.

Notwithstanding these difficulties, the JCSEF did find receptive responses from two sources. First, the HEART Trust responded favorably. HEART Trust is a statutory corporation reporting to the Ministry of Education. Its mission is to promote and provide technical and vocational training to school leavers and young adults. It is supported by a payroll deduction tax paid by all businesses over a particular size as specified by the law according to which the Trust is established. Having examined the mission of the JCSEF, HEART concluded that it could support the former as part of its mandate to promote technical and vocational training for young people.

Second, the JCSEF found support from a very influential CEO of one of the large insurance companies in Jamaica. That company had just completed a project in developing videos to support the teaching of mathematics in secondary schools. Based on that experience, the CEO was convinced that the JCSEF had the potential to make a dramatic impact on secondary education. This CEO volunteered to become the chairman of the Business Partners, which was a group that the JCSEF was inviting to become its ally in providing funds to put computer labs into schools.

Both HEART and the Business Partners had wider interests than providing computer labs for secondary students specializing in computer studies who in the medium term would become computer professionals. HEART and the Business Partners were interested in the potential of computers to improve learning efficiency in schools.

HEART was established in 1982. After nearly a decade of providing vocational training to school leavers and young adults, it found that, while they were successful in providing high quality specific vocational training, the general education of many secondary school leavers was inadequate. In fact, many employers in their feedback to HEART had noted general weaknesses particularly in English and mathematics, which detracted from, or limited the effectiveness of the trainees, notwithstanding their mastery of specific vocational skills. The Business Partners shared both the observations and the concern.

Both HEART and the Business Partners therefore indicated to the JCSEF that in supporting the provision of computer labs in secondary schools, they needed to expand their use beyond the needs of students specializing in computer sciences. In particular, they wanted to use computer labs for delivery of computer-assisted instruction to strengthen basic skills in English and mathematics. As a result, the mission of the JCSEF was revised to include improving the quality of learning in secondary education through the application of computer technology. The Jamaica 2000 project, of the JCSEF, was launched as a means of accomplishing this mission.

The Jamaica 2000 Project

The Jamaica 2000 Project was launched in May 1992 as a partnership between the Government (through the HEART Trust), the private sector (through the Business Partners), and the secondary school community. The overall aim was to improve the quality of secondary education through the used computer-assisted instruction, particularly in English and mathematics. Accordingly, an important target, by the year 2000, was to place at least one fully equipped 15-station lab in all secondary and tertiary institutions. This entailed placing computer labs in each of the 145 secondary schools, three vocational schools, eight community colleges, and ten training teachers colleges. Overall, the target was to place a fully equipped 15-station computer lab in 166 secondary and tertiary institutions: 148 schools and 18 tertiary institutions. Through the Jamaica 2000 Project, JCSEF would assist the schools and colleges in the installation of the lab and provide in-service training for the teachers using the facility.

A formula was worked out among the partners for sharing the cost of establishing the labs. The schools and colleges would be responsible for providing the room for the computer lab, fully fitted with electrical outlets and fixtures to accommodate the computers. In providing the equipment, the Government, through HEART, would provide 40 per cent, the Business Partners would match this 40 per cent, while the school or college community would contribute 20 per cent. Since the schools and colleges had responsibility for providing the physical accommodation, their 20 per cent contribution to the cost of the equipment meant their contribution sometimes exceeded the contribution of the other partners. In effect, the formula for equipping the computer labs in secondary schools and tertiary institutions ended up as about one-third from each group – HEART, the Business Partners and the school or college.

In implementing the Jamaica 2000 Project in 1993 and 1994, JCSEF stuck close to the mandate to improve learning efficiency in English and mathematics. However, several schools and colleges found this limitation highly restrictive and argued for wider use of computers. In addition, development of the multimedia and Internet capabilities during the period supported those who wished for wider application of the technology to learning needs.

In 1995 the JCSEF responded to these entreaties by again expanding its commitment to improve learning efficiency. No longer limited to English and mathematics, their commitment now encompassed the entire range of the secondary school curriculum. Accordingly, workshops were held with teachers to develop appropriate strategies to reach those objectives.

Implementation

In examining the implementation of the Jamaica 2000 Project, it is necessary to separate the work of the JCSEF, operating at a national and central level, from activities at the level of schools and colleges. While the two are interrelated, the dynamics and rhythms were different. While the JCSEF co-ordinated inputs and partners, administered projects from different sources and controlled the purchasing and distribution of equipment, the schools and colleges focused on fund raising, providing labs to house the computers, and matters related to the delivery of instruction.

By May 1996 the JCSEF had placed computer labs into 71 of the 166 public secondary and tertiary institutions in Jamaica. By December 2000 the JCSEF had provided a total of 102 secondary schools and tertiary institutions with 15-station computer laboratories. Hence, the Jamaica 2000 Project fell short of its stated target of 166 secondary and tertiary institutions. While the JCSEF did not achieve its target by its own efforts, the target was achieved as a result of the efforts of schools acting on their own and a co-operative agreement between the Governments of Jamaica and China. Before describing and discussing these additional initiatives, it is necessary to comment on some other important aspects of the Jamaica 2000 Project.

Faced with the rapid changes in computer technology during the 1990s leading to the virtual obsolescence of some of the labs equipped in the early 1990s, the JCSEF offered schools the replacement of labs on the same terms used in equipping the original labs. Thirty-three schools took up this offer and either upgraded or replaced their computers labs. In all therefore, the Jamaica 2000 Project provided schools with 135 fifteen-station labs, although 33 of these were replacement labs in the 102 schools that participated in the Project.

Another of the challenges faced by the JCSEF and the schools and colleges was the maintenance of the equipment after it was provided. Responding to the Y-2K concerns and the problems experienced by schools and colleges in 1999, the JCSEF designed and launched a maintenance service. A Y-2K kit was developed and distributed to the schools at no cost to the schools. The maintenance service included training for technicians employed by the schools and colleges, a Help Desk, online trouble shooting, site visits and preventative maintenance. The service required schools to pay small fees. The JCSEF evaluation of this service in 2000 concluded that it had been ineffective. Many schools made alternative arrangements and did not utilize the JCSEF provisions.

Over the period, the Jamaica 2000 Project trained 400 secondary teachers to teach computer science, 200 teachers to use ICT in the delivery of instruction, 90 teachers as specialists in computer science, and 12 teacher trainers. On an average, the Jamaica 2000 Project trained 5 to 6 teachers in each of the 102 schools in which the computer labs were installed to use the facilities and equipment in the delivery of instruction.

For most years between 1992-2000, the JCSEF mounted exhibitions in the use of computer technology in schools. These exhibitions, which received a great deal of press coverage and attracted considerable public attention, were extremely well supported by schools. They did a great deal to raise awareness about the application of ICT in instruction and school management.

One of the most innovative concepts introduced by the JCSEF was the cluster relationship. In 1994, with funding from the Inter-American Development Bank and later the World Bank, JCSEF launched the Ed Tech 20/20 initiative. This initiative involved putting computers into 20 primary schools for the purpose of improving instruction and raising student achievement. JCSEF then linked 4 to 5 primary schools with a secondary school or teacher training college as the focal point of each cluster. The secondary schools and colleges provided leadership, training and technical support for the primary schools (Miller, 1996).

By virtue of its annual exhibitions that raised public awareness, the Jamaica 2000 Project, the Ed Tech 20/20 Project, and the cluster concept linking primary schools to secondary schools and colleges, JCSEF became the *de facto* leader of the movement to apply ICT to the operations of schools. This non-governmental organization, created in 1990, became the hub of leadership for a grassroots movement to put computers into schools in Jamaica. However, the JCSEF partnership was not the sole provider of facilities for secondary schools and colleges.

Independent initiatives by schools and colleges

The Ministry of Education conducted a survey in April 1996 to determine the number of schools and colleges with computer labs. The survey found that 101 of the 166 secondary and tertiary institutions had computer labs. Hence, with 4 years still to go, there were 65 institutions that still need to be equipped in order to achieve the target of introducing CAI into all secondary and tertiary institutions in Jamaica.

The Jamaica 2000 Project had provided 72 schools and colleges with computer labs; 29 institutions had acquired labs without the assistance of this project. By 2000 a total of 39 secondary schools and colleges had provided computer labs for themselves without external assistance.

Miller (1996) found that, in several instances, institutions could not meet the cash requirements of the Jamaica 2000 Project. However, they were able to tap sources that provided in-kind contributions in the form of computers and sometime entire computer labs. Some of these sources included Past Student Associations, local businesses and parent/teacher organizations.

What should not be overlooked is that approximately 23 per cent of the 166 secondary and tertiary institutions using computers in the delivery of instruction did so independent of the JCSEF's Jamaica 2000 Project. While JCSEF provided vision and leadership in establishing the goal of donating computers to all secondary schools and colleges in Jamaica by 2000, it was not the sole provider of computer labs to those schools.

The Government of Jamaica–China initiative

In 2000, under the Jamaica-China Co-operative Program of the People's Republic of China, 29 high schools were provided with computer laboratories. Through this donation, all secondary schools that had not received computer labs through the Jamaica 2000 Project or through their own initiative received fully equipped computer labs.

The Ministry of Education, Youth and Culture provided special grants to these 29 high schools to allow them to install the equipment, train teachers, and acquire software. This bilateral assistance enabled the goals of the Jamaica 2000 Project to be achieved in 2000, i.e. all public secondary schools and tertiary institutions were equipped with computer labs by the end of 2000.

JCSEF reinvented itself in 2001

At the end of 2000 the JCSEF found itself in the following position:

- It had established an impressive track record in providing vision, leadership and capacity building in the application of technology in classrooms for instruction and school management. It had achieved its objective, even if it was not the sole provider of computer labs to schools in Jamaica.
- The Ed Tech 20/20 project funded by the Inter-American Development Bank and the World Bank was completed.
- JCSEF had implemented a number of other initiatives, but these were unable to sustain its operations.
- HEART had not only provided 40 per cent of the cost of the equipment for the computer labs but had also provided funding for the administrative expenses and overheads of the Foundation. However, it was unwilling to continue to do so, arguing that (1) the objectives of the Jamaica 2000 Project had been achieved and (2) that the Ministry of Education, Youth and Culture had now established its Information and Communications Policy and Program, which addressed several of the areas previously served by the JCSEF.
- The Business Partners had become defunct as a result of the death of the private sector benefactor who had led this segment of the partnership and also because of the depressed state of the private sector in Jamaica following the collapse of the insurance and banking sectors and Government bailout of the same.

In discussion with the Ministry of Education in July 2001, JCSEF agreed that the funds it provided for 2001-2002 should be used to determine whether it could survive without the Jamaica 2000 Project, and if not, to close down the Foundation. JCSEF employed a management consultant to review the options and develop both a plan for closing down and a business plan for continuing to operate. Since JCSEF had ongoing contracts for establishing laboratories and resource services, self-financing teacher training arrangements, and consultancy activities, the Board decided that the JCSEF would continue but would be scaled down to operate within the revenues earned from these sources.

Discussion

The movement to install computers and use information technology and communication to improve instruction in secondary and tertiary institutions in Jamaica represents a classic case of bottom-up educational reform. In 1990 neither the Jamaican Government nor the international community placed any priority on the application of information and communication technology for instruction or school management. They were concerned that developing countries faced far more important issues, such as providing every child with primary and secondary education, providing books, supplying sufficient teachers and upgrading education. Leading analysts regarded the use of computers in classrooms as a blind alley (due to their costs and the need for teachers trained to use them) compared to other promising alternatives, such as good textbooks and teachers' guides (Lockheed and Verspoor, 1991).

This was not the position taken by many teachers, parents and computer professionals who regarded computers as the new symbol of modernity and progress. From their perspective, failure to embrace the new technology was to run the risk of being left behind. The policy of governments and agencies to invite private and public sector partnerships opened the door for these groups to push their agenda in the public school system and thereby counter the official policy position on computers in schools. In discussing this bottom-up case of educational reform in Jamaica, it is necessary to examine the position of several of the actors and stakeholders.

The JCSEF as an NGO actor

The rise and fall of the Jamaica Computer Society Education Foundation, or at least its ups and down, are nothing short of spectacular.

Founded in 1990, it was, by 1996, the acknowledged leader and focal point of the reform to place computers in secondary schools and colleges and to use them to modernize and improve instruction in schools. Having led the country to accept the goal of putting computer labs in every secondary and tertiary institution, the JCSEF, in 2001, began to scale itself down to be a small self-financing service provider removed from the centre of policy-making and programme delivery.

Given the importance that many advocates have assigned to NGOs in promoting educational change, the case of the JCSEF warrants attention. Throughout the history of education, NGOs have pioneered new developments and advocated for their areas of interest. Where advocacy has been successful, NGOs have organized support for their cause. At the same time, their success has often either put them out of business or circumscribed their role to much less than during their pioneering phase. This is because the process of mobilizing strong grassroots support also invariably involves rallying governments to formulate policy and take state action.

In this regard the experience of the JCSEF has been no different from churches and other religious organizations that were pioneers in primary and secondary education or associations that pioneered special education. When these bodies were sufficiently successful in mobilizing the particular sub-sector to the point where the State itself had been mobilized, entry of the State curtailed the role that those bodies previously played as it established policies and programmes in that particular sector.

In its first 5 years of existence, the JCSEF exhibited vision, provided expertise that was not widely available, and mobilized grassroots support for its activities. By the end of the decade the JCSEF vision was shared by virtually all. JCSEF's expertise that had allowed it to set standards and provide technical assistance was much more widely available. The grassroots support it organized was so exhaustive that the State itself was ready for action. Further, the technological developments over the decade made use of information and communication technology in schools as a national and international imperative. All of these undermined the JCSEF's role as the leader and standard bearer of the reform.

Probably, the greatest single factor that undermined the JCSEF's continued leadership was the diminishing support from the private sector.

Through the Business Partners, the JCSEF brought resources to schools that were not available directly to them or to the State. When funds from this source virtually dried up, the resources came from the school community and the State, traditional providers of resources for schools and education in Jamaica.

The lessons learned from the case of the JCSEF as it stepped into the twenty-first century could have implications beyond the JCSEF itself. Indeed, it could portend the fate of successful NGOs in other countries across the developing world. The case of the JCSEF suggests that continuing and sustaining NGO activity in education is most likely to be in areas in which NGO advocacy has had limited effect. When NGO activities are successful, they tend to be taken over by other, more mainstream, institutions.

The private sector and ICT

Given the importance that the international community has placed on private sector partnerships in education, the involvement of the private sector in this Jamaican case warrants examination. The role and impact of the private sector in Jamaica, with respect to the introduction of computers in secondary schools, was not straightforward. Indeed, it manifests several contradictions. In the first instance, in the early 1990s the JCSEF found it difficult to solicit support from the private sector for its vision because many companies had not yet begun to use computers in their operations and were not about to provide them for schools. However, when the JCSEF did succeed in getting private sector support, this was contingent on broadening the vision to include the use of computers to improve instruction generally and not just to prepare prospect specialists in computer science. Further, the Business Partners viewed the introduction of computers in schools to improve instruction as one of the major planks of involvement as partners in the education enterprise. The Jamaican private sector cannot be seen as monolithic but as very heterogeneous. The segment of the private sector that supported the JCSEF could be credited with far-sightedness that anticipated the ubiquitous nature of the information revolution that was occurring.

There appeared to have been two critical aspects to the involvement of the private sector in the Jamaican case of bottom-up reform. First was the influence and inspirational leadership of one of the captains of industry in the country. Second was the general health of the private sector, particularly of the financial sector from which the support had come. The death of the captain of industry that led the Business Partners and the collapse of the financial sector resulted in the demise of private sector support for the JCSEF. Sympathetic leadership and strength of the private sector appeared to have been the pre-conditions of support for bottom-up reform that introduced information and communication technology in secondary schools and colleges. When both of those assumptions were invalidated (for different reasons), the private sector support collapsed.

While the collapse of the financial sector in Jamaica has not attracted the same worldwide attention as the cases of Mexico, Argentina, Russia and the Asia tigers, it was not less real. Questions that still remain to be answered relate to the extent to which adverse conditions in the private sector stymied support for education, and undermined partnerships that were emerging. There can be no question that adverse conditions in the private sector undermined the Business Partners and their efforts to support the modernization of schools and the improvement of instruction through the use of information and communication technology.

The Ministry of Education and ICT reform

Up to the late 1990s, the posture of the Ministry of Education with respect to introduction and use of information and communication technology in schools was one of benign support. Policy-makers and Ministry officials have publicly endorsed the work of the JCSEF, the Business Partners and the schools. However, the Ministry did not embrace the reform as official policy. Indirectly the Ministry supported the reform through HEART, which could not have been such a substantial partner had the Ministry not consented. However, officially the Ministry was not a partner, though it was represented on the Board of the JCSEF, and Education Officers participated in the workshops and other field activities sponsored by the JCSEF. In other words, the reform was not rooted in Ministry policy, projects or programmes, although the Ministry maintained good fraternal relations with the partners implementing the reforms and was mindful and informed of the objectives, content and progress being made. In fact, the Ministry recently appointed an Officer whose responsibilities included information technology applications in the school system.

While Ministry personnel were generally in favour of the reform, and saw it in a positive light, there were concerns at some levels and in some quarters. Some of the concerns were:

1. Several schools constructed or added to buildings without informing the Ministry, whose responsibilities include the maintenance of school plants. In this regard the Ministry's responsibilities were being added to without its knowledge or consent.
2. The national curriculum, at both the primary and secondary levels, could be undermined by some of the software packages that were employed in CAI. From this perspective, the national curriculum was seen as threatened by both the content of some packages and the lack of uniformity of the software packages acquired across the schools.
3. Policy-making was taking place outside the policy-making machinery: market driven educational policy formulation, so to speak. While such an approach may be feasible with respect to one or two areas, some officials viewed, with considerable unease, the prospect of this approach becoming the norm.
4. There was an absence of any regulatory role played by the Ministry of Education to ensure at least minimum standards.

For the most part, these concerns were muted and expressed only by a few members of the Ministry. There were two main reasons for this. First, the Ministry's stated policy was to promote and support partnerships in education. Therefore, to the policy-makers within the Ministry it was totally unacceptable to invite partners and then deny them authentic action. Second, the financial circumstances of the Government and the Ministry constrained capital development from the public purse. To decline developmental assistance in an area that was growing internationally at a time that the Ministry was unable to provide the assistance would have totally destroyed the Ministry's credibility.

It is against this background that the Ministry took the safer role of supporting the initiatives led by a professional body and sustained by the private sector and the school community. The centre of policy-making accepted a marginal role in this reform as it followed the leadership of other stakeholders and actors.

However, from 1997 the situation began to reverse. In his budget presentation for 1997, the Prime Minister announced a government initiative to provide every school with at least one computer with Internet connection. The Ministry of Education, Youth and Culture began implementation and projected the achievement of this goal in 5 years. The initiative was assigned to the Media Services Unit of the Ministry and funding was provided mainly by HEART.

By December 1998 the Ministry had developed a draft Information and Communication Technology policy with respect to its use to modernize schools and improve instruction. This draft policy was widely circulated in 1999. The main objectives of the draft policy were to:

- promote equitable access to educational resources through the strategic application of ICT;
- make all school leavers computer literate thereby providing them with the requisite ICT skills as a platform for imminent employment and/or entry to specialized training for the information economy;
- create a teaching force in which all practitioners possess the critical requisite skills and competencies required to use ICT as a tool in enhancing the teaching/learning process and a cadre of ICT teacher specialists;
- improve the efficiency and effectiveness of educational administration through the promotion of the use of appropriate school management information systems;
- exploit the interactive potential of ICT in the provision of lifelong learning, anytime, anywhere via distance education programmes;
- create smart partnerships for the sustainable ICT Programme through collaboration with and between public, private and community sectors;
- establish a school network system for collaborative sharing of educational resources and stakeholder participation;
- employ the new ICT tools for increased online communication, stakeholder participation and improved management of the sector.

By 2000 the MOEYC included ICT applied to education in its loan proposals to international agencies. For example, the Primary Education Support Project, funded by the Inter-American Development Bank included an ICT component intended to modernize both instruction and management in primary schools.

The Ministry's move to centre stage was facilitated by the collapse of the support for the bottom-up reform from the Business Partners and by the fact that multilateral and bilateral agencies were giving grants and loans for ICT in schools. Indeed, the Ministry's move to centre stage could be seen as rescuing the reform from total collapse. Accordingly, no conflict or controversy surrounded the Ministry's take-over of the bottom-up reform. At the same time the take-over allowed the Ministry to address its long harboured and muted concerns.

International agencies and the reform

By the late 1990s, international agencies had changed their opinion of regarding computers in classrooms in developing countries as a dead end. On the contrary, international agencies had joined the ranks of those who regarded such application to education as cutting edge. Grants and loans almost routinely began to include components related to the application of information and communication technology to the management of schools and instruction within them.

To an NGO like the JCSEF, this change of posture of the agencies had not yet constituted a blessing, primarily for two reasons. First, grants and loans continued to follow the traditional paths of being government-to-government or multilateral agency-to-government operations. Second, in the procurement of services related to the implementation of projects including an ICT component, there is the requirement of international competitive bidding. This does not work to the advantage of a small NGO. Both the World Bank and the IDB had given grants to the JCSEF, which could be classified as business development. However, when the business was developed, the JCSEF seemed to have been forgotten. This is despite rhetoric espousing the worth and value of NGOs in the education enterprise. For the JCSEF this rhetoric had yet to find practical expression in the very area in which it helped to pioneer in Jamaica.

The school community and ICT reform

The schools and their community could be said to have been the most consistent partner and the main beneficiaries of the reform. In the first instance, the schools started the reform process in the late 1980s through their attempts to equip some of their students for the emerging field in information and communication technology. While not envisaging the exact shape and content that would evolve from their efforts, it seems fair to say that the reform process started with about 10 high schools.

The schools have been the main beneficiaries because all the hardware and software provided over the course of the decade now belongs to the schools and are used by them. School-based ownership and management has allowed each school to exercise maximum control of the provisions made to them.

At the same time the secondary schools and colleges, along with HEART, were the most consistent contributors of financial resources to the reform. All secondary schools and colleges were able to find, from one source or another, the resources required to extend or modify their physical plant in order to provide computer labs. In addition, the vast majority of secondary schools and all colleges found their 20 per cent of the equipment cost in the JCSEF scheme or were able to inveigle former students, parent and teacher associations and businesses to provide the equipment. Only 25 of the 148 secondary schools needed external assistance. These schools were located in communities with very limited resource potential.

From this case it would appear that the school community might be an underrated partner in the education enterprise. Certainly, the school community was a more reliable partner than the private sector. This appears to be so as the school community was able to draw on a broad constituency at the local level that often included private sector organizations operating in the locality. The school community includes past students, parents, community organizations, teachers, students and companies with which they do business or who adopt them for different reasons. The main difficulty in finding partners was faced by schools located in very poor communities.

Conclusion

The Jamaica case is about schools initiating, and an NGO leading, a movement to put computer labs into all secondary schools and tertiary colleges in Jamaica by the year 2000. This goal was achieved. The objectives to be achieved changed over time from preparing students to enter the ranks of computer professionals, to using information and communication technology to improve reading and numeracy skills, to using computers to modernize instruction and improve management in schools. In other words, the purpose for putting computer labs into secondary schools and tertiary colleges shifted over the decade of the 1990s and, in the process, broadened and became more comprehensive.

To date there has been no evaluation of the impact of the reform on these various objectives. Putting computer labs in schools and colleges has been perceived as productive. At the same time there are many questions that remain unanswered and should be the subject of future investigations.

- Which students have benefited most from the provision of computer labs?
- What is the frequency of use of these computer labs?
- How many teachers, and in what areas, have been able to utilize computer labs in their teaching?
- How effective is a 15-station computer lab in schools with over 1,000 students enrolled – the case of most secondary schools in Jamaica?
- What is the overall cost of equipping the 166 schools and colleges with computer labs?

The fact is that Jamaica was able to successfully overcome multiple hurdles in putting computers into secondary schools and colleges. But so what? One answer could be that by 2000 Jamaica accomplished what several other developing countries are still seeking to achieve. The question still remains, so what? Probably, the simple answer is that, not only research and evaluations remain to be done, but it is too soon to tell.

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Chapter 6

Distance education in Ethiopia

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The main purpose of this chapter is to analyze the needs, types, effectiveness and challenges of distance education in Ethiopia. The need for distance education in Ethiopia is addressed from six perspectives: expanding access, improving flexibility of education, improving the competence of teachers, improving student learning, reducing educational costs, and strengthening capacity in the education and civil service sectors. The chapter analyzes several types of distance education used in Ethiopia: Interactive Radio Instruction (IRI), print and audio-based secondary education, distance post-graduate higher education, second cycle (grades 5 to 8) primary teachers, and special distance post-secondary programmes for civil servants. The chapter concludes with a discussion of challenges to distance education, focusing on the efficiency and effectiveness of the delivery system, relevance of content and modes of presentation.

Studying the distance education programmes is significant because it helps to identify areas and strategies for improving the programmes, as well as to recognize the accomplishments of successful initiatives. A case study approach using both reactive and non-reactive methods of data collection was adopted to obtain the information. The most useful reactive method was the interview. Non-reactive methods included a review of documents, reports and archives. The study helps identify why programmes are succeeding well or where there is need for improvement.

Background of distance education

The initiation of distance education in Ethiopia goes back to 1967 when the Ministry of Education collaborated with Addis Ababa University to establish a Correspondence Study Unit under the Extension Division of the University. The main purpose of the unit was to develop a Senior Secondary Correspondence Course for adults working in various ministries, factories and military organizations in general and teachers in particular (MOE, 1985). The Extension Division of Addis Ababa University led this programme until 1976. After this period, leadership for these was transferred to the Ministry of Education under the Department of Adult and Continuing Education, and later the Educational Media Agency (EMA). Although the initial development of the Secondary Correspondence Course had occurred the previous year, it was not until 1978 that the Ministry made available six courses (MOE, 1985).

Ethiopia renewed its pledge to deliver education using distance methodologies in the 1990s. During this period, distance education was used to raise student enrolment at the primary, secondary and tertiary levels of education. Currently there are Interactive Radio Instruction (IRI) programmes supporting primary schools, new post-graduate distance education programmes at Addis Ababa University, a new distance education initiative at the Ethiopian Civil Service College, and a new distance education programme for upgrading 21,400 primary school teachers.

The need for distance education in Ethiopia

Interviews and document reviews indicate that distance education is needed in Ethiopia for a variety of reasons (MOE, 1985; MOE, 1999; EMA, 2001*a*). Some of these reasons relate to access, educational quality and educational costs while others are associated with capacity building.

Expanding access to secondary education: Thousands of adults and out-of-school youth are living in the countryside where opportunities for secondary education are not available. Many of these people are anxious to obtain secondary schooling or other types of further education. In order to receive advanced schooling, some people transfer or migrate to urban centres where opportunities for further education are accessible, often resulting in overcrowding in already highly populated urban centres. Distance education programmes greatly reduce the need for out-of-school youth and adults living in rural areas to move to the cities for education.

Improving the flexibility of education with working conditions: There are many reasons why it is difficult or impossible for learners to make use of the available educational opportunities no matter how much they would like to learn or where they are located. For instance, farmers need to care for their fields and cannot attend school regularly. In the evening transport facilities are often unavailable between schools and their homes, and few rural schools have electricity for night classes. Full-time workers have similar problems. Distance education creates opportunities for these individuals to pursue their learning at their convenience wherever they are.

Improving the competence of teachers in primary education: When distance education courses were initiated in 1978, the Ministry of Education found that over 44 per cent of the teaching force in elementary schools (i.e. 10,000 teachers) were under-qualified, either lacking academic or professional competence or both. In the mid-1990s, Ethiopia embarked on a new policy of education, which changed the structure of education. These changes resulted in an even higher number of unqualified primary school teachers.

According to the new policy, the previous 6-2-4 system was changed to an 8-2-2 system. Within the 8 years of primary schooling, the new policy established two cycles. The first cycle comprises grades 1 to 4 while the second cycle includes grades 5 to 8. Teacher training institutes a one-year certificate programme following grade 10 to train teachers for the first cycle, and teacher education colleges (a two-year diploma programme following grade 12) prepare teachers for the second cycle.

As a result of these changes, there was a need to upgrade about 7,738 under-qualified teachers in the first cycle and 21,651 (EMA, 2000) in the second cycle of primary education. The MOE also said that the practice of employing unqualified or untrained teachers would be discontinued, and that teachers would teach only in the cycle for which they were trained. The Ministry recognized that the magnitude of the upgrading requirements for the second cycle was beyond the capacity of the teacher education colleges in the country. Also, the usual summer upgrading courses that had been in use for many years were too limited to meet the training needs. Thus, distance education was chosen as the best alternative to train this large number of teachers in a short period of time at the desired level of quality.

Improving student learning: Improved efficiency comprises one of the five major goals of the Education Sector Development Program in Ethiopia (MOE, 1998). This goal recognizes the high rate of wastage in Ethiopian education. For instance, the drop-out rate in primary education ranged between 13 per cent and 19 per cent over 5 years since 1995. Similarly the repetition rate was consistently around 13 per cent over the same period (MOE, 2000). The rates are significantly higher for grade 1 where only about 50 per cent of the initial cohort is promoted to grade 2. To help address the high drop-out and repetition rates, as well as to make schooling more relevant, the primary school curriculum has been totally revised. Not only is the content more up-to-date and relevant to the needs of the students and the country, but there is also a greater emphasis on student-centred learning, classroom interaction, participatory learning and problem solving. In addition, the radio programmes for primary schools are being redesigned, especially in English, so that the lessons incorporate an interactive approach. Both radio programmes for primary schools and radio and television programmes for secondary schools are distance education interventions that enrich and strengthen the education system.

Reducing educational costs: The national budget allocated to education has increased from 1,383 billion Ethiopian Birr or 13.7 per cent of the total government budget in 1995/1996 to 2,304 billion Birr or 19 per cent of the total budget in 1999/2000 (US $1 = 8.56 Birr). There will be a need for even more financial investment as the government seeks to achieve universal primary education by the year 2015 (currently, the primary gross enrolment rate is 57 per cent). The government is also committed to expanding access to secondary and higher education. The Ministry of Education recognizes that following only conventional methods of education to meet the objectives for expanding the system may not be financially possible for the government. Thus, the Ministry is committed to expanding the role of distance education, as well as encouraging non-formal education and the expansion of private education to help meet the growing needs for education.

Capacity building in the education and civil service sectors: Ethiopia adopted a federal system of government in the early 1990s. This system of government requires that power be shared between regional states and the central government. Within education, the regions now plan for, and administer primary education under guidelines and standards set by the Ministry of Education. The regions also administer secondary education, although the Ministry of Education is still responsible for developing the curriculum and instructional materials at that level. The central government administers higher education. However, implementing these policy reforms at national, regional, zonal, and district levels requires strengthening the human resource capacity. Distance post-graduate higher education was adopted as an important strategy. These programmes focus on providing applicable and useful education geared to the students' specific job requirements. In addition, the learners are able to continue to work while participating in the distance education programme.

In the civil service sector, apart from education, a similar situation prevails. In addition to shortages of trained personnel in a variety of fields, most of the existing employees (80 per cent) are unqualified and below the requirements of their jobs (ECSC, 2002*a*). Employers have indicated that, if employees have the opportunity to pursue higher education through distance education, they are willing to support them (ECSC, 2002*a*).

Types of distance education in Ethiopia

Interactive radio distance programmes for primary school students

Ethiopia has a long experience in providing schools with a weekly supplemental radio programme and a single lesson plan, but the current approach is different because it provides teachers and students with daily 15-minute programmes including daily notes to assist teachers in using the programme and in creating additional language learning activities after the radio broadcast. In addition to the audio programmes for children, there are special audio cassette programmes for first-cycle primary school teachers on how to use the IRI lessons and on teaching methodology for English.

The 1999-2000 Educational Media Agency (EMA) plan envisages the following benefits from the IRI project:

- improved learning of English by grade 1 boys and girls;
- greater skill and confidence in teaching English among primary school teachers;
- laying a strong foundation for maintaining the standard of English language across all regions;
- fully exploiting the educational potential of the radio medium;
- increased integration between EMA and the Regional Education Bureaus in the areas of evaluation and support for teachers in schools.

EMA is introducing the IRI English radio programmes in two stages. The first stage involves the production, distribution and piloting of programmes on cassettes in 1999-2000 and in 2001-2002; the second stage, beginning in 2003-2004, involves broadcasting the lessons nationwide. Accordingly, EMA has produced the radio programmes and the teachers' notes and guides for grades 1 and 2, and has distributed the audio cassettes and print materials to 24 carefully selected pilot schools in eight regions. The schools were selected based on their location and local language of instruction. Some of the most important findings from the formative and summative evaluations of the grade 1 series will be discussed later in this chapter.

EMA, in collaboration with the USAID/BESO Project, initiated Interactive Radio Instruction (IRI) programmes in 1999. The IRI programme has focused on teaching English in primary schools. The daily grade 1 series was piloted during 2001 in eight regions and a similar experiment was completed in 2002 for grade 2. There are plans to complete the English series for all eight primary grades by 2007. In addition, there are plans to develop an IRI series in mathematics.

IRI lessons are distinct from more traditional radio broadcasts to schools in the following ways. First, the radio curriculum is carefully designed to support the official curriculum on a day-by-day basis. Second, since the programmes are broadcast on a daily rather than weekly basis, they provide a much higher level of support and, therefore, have a greater impact on learning. Third, the radio programmes are designed with basic pedagogical principles in mind. Perhaps most importantly, the scripts are written in a way that invites learners to be active participants in the teaching-learning process. Children are asked by the radio characters to respond every few seconds. In most cases, they speak back or engage in simple conversations with the radio characters. At other times, they may read information on the blackboard, refer to physical objects that the teacher has gathered for the lesson, or sing songs. In addition, the radio lessons provide a time for the children to engage in their own basic conversations either with the teacher or among themselves.

The IRI lessons also give greater attention to evaluation. Since the underlying purpose of the lessons is to increase learning, it is common for IRI projects to include summative evaluations in order to measure the impact on learning. In addition, since it is critically important that the lessons be as effective as possible, IRI projects also incorporate formative evaluations in which information is gathered throughout the year, primarily based on classroom observations, in order to improve the quality of the radio lessons.

EMA is charged with improving the quality of English language instruction by producing high quality educational IRI programmes for primary schools. English is the official international language in Ethiopia and is the medium of instruction beginning no later than grade 9. Proficiency in English is critical for studying at the secondary level and above. The IRI lessons produce widespread benefits in primary school language instruction, measurably improving student learning and simultaneously providing teachers with new skills and confidence in teaching this subject.

Distance secondary education

The longest standing distance education programme in Ethiopia is the secondary equivalency programme begun in 1978. The main aim of this programme is to increase access to secondary education for out-of-school adults, youth and women. The programme is administered by the Educational Media Agency (EMA) which produces the print instructional materials and audio programmes, registers students, creates course examinations, and certifies the courses and the total programme.

The programme is print-based, but there are also tutorial sessions approximately twice per semester and audio programmes once a week for each grade level in English, biology and Amharic language. Geography radio programmes will be introduced in 2003. Students also have written assignments during the semester, and send their assignments to EMA in Addis Ababa.

Table 1 reports the percentage of students enrolled in distance education by category of student.

Table 1. Category of students enrolled in distance secondary education

Category of students	Percentage of enrolment
Army members	18.0
Financial administrators	14.7
Teachers	13.9
Unemployed	12.8
Health assistants	11.6
Private sector	9.7
General service workers	4.1
Educational administrators	3.8
Factory workers	3.6
Agricultural development personnel	2.9
Housewives	2.3
Other	6.2
Total	100.0

Source: Educational Media Agency (EMA), Distance Education Panel.

EMA (2001*c*) indicates that this programme has so far reached 13,426 students from a wide variety of backgrounds. The enrolment has increased steadily in recent years and EMA plans to further increase the number of students. Currently there are approximately 8,000 students enrolled, most of whom are in grades 9 and 10. Overall, EMA registers a relatively small percentage of the students studying at the secondary level. Their 8,000 students represent just 1 per cent of the 736,174 students studying in traditional schools. Nevertheless, it is catering to a different group with an average age between 30 and 40. It helps to meet the needs of students who would otherwise be deprived of a secondary education. Although there has been a steady increase in the number of students in recent years, there is also some evidence of drop-out or, at least, delay in progressing from one semester to another.

The content of these distance education programmes is based on seven subjects covered in the secondary school curriculum. Currently EMA is revising its courses in order to meet the new programme set by the government for secondary education. This process will continue until 2005-2006. EMA produces, records and broadcasts 312 educational radio programmes for distance secondary education (grades 9 to 12). It also produces, prints and distributes student guides based on the curriculum. There are tutorial classes conducted twice every year by 30 tutors in selected locations.

In addition to tutorials, guidance and counseling services are provided using letters and the telephone. Thus, EMA uses a multi-media approach where print, radio and face-to-face tutorials converge. However, the mixture is not equal, as print constitutes the major part, followed by radio and tutorials respectively. For instance, printed course materials cover seven subjects from grades 9 to 12 (Amharic, English, mathematics, biology, physics, chemistry, geography and history) while radio support programmes are produced in three subjects (Amharic, English and biology) across these grades. Students are given tests and examinations in order to check the quality of distance education by EMA. Moreover, those who complete their secondary education take the Ethiopian Secondary School Leaving National Examination.

Distance post-graduate higher education

The Faculty of Education at Addis Ababa University initiated new distance education post-graduate programmes in 1999 – M.Ed. programmes in Curriculum and Instruction, and Educational Planning and Management. The main aim of the programmes is to build the human resource capacity of the education sector at national, regional and zonal levels. The programmes are a collaborative effort among the Ministry of Education, Addis Ababa University, and the USAID/BESO Project. The focus of the Masters programme in Curriculum and Instruction is to strengthen the capability of trainees in curriculum development and implementation; the Educational Planning and Management course focuses on the preparation of able and creative leaders for planning and implementing effective educational policies and programmes. *Table 2* reports student enrolments in post-graduate distance programmes for 1999-2001.

Table 2. Student enrolments in post-graduate distance programmes (1999-2001)

Programmes	1999		2000		2001		
	Female	Male	Female	Male	Female	Male	Total
Curriculum & instruction	2	19	1	15	1	9	47
Educational planning & management	2	21	1	23	-	24	71
Total	4	40	2	38	1	33	118

Source: Distance Education Co-ordination Office, Faculty of Education, Addis Ababa University.

These programmes offer courses and require writing a masters thesis. Courses are delivered using both face-to-face (residential) and distance methods. Residential courses are considered as prerequisites for the instructional process and are conducted in two summers for 16 weeks. The learners study the distance education courses while continuing to work. They are supported by tutorials in five distance education centres. Students are also provided with printed course materials consisting of Modules and Set Readers. Tutorial centres are being equipped with computers, fax machines, books, television sets and video decks. The objective is to enable students to do their courses with minimal dependence on instructors and tutors by using the self-instructional modules and these technologies.

Distance education for second cycle (grades 5 to 8) primary school teachers

The main goal of this programme is to assist the regions in strengthening the standard and quality of the teaching force by upgrading all untrained second cycle primary school teachers through distance education. This programme also aims to enable teachers to understand the development plans of the country and to increase their participation in community affairs. As previously indicated, this programme is derived from the Ethiopian Primary Education policy, which changed the former structure of 6 years of primary schooling to an eight-year system. As a result of this change, teachers who were previously qualified to teach in primary education were faced with an immediate need to upgrade themselves in order to be qualified.

The programme is co-ordinated by the Educational Media Agency (EMA), which is a semi-autonomous agency of the Ministry of Education. EMA's facilitation role for the distance teacher upgrading programme involves the following:

- co-ordination with the Ministry of Education, the colleges of teacher education, the regional education bureaus, and the USAID/BESO Project;
- setting standards for the programmes;
- training university and college staff on writing distance education instructional materials;
- editing, typesetting, printing and distributing of these materials;
- procuring and equipping the 108 teacher resource centres;
- providing guidelines for the tutorial system that are administered by the regions and the colleges of teacher education;
- providing overall co-ordination for training the tutors, which is then carried out by the regions;
- helping to organize and develop the end of semester examinations;
- evaluating the programme.

Universities and teacher training colleges play a key role in the distance education programmes. Ten higher education institutions and teacher training colleges are participating in the programme. In each college there is a distance education unit that is responsible for co-ordinating the training programme, registering and maintaining data on each of the students, training the tutors and guiding the tutorial centres, and evaluating and certifying teachers upon their successful completion of the programme.

The number of credit hours for the distance education programme is less than in the traditional programme because the teaching experience of the participants is taken into account. Face-to-face sessions are held every six weeks, and tutors correct assignments and give feedback. Currently there are 21,400 trainees in these programmes from ten regions. About 84 per cent of these trainees are male while 16 per cent are female. Two-thirds of the courses in this distance education programmes are delivered only through print and the rest are delivered by print and audio cassettes.

In addition to MOE resources, the main source of funding has been the USAID/BESO Project, which has covered payments for the development and printing of the course materials, for the tutorial programme, and for the final semester examinations. Currently, trainees have completed the first year of their studies.

Distance post-secondary education for civil servants

The new distance education programme recognizes that 80 per cent of the civil servants in Ethiopia are at or below grade 12 in terms of educational attainment (ECSE, 2002*a*) and that opportunities for upgrading skills and qualifications are limited. In 1995, for example, the total number of civil servants in the country was 336,227 of which only 1,696 had benefited from any form of training (Ibid). Such low level of education of civil servants seriously hinders the ability of the government to provide quality services to the public. But addressing such a nationwide problem using the conventional mode of delivering education was unrealistic. An innovative distance approach with all its advantages of meeting the trained manpower needs of a country was required.

The Ethiopian Civil Service College (ECSC) is a specialized college with the vision to become a premier centre for training, research and consultancy for the civil service sector. The College was established in 1995 and after several years in development, has created a distance learning institute and the infrastructure for distance learning (ECSC, 2002*b*).

The World Bank is the major supporter for developing this sector of distance education in Ethiopia. It has provided the ECSC with membership to the Global Development Learning Network (GDLN), which is based at the World Bank in Washington, DC. This makes Ethiopia one of the ten countries in Africa that benefits from the highly advanced technology-based learning. The Ethiopian Global Development Learning Network Center (GDLNC) is a node in this global network of training and learning, with full multimedia (voice, video and data) connectivity to knowledge around the world. The Centre is furnished with state-of-the-art broadband satellite transmission capability for data and video conferencing in which images and words are captured in real time. It can send and receive distance learning programmes, activities and events through synchronous (communication in real time) and asynchronous (flexible learning time) modes of communication. Learning with one-way or two-way video integrated with print, audio and computer is possible.

So far the potential of this technology has not been fully explored. However, using the Internet and video conferencing, it draws quality programmes mainly from the World Bank Institute (WBI) and other sources to provide three learning programmes: courses, seminars and global dialogues. Courses are training packages designed to enable policy-makers, development practitioners and agents of change to attain specific learning outcomes. These courses can be sponsored inside or outside Ethiopia, but students pay a fee to participate. Seminars are short duration courses that focus on specific issues or skill sets that need to be developed in response to immediate, short-term problems or opportunities. Global dialogues are programmes that provide opportunities for experience sharing with leading experts around the world.

Recently, the Ethiopian Civil Service College concluded a US $4.9 million loan with the World Bank to improve its distance education programmes. It is planning to develop a range of different distance learning approaches to reach a large audience in Addis Ababa and in seven regional centres. Some of the planned activities in the Global Distance Learning Project document (ECSC, 2002*c*) include upgrading the existing video conferencing and Internet link at the College, satellite rental, facility maintenance, establishing video and Internet links with five regional centres, installation of computer and other equipment in regional centres, preparation and initiation of printed distance learning in nine regions, and the evaluation of alternative distance learning approaches.

Out of these distance education programmes in Ethiopia, only three have been evaluated for effectiveness, IRI English programmes in grade 1, those in secondary education, and those in post-graduate higher education. The other programmes are still in the initial stages of implementation or have not been fully evaluated. The evaluation shows mixed results and indicates where distance education programmes in Ethiopia can be improved.

Evidence of effectiveness of distance education in Ethiopia

Effectiveness of IRI English programmes in grade 1

The introduction of Interactive Radio English programmes for grade 1 in Ethiopia included formative and summative evaluations. Nekatibeb (2001) reports that the focus of the formative evaluation was to assess the micro-implementation of the IRI programmes. This evaluation was carried out in eight schools in eight regions from January-June 2001. Data were collected from multiple sources using several instruments including teachers' daily formative school observation questionnaires, zone media supervisor reports by telephone, external evaluator observation reports, focus group and workshop discussions, and written reports by zone media supervisors.

The major goal of the summative evaluation was to assess the extent to which IRI programmes were academically effective as compared to non-IRI classes. An experimental research method was adopted for the study using an English Listening Comprehension Test as an instrument for data collection.

Major findings from the formative evaluation indicate five main trends.

- First, there was a clear indication from teachers' classroom observation forms that the use of the IRI programmes in the classrooms was high.

EMA produced and distributed 124 programmes to each teacher. This meant that a total of 992 uses were expected from all schools. The achieved level of use was 79 per cent or 787 programmes. In five of the eight regions studied, the rate of utilization ranged between 83 per cent and 98 per cent. In the remaining three regions the rate of utilization ranged between 42 per cent and 79 per cent. In these three regions, the reasons for low use relate to wastage of instructional time such as the closure of schools by special government decisions and national examinations.

- Second, IRI programmes were positively evaluated by the users.

A majority of external and teacher evaluations indicated that the clarity of lesson objectives, appropriateness of content, relevance of the programmes to children's lives, the voice of radio characters, clarity of language in scripts, and the appropriateness of programmes to student ability were of a high standard. Written reports and oral testimonies showed the same trends (Leigh and Nekatibeb, 2001).

- Third, IRI enjoyed strong school support from the principals.

A school principal in the southern region of Ethiopia said:

... The programme is designed to improve the falling standard of the English language and I think it's a timely answer to this burning issue. It helps students to improve their language skills. The programme goes with their age and mental development. It's also a good way of practicing the student-centred approach ...

- Fourth, students, parents, teachers and community representatives ascertained that IRI programmes improved students' cognitive development.

  A parent said the following:

  I have a son in grade 1 and his elders in other grades. When I compared him with his elders, I discovered that he knows more names of animals, materials, sound of animals, and things in the environment in English than his elders. He also has good handwriting and makes no spelling errors. I did not know that he is in this special class, but now I realize the reason.

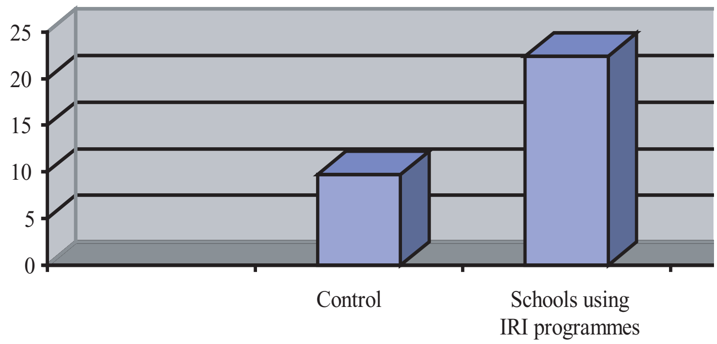
There were several such statements, which indicated agreement among users that IRI grade 1 English radio programmes were useful for students' academic gain and behavioural change.

- Finally, teachers also strongly indicated that IRI English radio instruction was extremely useful for their own professional development.

Most expressed the view that IRI requires more reading and adopting new styles of teaching unlike conventional teaching. They mentioned that IRI classes demand special preparation. From these perspectives, teachers think that IRI has a positive impact on teachers' knowledge and practices. Some even said that IRI is teaching them as well as their students. They told how their conversation, vocabulary, communications and knowledge of songs improved immensely. IRI teachers also noted that IRI helped to reinforce the use of teaching materials, the participation of students in the lessons, how to systematically conclude the lessons, and to base lessons on didactical rules. Teachers said that IRI helped them to adopt lessons to students' ability, encourage students to learn, develop appropriately planned lessons, correctly pronounce words, and make classrooms more participatory and student-centred.

Findings from the summative evaluation also indicated that there is a huge potential for IRI to improve students' learning in Ethiopia. Nekatibeb (2001*b*) reported that students who used IRI programmes gained 22 per cent as compared to 9 per cent in control schools, which did not use these programmes. Thus, IRI is more effective than traditional instruction in improving English learning. The following graph shows the learning gains in control and experimental schools.

Figure 1. Learning gains (%) in schools using IRI programmes



Source: Nekatibeb (2001*b*).

The summative evaluation also showed other important trends, which may have useful implications for policy-making, including the following:

- IRI programmes increased learning gains equally in urban and rural schools;
- female students learned more through IRI than did male students;
- IRI reduced gaps in academic performance between different age groups;
- IRI reduced the gaps in academic performance that may occur between self-contained and linear approaches to classroom organization;
- IRI eliminated differences in learning gains due to teachers' levels of experience;
- overall learning gains were higher in IRI than non-IRI conventional instruction in all regions.

Distance education secondary programme

The success of the distance education secondary programme is indicated by the number of enrolled students, the number of students taking the grade 12 Ethiopian School Leaving Certificate Exam (ESLCE), and the success rate on the exam. Data on the exam results are not available; however, data on the number of students taking the leaving exam shows a projected 500 per cent increase since 1997.

This data is significant because this is the same national exam given to all secondary students in the country. Thus, the distance students who pass the exam can be considered comparable to students who pass from traditional secondary schools. However, the distance education students are considered to be private students. One consequence of this classification is that the students must have a higher grade point average to be admitted to the University. The results on the examinations are retained by the National Organization for Examinations and EMA does not have a record of the pass rates.

Some indications of continued success of the distance education secondary programme are as follows:

- The programme has been in existence for 24 years.
- The enrolment of students has steadily increased over the years.
- The number of students taking the grade 12 examination has also steadily increased.
- Students take the same grade 12 leaving examination as all other secondary students, meaning that the students must meet the same standards as traditional students.
- The programme enrols students considerably older than secondary-age students, indicating that this programme is catering to populations who have needs that cannot be met in traditional secondary schools.
- The distance education self-instructional materials are good and are supplemented by occasional tutoring, written assignments, and radio programmes in some subjects.

There are other indications that the distance education secondary programme can be improved and have the potential to serve an even larger number of students:

- Although the number of students has increased steadily, especially in recent years, the number of distance education students remains relatively small as compared to traditional schools (about 1 per cent of the enrolment in traditional secondary schools). The gross enrolment ratio for secondary education is only 13 per cent and, therefore, there is much potential for enrolling students.
- Because the programme remains highly centralized in a large country, the turnaround time for correcting and returning written assignments is long – usually 2 months or longer. To be an effective programme, it must become more efficient.
- There is also some drop-out or, at least, delay in progress from semester to semester and from year to year.

There are also some unknown factors regarding the future of the programme. For example, there is uncertainty regarding the future prospects for grades 11 to 12 as a result of the recent change in school structure whereby most students will complete their studies at grade 10. Only a few students will continue on the academic track to grades 11 and 12. A few will enter a teacher training institute, but most will be expected to attend technical and vocational schools.

Effectiveness of post-graduate higher education

A major indication of success is that the completion rates for the first two cohorts of distance education learners were very high. For the cohorts completing their studies in 2001 and 2002, over 80 per cent of the initial students graduated with the M.Ed. degree. For more details on the first cohort, see *Table 3*. This table indicates that three of the four females (75 per cent) who were enrolled completed their studies and 33 of the 40 (82 per cent) male students obtained their degrees as scheduled. The fact that females show such effectiveness is encouraging, given the very low level of women's participation in higher education in Ethiopia. In general, the high completion rate of students may be explained in terms of the motivation and maturity of the students.

Table 3. Rate of completion of post graduate distance education in 2001

Programme	Enrolment		Completion		Completion rate (%)
	Female	Male	Female	Male	

Curriculum and instruction	2	19	2	14	76
Educational planning and management	2	21	1	19	87
Total	4	40	3	33	82

Source: Distance Education Co-ordination Office, Faculty of Education, Addis Ababa University.

There is no difference in terms of cost for regular post-graduates and distance post-graduates; the tuition fee at the University of Addis Ababa is the same. However, what makes distance post-graduate education particularly cost beneficial is the fact that students learn while they are working. Regular post-graduates leave their jobs and they are paid their salaries during their studies. Moreover, since their jobs have to be covered, it requires employing another person with a similar salary.

The academic requirements of the distance post-graduate programme are comparable with the regular post-graduate programmes. Course work, passing marks in all courses, thesis writing, and thesis defense as well as attaining a CGPA (Cumulative Grade Point Average) of 3.00 or better (out of a 4-point scale) are required. A comparison of regular and distance post-graduate programmes Cumulative Mean Grade Point Averages (total CGPA divided by the respective total numbers of graduates) for the year 2001 gives some evidence of effectiveness of the distance post-graduate programmes.

Table 4 indicates that both types of Masters Degree students achieved similar results. Although achievement level of distance students in Curriculum and instruction was slightly lower than students in the regular programme, the distance students in Educational planning and management did a little better than the regular students. These differences are not statistically significant but encouraging nonetheless. Thus, the distance learning programme can be considered to be as effective as regular instruction. *Table 5* presents achievements of both groups of students in thesis work.

Table 4. Academic achievements of distance and regular post-graduate students in course work (2001)

Programmes	**Cumulative mean grade point average for the programme**

	Regular Masters	Distance Masters
Curriculum and instruction	3.66	3.46
Educational planning and management	3.54	3.49

Source: Record Office, Faculty of Education, Addis Ababa University.

From the above results it can be concluded that the distance education programmes appear to be as effective as regular programmes despite the fact that distance learning is only at its beginning stage. *Table 5* indicates that in the Department of Curriculum and Instruction regular post-graduates achieved 'Good' grades or higher while none received a lower grade. A few of the distance post-graduates achieved 'Satisfactory' grades. But it has to be understood that the numbers in both groups were small and a shift in just one or two students could make a big difference in the results. In the Educational planning and management programme, the distance students rated higher than the regular students (*Table 5*).

Table 5. Rating of Masters dissertations by examination boards (2001)

Rating categories	Achievement by regular post-graduates (%)		Achievement by distance post-graduates (%)	
	Curriculum and instruction N=9	Educational planning and management N=12	Curriculum and instruction N=16	Educational planning and management N=19
Excellent	22	8	19	37
Very good	11	75	50	47
Good	67	9	12	16
Satisfactory	-	8	19	-
Fail	-	-	-	-
Total	100	100	100	100

Source: Record Office, Faculty of Education, Addis Ababa University.

Challenges and future directions for distance education in Ethiopia

Except for the Interactive Radio grade 1 English programme, there are very few credible evaluations. However, from the available reports some issues seem to cut across the programmes. These include the efficiency and effectiveness of the delivery systems, the appropriateness of content, and the mode of presentation. The key issues are summarized below:

- Based upon a wide range of interviews, EMA (2001*b*) reported that a major initial difficulty was the lack of people who could write well in English.
- A recent report by the Faculty of Education (2002) indicates that distance-learning materials are not properly edited. There are typographical errors, content duplication, omitted pages, disjointed pages, and poor photocopying.
- Tutors in teacher upgrading programmes have to work with a larger number of participants than they had planned.
- Tutors and learners in the post-graduate programmes lacked proper orientation.
- Teachers and post-graduates reported that instructional materials and modules do not arrive on time, in the right sequence, or in the quantities that are needed.
- Post-graduates indicated a lack of dynamism and variety in the assignments. Some students indicated that materials did not live up to their expectations.
- Face-to-face sessions in the teacher upgrading programme were reported to take place with varying commitment and quality.
- In addition, learners indicated that the location of the tutorial centres was not optimal and, in the case of the post-graduate programmes, the centres were not well equipped.

EMA's report further indicates that the content of modules is not consistent with the curricular demands in primary education. The post-graduate students indicated that their modules were packed with too much information. In both cases, learners indicated that some modules require students to use reference books that are difficult to find.

Although there has been significant progress in using distance education in Ethiopia, the potential is only beginning to be realized. In the Civil Service programmes, it was reported that the capacity of the technology already acquired has not been fully exploited due to lack of skills, supporting infrastructure and prior planning. It was also reported that planning for using the technology began after the hardware was obtained. Regarding the primary school upgrading and post-graduate distance education programmes, the students indicated that regional and zonal education bureaus had not provided the necessary financial and moral support for the face-to-face and tutorial sessions. In addition, the distance learners reported that they did not have a reliable and dependable means of communicating with the tutors and co-ordinators when they were at a distance.

The prospects for future development of distance education in Ethiopia and the increased use of technology are bright. There is already some use of the WorldSpace technology, which broadcasts digital audio and data from the AfriStar satellite. Currently EMA is testing the use of this technology by receiving radio programmes in a few primary schools. They also have plans to test the digital data download capabilities as part of a teacher support system. Materials for teachers would be identified or developed at EMA and then uploaded to the AfriStar satellite. This information would then be downloaded to teacher resource centres or teacher education institutions across the country. This technology is already being tested as part of the African Virtual University in Ethiopia whereby information on the Java programming course is delivered by satellite broadcast to the WorldSpace radios.

The government is also closely looking at the possibility of using television satellite broadcasts to support secondary education, vocational and technical education, teacher education, agriculture and other areas. Addis Ababa University has also recently established a fiberoptic backbone for its computer network, and there are plans to install similar networks at the other universities in the country and then to link them. Addis Ababa University has also recently established the Continuing and Distance Education Division. One of their departments will focus exclusively on creating and supporting distance education across the university. Currently the M.Ed. programme described in this chapter is the only distance education programme at the University, but other programmes are likely to develop soon.

The Ethiopian Internet Center is expanding Internet access to more cities and towns, which will increasingly enable this technology to be used in support of education. The USAID/BESO Project is helping to establish Internet connectivity at all of the twenty teacher education institutions in the country where the telecommunication infrastructure permits. Training has begun on how the Internet can be used as a major resource to the teaching staff. At least one of the colleges has developed its own web site. Although recently the Internet tariffs have been sharply reduced, the cost will continue to be a constraint for public education.

The UNESCO International Institute for Capacity Building in Africa (IICBA), based in Ethiopia, is providing programmes on distance education in collaboration with the Indira Gandhi National Open University. In addition, IICBA has established links among teacher education institutions across Africa and, along with the BESO Project, plans to examine the potential of the WorldSpace technology to strengthen teacher education institutions in Ethiopia.

Summary and discussion

Distance education in Ethiopia is used to expand access, adapt education to work conditions, increase teacher competency, improve student learning, reduce educational costs and strengthen human capacity. These goals are consistent with findings of Lockheed and Middleton (1991), who have summarized the main purposes for which technological alternatives to schooling have been used in developing countries over the last three decades.

There is a much potential for expanding distance education in Ethiopia. So far the sectors that are covered by distance education are secondary education, primary teacher education, post-secondary, and post-graduate higher education. Primary education is extensively covered by providing radio programmes to the formal school system. However, there is no use of distance education at the primary school level for out-of-school children. This finding is consistent with Nettleton (1991) who reports that primary education is less emphasized in distance education mainly because of the need for greater supervision for young children. Given the current limitations to secondary and tertiary education, distance education is likely to expand significantly at these levels in order to help meet the demand for education.

Although more studies on effectiveness are required, the available evidence indicates that the distance post-graduate and interactive radio instruction programmes in Ethiopia at present are academically effective. For example, the IRI programmes help to close disparities of different kinds in the educational system. These findings are consistent with the results of studies in many countries (Bosch, 1997; Tilson, 1991; Arnott *et al.*, 1993). Thus, the benefits of IRI can be extended nationwide. The positive results from the distance post-graduate programmes are exciting because they suggest great potential for expanding the benefits of distance education at the tertiary level.

Despite the notable successes of distance education programmes in Ethiopia, there are challenges that require attention. These are the efficiency and effectiveness of the delivery systems, the appropriateness of content, and the lack of readiness and proper communication among the actors. Unless these challenges are properly addressed, the emerging use of distance education in Ethiopia may not reach its potential. Nevertheless, given the impressive growth of distance education programmes in the last few years, and the commitment of senior officials to use this mode of delivery, the prospects for using distance education to expand access and to improve quality at all levels is promising.

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Chapter 7

Sustainability and interactive radio instruction: why some projects last

Andrea Bosch

After 25 years, Interactive Radio Instruction (IRI) continues to demand the attention of educational planners and researchers around the world as an effective use of educational technology to improve the quality, equity and access of education for students in poorer countries. The record also suggests that IRI projects have shown the ability to endure long after the pilot projects and the initial development stages have been completed. In Africa, Asia and Latin America, of 30 significant IRI projects that have been designed over the past 3 decades, 21, or roughly two-thirds, are currently being used as part of a formal or non-formal learning system. In five of these cases, where smaller projects were initiated, few details are known about how they have or have not evolved. Of the remaining 27 projects, in five countries, one or more series was sustained in its original form for at least a decade with tens of thousands of learners benefiting each year. In nine IRI projects, over 500,000 students have benefited, and in six of the 27 IRI projects, more than a million rural and urban students have participated in learning through an IRI project.

While these figures suggest that sustainability is possible both in terms of the reach and longevity of individual IRI programmes and in terms of a persistent interest in IRI as a response to poor educational quality, sustainability remains a challenge and not all countries have experienced equal success. Some pilot projects have met insurmountable obstacles due to recurrent costs, poor institutionalization, insufficient local ownership, or changes in policies or political leadership. Even with repeated demonstrations of learning gains, narrowed equity gaps and significant investments during development stages, some projects have not been sustained beyond a few years after external funds are phased out. This inconsistency presents a conundrum to researchers and planners planning to use an educational technology such as IRI to improve the conditions of education in developing countries: why do some efforts last while others do not?

This document reviews the lessons of sustainability of IRI projects over the past 25 years so that educational planners and researchers interested in the application of IRI and other technologies for education in developing countries can better understand how to best plan ahead, how to predict pitfalls that might exist, and how to best avoid them.

What is interactive radio instruction?

Interactive radio instruction is an educational strategy that was first developed in the early 1970s in Nicaragua by Stanford University with funds from the US Agency for International Development (USAID). It combined the widespread reach of radio and instructional benefits of active learning pedagogy to improve and standardize the educational quality of mathematics instruction for primary school students. Programmes were broadcast into first grade school classrooms across Nicaragua and were used on a daily basis by students. Unlike other distance education models, IRI programmes included stories, activities and exercises and required the students to participate and respond during short and regular pauses that were embedded in the radio lesson. Programmes were segmented and educational skills were distributed across a year's curriculum, based on knowledge of mathematics instruction and strategies used in popular television series in the USA, such as *Sesame Street*. The instructional design ensured that the subject matter was organized and well taught and the intermittent pauses actively engaged the students in the learning process.

The early experimentation with IRI had repercussions in the field of educational technology in the 1970s, particularly within the USAID community. Soon other related IRI strategies were developed that emphasized other subject matter, educational obstacles, learning environments and age groups. After 25 years, the original model of IRI mathematics developed in Nicaragua has been adapted in five countries and a new series that had emphasized other subject specific strategies has been developed for mathematics, English, Spanish, Portuguese, French, environmental education, science, health, early childhood development, reading, hands-on teacher training, adult basic education and junior secondary. Support for IRI development has been diversified across a broader range of donors, foundations, and governments and interventions have been crafted for specific educational conditions.

Most recently, IRI learning systems have been designed to address some of the key educational issues of the last decade, such as the number of students and teachers devastated by HIV/AIDS in Africa, the lack of educational resources among refugees and rural children, the persistent lack of quality in primary education in poorer countries, and the need for educational programmes for older students and adults who are out of the formal school system. In each case, a basic pattern of development for IRI learning systems has been followed to create an interactive educational radio series that uses local games, stories and songs to guide learning and focuses on the educational challenges of that environment, whether it is lack of teachers or teacher training, multiple languages, large class size, isolation, or a basic lack of educational resources, knowledge and training. (A list of IRI projects and information about their sustainability is included in *Appendix 1).*

Where have IRI efforts endured?

Over the past 25 years, IRI projects have endured in different ways and for different lengths of time (*Figure 1*). In some cases, IRI programmes are still broadcast or used on cassette in much the same way as they were originally intended, and the number of beneficiaries continues to increase. The series and approach may have been institutionalized on a national level or integrated into a training and implementation system that had not changed sufficiently and which could not sustain the original delivery system. In other cases, series that were originally planned to be delivered on a national level may now be delivered on a regional, municipal, district or school level due to decentralization strategies, privatization of communication systems, or changes in educational trends that forced the delivery system or scheme for covering recurrent costs to change. In a couple of cases in Bolivia, private or religious organizations have picked up the responsibility of delivering programmes when the government did not. Still other programmes were abandoned prematurely due to poor planning or unforeseen circumstances.

Of these projects, it is no surprise that three of the first four efforts to use IRI were not sustained at a substantial level for more than a few years. These projects concentrated much of their time on the research to improve the quality of education through active learning and then confronted political obstacles such as revolution in Nicaragua and a lack of government preparedness to cover recurrent costs in Kenya. The issues related to sustainability were either out of project control or not well understood at that point.

The bigger surprise is that the fourth IRI attempt in the Barahona region of the Dominican Republic has lasted 2 decades and, after 21 years, community demand remains strong and educational planners are again considering investing in increasing the scale of its use (Miranda, 2002). Four international IRI projects – Papua New Guinea Science, Honduras mental mathematics, Bolivia mathematics and Lesotho English – represent efforts that broke new ground by introducing inquiry in learning, were sustained for long periods of time, and reached from 500,000 to a million students. As this group of IRI projects began to address difficulties related to sustainability, the 1987 Honduras mental mathematics project attempted a public-private sector collaboration scheme to distribute costs that was probably ahead of its time in Honduras and did not succeed. The 1987 IRI English project in Lesotho introduced a tax to pay for recurrent costs associated with the programmes, a system that continues to secure this project. These projects set the stage for planning for sustainability.

Figure 1. Sustainability of interactive radio project initiatives

Delivered in original form	Adapted in new form	Abandoned	Pilots
1. South Africa English	1. Thai mathematics (cassettes hilltribe area)	1. Nicaragua mathematics	1. Haiti mathematics/ literacy
2. Honduras Adult Ed.	2. Honduras Mental mathematics (revised and rebroadcast after 10 year hiatus)	2. Kenya English	2. Costa Rica English
3. Dominican Rep. Integrated	3. Bolivia mathematics (broadcast locally on smaller scale)	3. Costa Rica Envir. Ed.	3. Zambia English/ mathematics
4. Lesotho English	4. Bolivia Health (broadcast locally)	4. Guatemala mathematics	4. Nepal dual audience (teachers and students)
5. Nepal ECD*	5. Papua New Guinea science (broadcast locally)	5. El Salvador mathematics	5. Ethiopia English
6. Bolivia ECD*			6. Honduras jr. secondary
7. Guinea French/ numeracy			7. Nigeria literacy/ mathematics
			8. Somali refugees mathematics/ literacy

* ECD = Early childhood development.

The chart represents 26 projects where current knowledge is available about the use of the IRI programmes. Projects missing include Indonesia teacher training, IRI for girls in Bangladesh, Costa Rica English and Portuguese and mathematics in lusophone Africa.

Based on these early successes, nine pilot projects using IRI were started from 1990-1992. Five of them were in Latin America and seven were funded by USAID. Three of them were relatively small efforts that received very little financial support. Of the nine, six of them were used effectively for a while, but were not sustained. Two of them became large sustainable projects – Honduras adult basic education and South Africa English in Action. The others may reemerge but currently remain dormant. This period may represent a stage where the enthusiasm outweighed the time, expertise and funds dedicated to the development and careful planning of an IRI initiative. It also immediately precedes a period where donors decreased funds to certain areas, and governments were tightening their belts. This may represent a dearth of funds that were counted upon. It is unknown exactly why so many of the projects that were developed at this time were not sustained, but it does represent an unusual period in IRI's short history that does not appear to be consistent throughout the 25 years.

Over the following 10 years, 13 IRI projects were developed. Ten are currently being used in their original form. The current status of one is unknown. Two are not being used. The projects ranged in size, audience, subject matter and region, and there was no particular pattern to their development. Progressively over this period, shifts begin to take place where projects were located. Within the last 2 decades, the majority of IRI efforts were concentrated in Latin America where there has been a long history and receptivity to radio education. More recently, an increasing number of projects have been implemented in African settings, where educational budgets are smaller per student, where situations of poverty and teacher training have not improved over the past few decades, and where IRI represents one of a few viable options to increase educational quality. Of the nine attempts to use IRI in Africa, five of them have been in the past 5 years. Five of them have been introduced in environments characterized by multiple mother tongues, multiple ethnic groups and low levels of literacy. These environments present different demands and challenges in the design of IRI programmes and in the plans for their sustainability.

What is sustainability in this context?

If sustainability is a difficult term to define in general, it is even more difficult within the education sector. The goals and benefits of learning extend into every realm of life, have a long-term impact, and are difficult to isolate. There are several ways to interpret sustainability and, more often than not, the definition has been too narrowly focused on institutionalization, to the detriment of assessing the benefits that are gained by the student or the educational community in both the short- and long-term. Rarely are programmes expected to adapt over time and be replaced or updated in order to sustain benefits. This broader definition, which analyzes the effectiveness of an intervention to deliver benefits, along with its ability to endure, extends and complicates the more generic view of long-term institutionalization. As a result, the concepts related to sustainability are often confused and misrepresented.

In *The Sustainability of Investment Projects in Education*, the World Bank (1990) elaborates a useful operational definition of sustainability, distinguishing it from institutionalization by attention to a continued flow of economic or social returns to beneficiaries. Sustainability involves the continuation of benefits, such as improved teacher-student ratios, materials, achievement scores and cost-effectiveness, and qualitative indicators such as increased curriculum and project relevance to educational needs and changes in subsequent educational practices. The definition includes the ability of a project to be flexible or adapt to changing circumstances and educational needs, and to produce beneficial side effects. Such side effects include changes in the way that teaching and learning is perceived, planned, and practised, and changes in the social or economic benefits to the student or family.

The definition is useful for these reasons. First, it outlines indicators in areas where data has been gathered on IRI projects, such as participation, achievement, equity, access to educational resources and cost-effectiveness. Second, the definition looks at a project as a stage in a process to improve systems of learning, and not as an end in itself. This distinction allows change and transition to occur in realistic ways and to be included in an overall vision of sustainability. This means, for example, that if educational policies change in a particular country, the delivery and even the composition and content of an IRI learning system would also be expected to change in order for the benefits to be sustained. National broadcast may change to local broadcast or use of cassette, or a teacher-training component may be added to increase the ability of the teacher to control or adapt his or her curriculum. While changes pose threats to sustainability, they do not necessarily determine it. Finally, this definition allows an investment in education to have multiple beneficial outcomes, some of which might be experienced among the original set of beneficiaries and some of which might be related to changes in educational practice and therefore might be experienced among new unforeseen groups of learners, and by society at large.

On a practical level, this means that sustainability of an IRI intervention can be viewed in at least three ways: (1) the use of IRI programmes with a demonstrated level of benefits for a designated population of students; (2) the wider use and development of strategies and benefits promoted by the IRI intervention among a larger community; and (3) the leverage of new benefits for students and teachers in other economically and socially salient ways.

What are the benefits to students associated with IRI?

Evaluations documenting educational impact indicate that one of the paramount benefits of exposure to IRI is increased learning gains. IRI programmes consistently result in significantly greater learning gains for students exposed to IRI than for students in control groups who did not use IRI (Tilson *et al.*, 1991; Leigh, 1995; Corrales, 1995; Bosch, 1997; Perraton and Hülsmann, 1998; Helwig *et al.*, 1999). On an average, students in IRI classes out-perform control students with an effect size of 0.5 standard deviations (Tilson *et al.*, 1991). This is a notable gain in learning.

For populations with diminished levels of educational access and social barriers to education, there are added benefits. IRI programmes have shown that they can consistently narrow equity gaps by increasing the achievement of girls and rural students and bring them much closer to the levels of boys and urban students (Tilson *et al.*, 1991; Hartenberger *et al.*, 1996; Bosch, 2001). This has been true for different subject matters, including mathematics and science, and for different age groups.

Benefits can also be demonstrated in other areas on a project specific basis. For example, the EDUCATODOS adult basic education programme in Honduras has found that there are immediate economic returns associated with participation in IRI and text-based educational programmes. For the fifth and sixth grade levels, individual income went up by an average of US $54 per year of schooling. They also discovered that graduates demonstrated increased civic participation, increased participation in elections, better health practices, increased knowledge of HIV/AIDS, lower repetition rates for children in primary schools, and more willingness to use family planning (van Steenwyk *et al.*, 2002).

Other projects use IRI as a means to extend access to schooling. The difference for students in these efforts is between going to school and not going to school. In the Barahona region of the Dominican Republic, the IRI programmes serve a core educational function. The same is true in community-based programmes in Zambia where the IRI programmes target AIDS orphans and where the teacher population has been hit hard by the disease. These programmes provide special benefits to students that non-IRI programmes may not.

Like these community-based projects, some IRI programmes target teachers in specific ways and include among other benefits, teacher development and corresponding changes in the teaching and learning environment. This is true of the early childhood development programmes, which produced increased interactions among teachers/caregivers and young children, and demonstrated reductions in the number of children who fall into the 'high risk' category, determined by local UNICEF social and health criteria.

Finally, there are other categories of benefits that have been suggested, but where evidence is anecdotal or, as of yet, untested. For example, the influence of social elements of IRI programmes to girl and boy students offers benefits in terms of role models and social options. It is likely that radio programmes can influence the social environment experienced by young students and their perception of their options, but, unlike the other benefits listed, it is unclear to what degree.

With the exception of the studies done on adult basic education in Honduras and early childhood development programmes in Bolivia, most evaluations of benefits to students have concentrated on immediate gains represented by achievement and increased educational access. The longer-term benefits of these gains to leverage other positive student outcomes can only be assumed.

What are the benefits to the educational community associated with IRI?

At the level of government and potential funders, there are benefits related to cost-effectiveness and affordability. While early economics studies may have over-emphasized the scale that some projects might reach in a short period of time, later studies showed that, with the economies of scale achievable with radio, the cost per student could be quite low. According to a 1999 World Bank/USAID study, the application of IRI to increase quality in primary schools is likely to result in costs in the range of US $3 to US $8 per pupil reached, depending on the size of the programme (Adkins, 1999). The Adkins' study calculated that once the lessons had been developed and the system was in place, the annual recurrent costs were approximately US $2.32 (large-scale programme) to US $2.97 (small-scale programme). Adkins (1999) also cites studies which show that IRI has been a cost-effective method of teaching language and mathematics in primary schools in a number of countries and that it is found to be more cost-effective than some textbook or teacher training strategies.

The combined benefits of cost-effectiveness and immediate and demonstrable expressions of gains in achievement have made IRI an intervention that is attractive to the educational community. In comparison to other educational interventions that may be difficult to measure, reach a smaller population, or may require a longer incubation period, the benefits of solid and immediate data gathered by external evaluators has made it easier to demonstrate effectiveness in periods of decision making.

Other benefits include changes in the teaching and learning strategies that are used in schools and the participation of the educational community. Studies in Guinea have suggested that teacher absenteeism, which influences the rest of the instructional day, is a serious problem in many countries and may be reduced by primary grades 1 to 6 IRI programmes. IRI initiatives differ in their teacher development approaches – some integrate teacher training into the programmes themselves and others complement the programmes with teacher training. Most IRI radio series do some of each, resulting in improvements in teachers' ability to do their jobs.

In several countries, one IRI series led to the development of one or two subsequent series, thereby proliferating the approach on a wider scale. In Honduras, for example, the first IRI primary school mathematics series failed to be sustainable in its first rendition. However, the educational community, including the government and USAID, began development of the adult basic education series for grades 1 to 6 soon thereafter. The government is now in the final stages of developing a junior secondary series for grades 7 to 9 and restoring the IRI primary mathematics series that was lost 10 years earlier. Bolivia had a similar experience. It developed IRI series for mathematics, health and early childhood development and adapted health and early childhood development programmes into indigenous languages. Even as the national broadcast of the mathematics programmes was lost during the educational reform period, the other two series persisted.

A similar form of proliferation has occurred across borders. Like many other broad technology-based initiatives, benefits to the educational community in one country spread among the international education communities of other countries. For IRI, successes experienced in one country have a direct relationship to successes in other countries. There are several reasons for this. One of the characteristics of the IRI methodology is the development of a basic framework to teach a particular subject matter or to engage a particular audience. As a result, programmes benefit from the experiments that take place elsewhere and, in some cases, actually adapt a curriculum for a new environment that has been previously designed elsewhere. As *Figure 2* indicates, early models of mathematics, second language acquisition and early childhood development designed in an initial country have been used as the starting point in the creation of another series in new countries.

Figure 2. The ripple effect of educational radio projects

Original series		**Subsequent series**
Nicaragua mathematics	⇒	Thai mathematics; Bolivia mathematics 1-2; Haiti mathematics; Somali mathematics.
Kenya English in Action	⇒	Lesotho English; South Africa English; PALOP Portuguese.
Honduras mental mathematics	⇒	El Salvador mathematics; Honduras revised mental mathematics.
Bolivia early childhood development	⇒	Nepal ECD; South Africa ECD.

These demonstrable benefits and effects of IRI have resulted in the development of a community of advocates for IRI that has its spread across disciplines, institutions, nationalities and occupations. Individuals that have participated in an IRI programme in one setting, and have seen the results first-hand, often emerge with new positions and different responsibilities but with a continued quest to resolve educational challenges. As a result, the enthusiasm of this dispersed community has contributed to the sustainability and development of the strategies that IRI uses and the adaptations of applications that now exist.

What factors influence sustainability?

Several factors have consistently influenced the long-term use and sustainability of IRI programmes. The key internal factors listed below were found to be important in IRI projects over time.

1. *Project design and evaluation.* The development of a new IRI series is a complex task that involves transforming a national or local curriculum into a radio series that is locally relevant and pedagogically sound. The majority of the investment in IRI is expended at this stage. It requires local talent, formative evaluation and testing. Contrary to claims of some critics, the vast majority of IRI projects have used external evaluators to test learning gains, assess impact, and ensure that the series is effective before distribution (Perraton and Hülsmann, 1998). IRI programmes that have not dedicated sufficient effort to these systems during the development stage have encountered trouble later on. Quality has either suffered or the programme was not well understood.

2. *Strategy for recurrent costs, particularly for airtime, power supplies (batteries) and training.* Recurrent costs are an obstacle that has been associated with the abandonment or the under-utilization of several IRI projects. Projects that pay for recurrent costs during the pilot stage and do not negotiate a way to sustain those demands afterwards have consistently had problems. Governments or schools who may have been receiving the programmes for free are not eager to suddenly factor in these costs. At the same time, radio stations may not pick up broadcast fees. The solutions vary depending on the country, from agreements between ministries of communication and education to long-term contracts with radio stations for airtime to

line items that will cover airtime and batteries at the local level. To reduce the cost of batteries and airtime, some projects are beginning to experiment with the use of wind-up radios, school sponsorship, and agreements with local radio stations. In other places, ministries, district education offices, schools, or local development agencies may pay for the recurrent costs that are needed. Whatever the agreement may be, it needs to chart out and plan for sustainability from the beginning stages of project development.

Training is an area that is generally organized through the Ministry of Education or local institution so that it is integrated into existing pre-service or in-service training. The repercussions of not being able to sustain airtime and training have been demonstrated in several countries. In Honduras when private radio stations stopped airing the *Fámilia de los Números*, for example, the programme was no longer used. In Papua New Guinea, inability to train science teachers in the use of IRI reduced the numbers of teachers who could use the radio programmes.

3. *Changes in administration or educational policy.* Changes in administration and educational policy are probably the single prime constraints to sustainability. Generally the changes involve large reform efforts, such as the decentralization of educational systems or the privatization of communications systems. Countries going through restructuring and privatization must confront new frameworks for how education and communication systems operate. Agreements between a centralized national radio station and a centralized Ministry of Education become quickly outdated. These obstacles have been overcome in many places, however, if there is leadership in troubleshooting that addresses how to adapt the programmes to new conditions or sustain the benefits. When IRI was first being developed in the 1970s, many of the experimental countries had centralized education systems. Today, most IRI programmes are developed with decentralization in mind. Plans for sustainability and ownership are distributed across a much broader range of public, private and community-based stakeholders. This shared responsibility has made institutionalization efforts much more dispersed, but, at the same time, much more stable.

4. *Leadership and advocacy.* The importance of strong advocates comes up in almost every IRI project. In a recent study of the

sustainability of IRI projects, effective leadership was one of the major indicators of sustainability in any single location (Helwig *et al.*, 1999). The presence of a key troubleshooter and advocate was identified in nearly all the programmes that had survived and continued to show benefits. Usually, the leadership is a combination of local and international personnel who can make sense of changing situations and determine if the IRI project has a new role. Given the relatively small recurrent costs once the programmes have been developed, finding a new role is almost always possible.

5. *Changes in trends and demand.* Another factor in sustainability is changing local trends in, and demand for education. Changes in the way that radio mathematics has been used in Thailand, for example, can be at least partially attributed to a growing interest in and availability of other technologies, such as television and computers. While these technologies may not offer the cost advantages that radio does, other attributes may be compelling in South-East Asia, such as the donation of free computers or connectivity. The success of English in Action in South Africa was also due partly to external factors. In particular, its success was linked to the increased demand for methods for reaching large populations that were excluded from educational resources under apartheid and a burgeoning network of local radio stations that was created when the Independent Broadcasting Agency was formed. In this case, the external factors related to using radio were conducive to a learning system such as the IRI.

   Other related changes in trends that have influenced sustainability are related to perceptions of teaching and learning. Some of the early IRI programmes were criticized as not being constructivist enough. Later series integrated more constructivist strategies into the lessons and gave the teachers a larger role. Even when the programmes were effective, the impression that an approach may not be in line with current theory can sometimes be detrimental.

6. *Shelf life.* One of the key elements of sustainability often overlooked is the useful shelf life of an educational intervention. Rarely do educational planners say that in order to sustain benefits and reduce monotony, a programme should actually be revised and updated. In the case of Lesotho, IRI has been sustained in the same form for so

long that teachers are bored (Helwig *et al.*, 1999). The institutional arrangements to sustain the programme delivery are in place, but the programmes themselves should be updated. This experience begs the question: when has a programme been used long enough? Is 10 years a good benchmark? Fifteen?

7. *Systems that build on new skills. Susta*ining the benefits of the programmes is a two-step process: (1) understanding what those benefits actually are and (2) finding linkages to other activities that build on them. For example, finding ways for teachers to use active learning pedagogy in other areas of instruction would extend the benefits that he or she experiences for interactive radio. Building on new local expertise in a given country to design parent involvement programmes, to develop new avenues for community members to be involved in decisions about education, to promote new education or health interventions, or to help students find jobs are strategies that extend the benefits gained through IRI. These areas should be planned early and monitored for success.

What can we conclude?

IRI projects are subject to the same vicissitudes and fortunes that all educational initiatives in developing countries face. New projects are often not institutionalized sufficiently, are impacted by changes in administration and policy, or are not prepared to cover the costs and responsibilities needed for continued use. Sustaining the benefits of a project is a complicated and dynamic business, but there seem to be at least some common trends. A large part of sustaining an IRI project involves ensuring that it is responsive to contextual changes and that there is a plan for shared ownership and recurrent costs. Advocates who are willing to troubleshoot through changing times can help adapt learning and delivery systems so that the programme addresses changing social, economic and political conditions. Access to the means to perpetuate and measure benefits beyond the initial intervention are important and influence public opinion and sustainability. Further, the extension of the educational initiative must emerge from the local environment and respond to the local needs on an ongoing basis. If it fails to do so, long-term success may involve revising, updating, or retiring some elements of the project in order to sustain the level of benefits that were originally conceived.

Given the challenges in education that developing countries face and the circumstances that are beyond planners' control, IRI's sustainable success rate of about 66 per cent (about two-thirds) of IRI applications over 25 years is not bad. With the added insights of experience and the onset of new techniques and technologies for education, the ability to sustain the benefits of new initiatives is likely to continue to improve. Only time will tell.

Appendix 1. Summary of recent interactive radio projects

Country/year pilot initiated	Subject	Total learners reached	Elements of sustainability	Key points
Nicaragua 1974	mathematics, grades 1-3	did not go beyond pilot	IRI not continued due to the revolution in Nicaragua in 1979. The mathematics model was adapted for Thailand and Bolivia. Dev't funded by USAID.	• original model developed • adapted in other countries • large shadow audience (37% of the people in area)
Kenya 1980	English	did not go beyond pilot	IRI not institutionalized due to disagreements over recurrent costs. The English model adapted in Lesotho and South Africa. Development funded by USAID.	• original model developed • adapted in other countries
Thailand 1980	mathematics, grades 1-2	unknown	Mathematics originally broadcast nationally and still broadcast in some areas. Programmes used daily on cassettes in some hilltribe areas. Interactive methods have increased in Thailand and the education community is looking towards more complex technologies, such as television and computers. Development funded by a World Bank loan; recurrent costs originally covered by the Ministry of Education of Thailand and then provincial education offices.	• adaptation from Nicaragua mathematics • audience changed (formal schools to non-formal hilltribe schools) • distribution methods adapted (radio broadcast to cassette) • country's economy improving and looking towards more expensive technologies
Dominican Republic 1981	integrated programs for non-formal; mathematics for formal	168,000+	Programmes continue to be broadcasted in 25 centres in Barahona. Development funded by USAID; recurrent costs covered by district educational system.	• original model developed (integrated programming) • broadcast both formal and non-formal settings • small non-formal population reached annually (approximately 8,000 per year), but has been sustained for 20 years

Appendix 1. Continued

Country/year pilot initiated	Subject	Total learners reached	Elements of sustainability	Key points
Papua New Guinea 1986	science, grades 4-6	500,000+	IRI science broadcasted for 10 years. It is still broadcasted in PNG, but privatization and decentralization strategies have caused uncertainty in ministries around payment for airtime and have caused national broadcast to be halted in favor of fewer local broadcasts. Development covered by USAID funds and recurrent costs by local education groups.	• original model developed (science) • strategy compatible with educational needs • needs troubleshooting to overcome difficulties as policies change • payment for airtime (recurrent costs)
Honduras 1987	mathematics, grades 1-3	approximately 850,000 over first 3 years; 579,000 in 2001	Programmes were broadcasted for 3 years beyond original pilot. When the key NGO maintaining the project activities got into political trouble, the private sector radio stations pulled out. In 2001, mental mathematics was upgraded and began broadcast under a new government. Development funded by USAID.	• original model developed (mental mathematics) • attempted cost-sharing • first series to be upgraded and rebroadcast.
Bolivia 1987	mathematics, grades 1-5	over a million	Programmes broadcasted nationally for 10 years and halted with decentralization and education reform. Programmes criticized for not being constructivist enough but still used in certain municipalities and in Fé y Alégria schools. Development funded by USAID and recurrent costs by the MoE, and then, municipal education offices.	• strategy compatible with original educational needs • was unable to be adapted to as policies changed and revisions were needed

Appendix 1. Continued

Country/year pilot initiated	Subject	Total learners reached	Elements of sustainability	Key points
Lesotho 1987	English, grades 1-3	estimated at 200,000 per year	Programmes broadcasted nationally for 14 years and continue to be broadcasted. Teachers complain that they would like them to be revised or expanded to reduce teacher monotony. Recurrent costs covered by an education tax.	• strategy compatible with educational needs • innovative levies pay for recurrent costs
Guatemala 1990	Spanish, mathematics	estimated at 50,000 per year (3 grades in 220 schools)	The national programme was phased out following a midterm evaluation that showed that while learning gains where high, it was not cost-effective. A new agreement is underway to renew the radio mental mathematics series in one region for 220 schools.	• strategy not found to be cost-effective • local agreement more compatible • broadcast discontinued
Costa Rica 1991	environmental education grades 4-5	did not go beyond pilot	Programmes not institutionalized due to changes in administration and changes in Costa Rica's status as a recipient of international funding. Strategies of using drama incorporated into other programmes. Formative and summative evaluation didn't produce easy to interpret data. Development funded by USAID. Recurrent costs initially covered by the MoE, until a change of administration.	• new model developed (environmental education) • transition from pilot to national programme do not occur – potentially connected to changes in policy and the administration at key moments • did not collect adequate evaluation data

Appendix 1. Continued

Country/year pilot initiated	Subject	Total learners reached	Elements of sustainability	Key points
Bolivia 1992	health, grades 3-4	600,701	Programmes continue to be broadcasted on the regional levels. Development funded by USAID and recurrent costs by municipal education offices.	• original model developed (health) • strategy compatible with educational needs • broadcast localized with decentralization
El Salvador 1992	mathematics, grades 1-2	estimated at 80 per cent of students in grades 1-2	Programmes and training system fully incorporated within national curriculum and Ministry of Education plans. Funded by USAID.	• strategy compatible with educational needs • agreements between Government and private press and radio stations to sustain airtime
Honduras 1992	adult basic education, levels 1-6	396,070 since 1995	Programme is institutionalized within the Ministry of Education, and implemented through agreements with local organizations. Levels 1-6 are completed. Currently 25 per cent of the country is covered through private regional radio stations. Government covered the payment for facilitators and supervisors. Development funded by USAID and the MoE.	• original model developed (adult basic education) • strategy compatible with educational needs • agreements among government, regional radio stations and organizations. • assessed to increase income per graduate by an average of $54 for each grade level achieved.
South Africa 1992	ESL, grds 1-3	over a million	Programmes continue to be broadcasted on national level. Development funded by USAID and NORAD. Recurrent costs shared across several institutions.	• model adapted dramatically to make it compatible with South Africa's needs

Appendix 1. Continued

Country/year pilot initiated	Subject	Total learners reached	Elements of sustainability	Key points
Indonesia 1992	teacher training/ split shift	unknown	Planned to be institutionalized between the University of Terbuka and the Ministry of Education.	• strategy compatible with educational needs • little external assistance given • status unknown
Pakistan 1992	English, grades 3,4,5	unknown	Programmes broadcasted in 300 schools on a daily basis. Development funded by USAID; recurrent costs covered by MoE. Quality unknown.	• pilot continued through the Ministry of Education
Portuguese speaking African countries 1992	mathematics, grades 3-4, Port.	pilot discontinued	Programme development had a slow start and lost a year due to administrative problems. Programme assessed to seek additional technical assistance and unable to function well enough to complete the ambitious goals. Funded by the Dutch Government.	• first attempt to develop a multi -country series • status unknown
Bolivia 1994	early childhood development	650,000+ with large shadow audience	Original model developed. The Bolivian tapes are also used in some areas of Ecuador and Colombia. This pilot was the first to have two distinct sets of learning objectives: one for teachers/parents and one for children. Development funded by USAID and recurrent costs covered by local institutions.	• original model developed (ECD) • uses both radio and cassette • decentralized dissemination matches education reform • recurrent costs covered by local institutions
Bangladesh 1995	English	unknown	The NGO Bangladesh Rural Advancement Counsel (BRAC) planned to produce IRI programmes for non-formal education for girls alongside other activities. BRAC received training and production and is currently underway. Funded internally.	• methodology planned to be integrated into current work in Bangladesh • status unknown

Appendix 1. Continued

Country/year pilot initiated	Subject	Total learners reached	Elements of sustainability	Key points
Nepal 1996	ECD	unknown	Adapted from Bolivia ECD with added emphasis on gender and nutrition. It is a joint venture between ECD, UNICEF, and Radio Nepal and is broadcasted nationally twice a week. Development funded by UNICEF. Recurrent costs covered by Radio Nepal.	• model adapted from Bolivia • institutionalized within Radio Nepal • national broadcast; unknown amount of use
Haiti 1996	reading, mathematics	40,000 per year up to 2001; plan for expansion	Programmes are broadcasted and used in private schools, despite continued political unrest. Funded by USAID.	• mathematics adapted from Nicaragua • new model developed for literacy
Costa Rica 1997	English	unknown	IRI programmes developed and broadcasted locally. Funded by a World Bank loan.	• pilot • status unknown
Guinea 1997	French, mathematics, primary 1-6	over a million	IRI programmes broadcasted nationally. Funded by USAID.	• first IRI series to go to national scale in West Africa • extensive teacher training added to support the use of programmes • anecdotal evidence that teacher absenteeism reduced
Venezuela 1997	mathematics	over 3 million	IRI programmes delivered as part of core curriculum and developed with little external technical assistance. Funded by loan from World Bank and a grant from a foundation.	• series discontinued with change in administration
Zambia 1999	integrated	still in pilot stage	IRI programmes broadcasted for community use where there are few teachers and children are particularly vulnerable due to widespread HIV/AIDs and poverty. Funded by USAID.	• first community-based IRI series to target orphans and children vulnerable due to HIV/AIDs • pilot

Appendix 1. Continued

Country/year pilot initiated	Subject	Total learners reached	Elements of sustainability	Key points
Nepal 1999	teacher training for grade 3 mathematics and grade 5 English	going to scale in stages, 35,000 in pilot stage	IRI programmes developed to provide hands-on support to teachers in particular subject areas as they work with students. Development funded by UNICEF; recurrent costs being negotiated.	• pilot completed and strategy of evaluation and going to scale staged
Ethiopia 1999	English	pilot	Pilot developed as part of larger education programme. Funded by USAID.	• status of pilot unknown.
Honduras 1999	integrated (mathematics, English, civics) grades 7-9	3,500 in first year of pilot, projected to increase	Pilot developed and delivered in communities and at worksites. Pilot materials completed August 2002. Development funded by USAID and MOE.	• first pilot to address secondary schools and working adults.
Nigeria 2001	integrated literacy, numeracy, primary 3-6; Koranic schools	pilot	Series developed to correspond to national curriculum for English (spoken and written) and includes basic numeracy skills. Additional series created for Koranic schools.	• four levels of IRI in primary school • first pilot to be created for use in Koranic schools.
Somali refugees	literacy, mathematics	pilot	Series created for Somali refugees living in refugee camps in Ethiopia.	• mathematics adapted from Nicaragua • first series created for refugee population

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Chapter 8

Is constructivism universal? In search of meaningful technology in Morocco and Namibia[6]

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Introduction

The question we tackle is basic: Is a shift from instruction via the transmission model to constructivism a universally desirable outcome for educational systems and societies worldwide?[7] If so, can small, pilot technology initiatives provide creative disturbances that encourage learner-centred education, particularly in rural areas of the developing world? Should the answers be affirmative to these questions, these findings would suggest that education technology projects with constructivist orientations could be widely applicable and be taken to scale, that technology may improve (universal) access to quality education, and that strategic spending can go a long way to supporting reforms within countries. In other words, the benefit to cost ratio would be overwhelmingly favourable throughout the developing world without the need for Pareto-safety allocation

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7. Constructivism is a theory of learning that 'defines knowledge as temporary, developmental, socially and culturally mediated and thus non-objective. Learning from this is understood as a self-regulatory process of resolving inner cognitive conflicts that often become apparent through concrete experience, collaborative discussion and reflection.' Brooks and Brooks, 1993:8, cited in Sandholtz, Ringstaff and Dwyer, 1997: 12. It often stands in contrast to what many term the transmission model of instruction, 'just-in-case' learning, and implies shifts towards authentic assessment, student-centred learning, active inquiry, the teacher as facilitator of collaborative learning processes, and real, meaningful and connected learning to problems of real life in a complex socio-cultural environment.

conditions in which the reform winners compensate reform losers. The education technology tide should show the potential to lift all boats and redress disparities in access to quality education. The digital divide would be a short-lived concern, relegated to the trash directory on history's hard drive.

These questions are being asked by planners and educators who seek quality improvements in education and place digital technologies alongside complementary and competing investments in other reform priorities: decentralization, whole school improvement, private-public partnerships, community involvement and curricular change. Over the past 2 years, the ministries of education in the Kingdom of Morocco and the Republic of Namibia have mounted new initiatives in education technology. Planners in both countries are examining technology's potential for improving the delivery of training and support to teachers at all levels and at all points in their professional development.

The authors of this paper have been involved in piloting two small, model projects financed by the US Agency for International Development (USAID) under its Computer-Assisted Teacher Training (CATT) initiative. The Moroccan and Namibian projects have served a very small part of larger technology initiatives. Both national initiatives are part of national reform efforts spelled out in Morocco's National Charter on Education, and Namibia's Ten-Year Plan for Educator Development and Support in Namibia. The involvement of development assistance begs another set of questions: How can foreign assistance best facilitate the use of education technology integration in reform contexts? And, is constructivism itself heuristic?

Planners, parents and taxpayers are faced with decisions about how to deploy limited technology money in education so that it can be leveraged and multiplied in environments of scarcity and need. Integration has become a critical concern because the technology, too frequently, has been provided seemingly for the sake of providing technology. The technologies, therefore, go underutilized, and the fixed investments depreciate without yielding improvements in desired educational outcomes. Certain bundles of technologies lend themselves to leveraging and multiplication more than others – they are inexpensive, easily maintained, enable access and are effectively used. Other institutional reforms lend themselves to greater educational returns that may be multiplied through technology. So, might it be true that constructivism is both an end and a means, for which digital technology is one potential vector, and development assistance a potential facilitator? Would this be universally applicable if two pilot programmes in two disparate developing countries showed similar signs of potential to develop human capacity, through divergent institutions and programmes in disadvantaged rural areas?

This approach defined here as $e^{(y)}$ or $e^{(it)}$, denoting the exponential potential of technology and inquiry in education (*e*), advocates investments in teacher professional development and a focus on teacher technology skills development in inquiry-based learning and problem-solving. This stands in contrast to a strict focus on either distance education or computer-assisted instruction. Not only does inquiry learning build upon what teachers know, but it models desired pedagogical change and moves debate away from techno-centric topics. Through active technology training programmes, and development assistance structured on 'learning processes,' learners come to appropriate the network, the programme, their community and their learning as they build technology competency (if not before). Such a model does not depend on experts, planners, or international consultants. Rather, technicians, planners and consultants facilitate problem solving (particularly by providing enabling policy) rather than determine the problems to be solved. In so doing, education professionals become practitioners of learner-centred education and project-based learning. With the mobilization of participants, scarce money becomes multiplicative.

This chapter makes a case that $e^{(y)}$ – inquiry technology in education, for lack of a better term – (1) does allow for education technology to be transferred in meaningful, relevant ways, and (2) provides a model for effectively leveraging scarce pilot programme money. It also contributes to an argument for a universal constructivism with which social capital can be built locally – with or without significant technology endowments. However, we argue that neither development assistance, state, nor private commercial firms are efficient vehicles for effectuating these types of changes. They require partnerships in order to move down the path to efficient and sustainable learning organizations or systems operating in public interest.

This discussion begins by outlining the parameters and design elements of Computer-Assisted Teacher Training (CATT), the subsequent modifications and attributes that characterize $e^{(y)}$ in light of current thinking on educational technology. We then discuss the experiences of CATT project designs in support of Plan 2008 in Morocco and Namibia's Ten-Year Plan. Finally, we conclude with some lessons and recommendations for future technology projects in education.

$e^{(y)}$ development and construction

As its name implies, the Computer-Assisted Teacher Training (CATT) programme at USAID was informed by successive waves of thinking about education technology – an earlier wave on computer-assisted or computer-mediated instruction (CAI), and a latter wave that was more inquiry-based and focused on the relationship between technology and reform. For many, the paradigm of computer-assisted teacher training invokes 'teaching by machine' and a 'top-down process of advocating and implementing technology,' which often left teachers out of the equation' (Tyack and Cuban, 2000). It evokes promising investments in smart tutors, simulations, and expert-based systems that are not yet at the point of perfection. As Bellman notes:

> *... We have seen the development of some stunning beginnings in educational technology, but it's not yet the right stuff. Education technology needs to support different teaching and learning styles, gracefully specialize into individual differences, handle diverse theories of pedagogy and learning, evaluate performance within a variety of media, support group as well as individual learning, and incorporate deep and rich content resource* (Bellman, 2001: 379).

In some respects, smart machines and expert systems share the premises underlying a host of other initiatives in technology: that teachers are the problem and a supply of experts and expert digital materials are the solution. They share these premises with advocates of distance education and more populist approaches, who prefer putting computers in students' hands outside formal educational systems. Similar assumptions are shared by engineers and technicians for whom educational technology is but the long march from computer literacy to programming proficiency. These smart machines and expert systems represent intriguing but sub-optimal investments in technology where resources are scarce. Further, most discount systemic change and the importance of the teacher in the learning and reform process.

USAID's Computer-Assisted Teacher Training (CATT) programmes in Namibia and Morocco were most extensively influenced by the growing body of experience and literature on education technology, constructivism and teacher professional development. The literature augured for:

- Investments in teachers and advisors with the potential to develop learner-centred pedagogies and instructional designs that could effectively integrate technology and could be enhanced by it (Archer, 2000).
- Investments in tools and technologies that (1) are inexpensive; (2) address and develop critical and creative thought, multiple intelligences and learning styles; (3) allow learners to imagine and use the tool in other contexts; (4) are flexible, accessible, and easily learned (Jonassen, 1996).
- Investments in organizations and networks that could sustain computer networks and peripheral equipment while simultaneously providing the necessary encouragement and support to teachers moving along steep technology learning curves. The networks not only served to exchange information but knowledge, particularly pedagogical knowledge.

The beauty of this approach for developing countries is that constructivism – in the presence or absence of technology – had the potential of serving as a *lingua franca* for teachers and student teachers with limited or intermittent access to technology via provincial or regional resource centres. Schools could locate their progress within a context of school improvement planning, much as they would develop indicators for progress in other dimensions of institutional improvement. The conditions favouring successful technology integration were simply the conditions that favored education reform more broadly – and significant quality improvements in rural education through community, multi-grade education as well as through whole school reformist approaches. The downfall of providing technology to schools, at least from the US experience, is that constructivism and project-based learning characterize apparent positive results from computer use in schools serving wealthier communities. In contrast, computer use in poorer districts, characterized by drill, practice and remediation, has proved to have negative results for students when used beyond primary education (Archer, 2000).

Consequently, the big unknowns are the institutional and socio-cultural environmental variables enabling this approach to education technology. In many developing countries, the factors behind institutional incapacity are familiar – centralized ministries, inspectorates, nationalized testing, textbook teaching, rigidities in certification and professional development paths, administrative rules for facilities management and use, revenue-raising restrictions, corruption, unaccountability, shortages of leadership, insufficient investment and public reach into rural areas, etc. This is similar to other investments in professional development that often do not yield expected benefits when educators are not provided the freedom or the opportunity to apply their newly-acquired skills. Moreover, the development paradigm itself presents other constraints: blueprint planning, international expertise without sensitivity to local culture and society, two-year implementation schedules, a need for visible products and photo opportunities, and the bias toward achieving expedient results over learning processes and capacity-building.

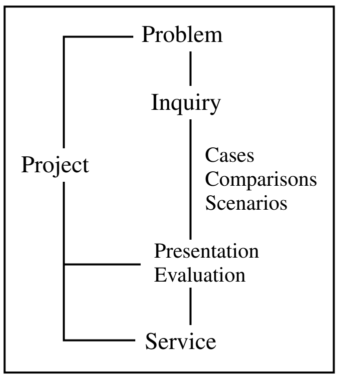
The inquiry technology in education $e^{(y)}$ approach devised through CATT, not only incorporates institutional considerations, but it challenges some tenets of the constructivist paradigm. $e^{(y)}$ works along four principle dimensions:

1. Institutional dimensions related to policy ideas, roles, rules and procedures that enable educational technology programmes, constructivist reform and the creation of social capital;
2. Improvement in learning systems that become more open, accountable, transparent, inclusive and flexible;
3. Instructional designs for pre-service and in-service training (preparation and continuing professional development) that are inquiry-based and active (case teaching, Socratic seminars, action research, school improvement planning);
4. Training and implementation designs that are equally inquiry-based and active, and that cover skills training, pedagogical changes associated with construction, with overviews of communications in learning systems, and the institutional and technical dimensions of education technology.

The main assumptions challenged by CATT are the following:

1. *Movement towards developing inquiry-based applications and technology skills need not be linear and incremental in the present development context.* A widely held perspective is that educators pass through stages beginning with the development of technology entry skills through drills and exercise and continue through to technology integration and developing collaborative projects and inquiry-based learning activities. Developing countries, though, are mounting education technology programmes at a different point in educational technology's historical timeline. This is to the extent that adoption might be accelerated, training might focus on creating technology champions rather than applications-cognizant educators, inquiry-based instructional designs may appear earlier, and entry into communities of educators may be encouraged during the initial stages in order to accelerate a non-linear acquisition of technology and inquiry skills.

Figure 1. Relationship between inquiry designs



2. *Technology integration through constructivist, inquiry-based, or learner-centred education may include the teacher playing multiple roles, alternately shifting from the lecture podium on centre-stage to the workstation and workspaces throughout the classroom, offstage.* Much of the current literature suggests a gradual shift from one end of the spectrum to the other. The conception of this transition requires clarification and less hyperbole.

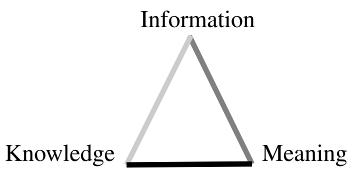
Currently, theorists and practitioners overly differentiate among designs termed problem-, project- and inquiry-based by definition, or they become constrained by their historical and philosophical origins and orientations. In too many cases, these typologies fail to offer insights into technology's relationship to basic methodology (i.e. knowledge construction through comparison) or into technology's integration into case teaching.

There is also a long track record of technology crash courses (and methods) that are paired with initiation sequences for student-professionals in education and in the social sciences. Typically, technology's relationship to improvements in delivery mechanisms for in-service training, beyond distance education, receive scant review. Depending on the instructional design, the education system level (primary versus secondary), and learning and teaching styles, teachers effectively convey information and knowledge directly to students and play a central, active role in directing structured inquiry. The field and the paradigm often lack the pragmatism they embrace.

3. *Technology training can begin with active learning and inquiry.* Because of its linear and logical infrastructure, many trainers feel the need to construct their training following a line of linear, logical and overwhelmingly passive review of the equipment's architecture, history and known uses. Technology provides a window to demonstrate new learning paradigms to education professionals, particularly in the international development context. $e^{(y)}$ implies an active involvement of learners in education technology training. This includes thinking critically about technology, imagining and testing possible applications in instructional design, evaluation of results, and reflection on the processes and outcomes involved. The training walks educators more broadly through the creation of their professional projects and instructional designs and involves them in the appropriation of their community and learning environment very quickly. In this way, technology training allows the professional to acquire the skills to use the technology, but immediately begins to press him to give it meaning, while providing him with an experience as a learner in a new paradigm as well. Moreover, $e^{(y)}$ encourages training heterogeneous groups that may yield high multiplicative effects in various domains using technology.

4. *Meaning is as important as knowledge and information*. While economists recently discovered knowledge after decades of focusing on information (perfect information and information asymmetries), education researchers have focused on knowledge and its relationship to cognition and intelligence. But the more interesting connections to be drawn are tri-fold, between information, knowledge and meaning, in direct relationship to experiential if not existential learning (with potential negative and positive effects of computer-mediation). Meaning begs the questions of culture, values, language, effort and struggle, currency and relevancy that are critical components of educational quality. In this case, $e^{(y)}$ suggest that both *e* and *IT* should be a function of why (i.e. $e^{(y)}$ and $it^{(y)}$). Through such questions, meaning is explored and created in line with the constructivist paradigm. This is not solely a domain for economists or knowledge-management consultants, but for the pragmatists and the advocates of project-based learning and social capital.

Figure 2. Information to meaning



5. *If technology is to be seen and used as a catalyst for change, then institutions and institutional roles must be assumed capable of change.* As the case studies will demonstrate, $e^{(y)}$ would suggest that technology has perhaps its greatest impact where it can be a catalyst for change. Where change and reform are desired or imminent, institutions should not be considered fixed or immutable, but variable and subject to experimentation and change. Technology programmes, therefore, should take 'responsible risks' in support of institutional change.

6. Finally, *technology integration and adoption are facilitated by community IT Projects and benefit from democratically fostering the development of community.* On the other hand, knowledge networks and collaborative exchange cannot be simply mandated and

do not fit easily within blueprint planning and non-participatory approaches to international development. In the absence of congruence between desired outcomes and implementation processes, a community cannot be created by fiat or by contractual stipulation. This is the equivalent of expecting change by mandating that meetings will be scheduled. Rather, it demands mobilization and participation in the conception of the education technology enterprise itself. Because learners are appropriating their learning, $e^{(y)}$ provides the architecture for inquiry but not the content, provides ideas that are open to cultural values yet are non-determinative, asks questions with multiple answers that depend on environmental factors, and poses options that stop short of decisions.

The $e^{(y)}$ approach thus attempts to combine institutional and programmatic approaches. It develops a consistency between constructivism in education, training and project implementation. It challenges development timelines; it augurs for emphasis on meaning and experience in keeping with pragmatism; and, it centres the debate on inquiry and instructional design, and personal/professional projects. Sustainability and organization require fresh thinking about organizational roles and networks that support active inquiry. These requirements suggest that technology tools should be powerful and simple. Teachers figure prominently in both old and new equations, and the computer is relegated to a tool to be used in the proper context per the proper instructional design.

The $e^{(y)}$ approach is consistent with Sen's (1999) conception of development as freedom, and with the proposition that development is closely related to a complex multifaceted understanding of 'maturity.' Founded in pragmatism, $e^{(y)}$ acknowledges cultural values but is ideologically independent in that it provides for deliberation and problem-solving among members of the educational community. It is democratic in that it asks learners to exercise choice in the course of their own learning and to contribute to problem-solving in the public sphere. $e^{(y)}$ is not antithetical to markets or governments but, because it is community-based, it is not wholly situated in any one particular segment or sector of society. It looks at technology costs per student or teacher as a point in a cycle of human-fixed capital investments that depreciate over time and that have varying salvage values at the end of an amortization period. It envisions community and equitable institutions of trust as cost-effective vehicles for managing maturity and retooling. $e^{(y)}$ thus builds social capital over the course of an extended, institutional learning process.

Critics would argue that there are intractable problems of collective action in $e^{(y)}$, namely free-ridership. They would suggest that community members must still overcome myopic under-investment in the short term in order to reap long-term benefits. Property rights issues arise, as do conflicts requiring resolution. Incentives must be provided to educators who take risks for innovation and change. And thought must be given to the time frame in which the under-served are reached. Many problems become apparent only as technology programmes develop – and consequently inquiry and problem-solving skills again are requisite to an $e^{(y)}$ approach.

Inquiry technology programmes of an institutional nature [$e^{(y)}$] is in many respects a short-hand for the Computer-Assisted Teacher Training (CATT) programme dimensions that developed out of a combination of theory and practice from 1999 to 2001. In order to determine the 'goodness of fit' in two development contexts, we turn now to experiences of Morocco and Namibia to compare the programmes against the four dimensions of the model, and the six challenges to the conventional constructivist paradigm for education technology.

The CATT programme in Namibia and Morocco: general outlines

The CATT programme was developed by USAID's Center for Human Capacity Development in order to assist its country offices in cost-sharing projects that piloted education technology in teacher training.[8] During the latter half of 1999 and early 2000, the USAID offices in Morocco and Namibia expressed their interest in exploring education within the context of their strategic objectives in improving access to quality education.

Many of the design components in the Morocco and Namibia projects were similar. For example, the main objective in Morocco was to develop a network of seven teacher training colleges linked by Internet, and to

8. The CATT programme was developed under USAID's LearnLink Initiative by Stephen Tournas (USAID/HCD).

develop a basic training programme for in- and pre-service training that would teach teachers how to use and maintain the network, computer equipment and peripherals. A similar objective in Namibia was to link five Teacher Resource Centers and develop capacity at the National Institute for Educational Development to produce multi-media professional development materials largely to assist in delivering teacher certification training programmes via distance education. An interesting challenge in the project designs was their foci on training (and creating) 'technology champions' over and beyond demonstrating that a certain number of teachers received applications training that resulted in proficiency. In both cases, USAID asked that CATT build communities of educators be able to communicate and collaborate via electronic mail with one another and capable of producing instructional materials. Technology integration was a core concern. The budgets and time frames were modest – US $700,000 over a two-year period in Morocco initially and US $1.0 million in Namibia over a sixteen-month period.

In neither country was technology a major component in USAID's education portfolio. These were not technology-centric endeavours. The issues confronting policy-makers in both countries were primarily issues of systemic under performance and unequal access to quality education. In Morocco, where development falls on the urban-rural divide, the principle losers are rural women who are illiterate and fail to enrol or persist in the educational system. In Namibia, educational opportunities did not historically avail themselves to black Namibians in the apartheid years prior to 1990. USAID in Morocco supported a girls education initiative that focused on rural educational improvements and quality instruction in demonstration schools under the Morocco Education for Girls (MEG) Project. The USAID Mission in Namibia assisted the MBESC in piloting a 'whole school' approach to educational quality improvement, involving community participation in school improvement planning, under the Basic Education Support (BES II) Project.

As *Figure 3* indicates, the CATT initiatives in Morocco and Namibia nonetheless were unique in many respects, reflecting the needs and the institutional specificities of the two education training systems. The figure provides a brief description of the project design elements in each of the four dimensions of CATT or alternatively the $e^{(y)}$ approach. This summary will assist in framing the discussion and comparison across the two countries.

Case 1: CATT-PILOTE/Morocco: Ibtikar

CATT's programme in Morocco arrived at a time when the Ministry of National Education (MNE) was in the midst of developing a reform agenda. Prior to his death in 1999, King Hassan II voiced the mounting frustration of the general population at the poor performance of its educational institutions. The king called together various members of civil society to develop a National Charter on Education, working under the auspices of the Belfikh Commission. These consultations took place under a Palace-led coalition government that was nonetheless headed by a socialist Prime Minister and placed left-centrist ministers at the education helms.

In 1999, the Belfikh Comission released its report as the MNE developed a series of 12 quality plans for educational system improvement. One of the 12 was devoted specifically to education technology in primary education. The plan, entitled 'Plan 2008: un centre – multimedia – Internet', here denoted as Plan 2008, was very ambitious in terms of its roll-out. In its first year of operation, 1999-2000, the MNE undertook a large-scale procurement of a computer-based local area network for 300 educational establishments which was to be doubled in its second year. The MNE established a computer-training venue in Settat, and set about training technicians and educators capable of manning the centres. The training programme was partially underwritten through a donation by Microsoft, which provided the software packages, operating systems, and training assistance in Microsoft software.

Figure 3. CATT project dimensions in Morocco and Namibia

Dimension	Morocco	Namibia
Learning systems	Teacher preparation /development of community of educators associated with the CATT-PILOTE project; outreach by individual training colleges to members of their communities; Technology consists of local area network connected by server appliance and peripherals with permanent connection to the Internet; supplemented by second LAN consisting of five additional ministerial workstations. Communications tools and training college web sites developed locally.	Teacher professional development/ development of community of educators supported through professional development unit at the National Institute for Educational Development (NIED), with ties to local non-profit, SchoolNet, working with out-of-school youth; Technology consists of local area network connected by Linux servers with permanent connection to the Internet; wireless hubs and laptops proposed for advisory services; thin clients for future laboratories.

Figure 3. Continued

Dimension	Morocco	Namibia
Institutions	Decentralization/regional academies of education; training colleges as provincial resource centres, with some autonomy for revenue generation; local academies to be given responsibility for creating 15% of the national curriculum; pedagogy to become differentiated and project-based at mid-semester.	NIED and a proposed Educator Development and Support Network offering certification, extension support and ongoing professional development through Teacher Resource Centers.
Inquiry	Constructivism, questioning strategies, inquiry-based learning (web quests) and project-based learning among topics covered in training, with view to future reform.	Social constructivism is an MBESC philosophy; CATT putting existing materials online; development of InformED – a programme that combines civic education and web quest competitions; development of inquiry-based, reflective approach to technology acquisition by education professionals.
Training model	Pre-service; seven module introductory series influenced by ministry design, STaR chart progression, ministry needs assessment; opportunities for mounting professional projects and reflection.	Active training piloting a seven-step process from entry to reflection; integrated training into systems for in-service training: certification, school improvement, and mobile advisory service development.
Participants	Heterogeneous regional training groups of college instructors, primary teachers, project centre advisors and student teachers; study tour of education technology programmes in the United States for training college directors and senior ministry directors; Network administration and support provided by ISP Morocco Trade and Development Services (MTDS).	Training of unemployed, semi-skilled youth (women) as resource centre facilitators; Training of multimedia working group at NIED; Training of Regional Education Technology Teams (RETTs) that include teachers, student teachers, regional education advisors, adult education tutors and adminstrators.
Materials	Training modules and web site developed in Arabic.	Training modules repurposed to provide basic skills materials available online and on demand.
Main indicators	Participants, beneficiaries and adaption rates, web presence.	Number of participants and visitors at resource centre computer facilities. Demonstration of competencies achieved by training participants.

CATT was developed in consultation and partnership between USAID and the MNE. In November 1999, the project undertook a technical needs assessment at the teacher training college in Sidi Kacem. This assessment was intended to develop the specifications for a modular network of sorts, consisting of (1) local equipment and physical improvements to facilities at the teacher training colleges and (2) the sets of central services (ISP hosting, addressing, network support and troubleshooting) that would be consistent with the MNE's Plan 2008 and meet the objectives of the project. As quotations were solicited for the entire network, the contract was expressed as a series of options for installation and configuration at each training college. The mechanism allowed for adjustments, and in principle, could accommodate as many or as few additional 'modules' or LANs as required. Based on this assessment of technical needs, CATT worked with USAID and the MNE to formalize a memorandum of understanding that specified the obligations of the partners. Over time, this formed the basis for credible commitments of resources to the project. It was agreed that the programmes would cost-share, each providing five computers to the colleges, with USAID picking up the network installation and peripherals, and the MNE covering recurrent connectivity charges and the costs of improving and securing the physical locations for the multimedia centres.

The training design considerations were multiple, and consensus was not always reached on issues before the joint working groups and consultants. First, there was the issue of language and the appropriateness of technology training manuals available on the market. It was decided that it was worth CATT-PILOTE's time and effort to craft a modular series in Arabic language with which to reach 100 per cent of the educators working in rural areas of the country. The series, moreover, would open with discussions of constructivism and situate skills acquisition within a broader context of reform and change in Moroccan education.

Second, there was an issue of structure, training objectives and backwards planning. The Plan 2008 training programme was sketched out, with introductory modules to cover basic office applications, communications and network basics. Yet it left the latter modules covering topics of technology and instruction 'to be determined' for development prior to Year 2 of the programme. Through collaboration with Future Kids, the MNE sought to develop a similar training design for professional development involving approximately 40 to 60 hours of training that could be completed in a week. The materials were to be flexible, allowing use in formal seminars and self-study modes.

For months, CATT-PILOTE attempted to get a sense of the training college curriculum, reform strategy under consideration, and what integration of technology training might involve. Unlike other areas of education, it turned out that the training colleges had been relatively neglected and untouched. They were characterized by courses with syllabi and by instruction that did not deviate often from training in the use of the primary school textbooks. From discussions with counterparts, it became clear that the MNE was itself moving towards systemic reforms inspired by Philippe Perrenoud's work on differentiated pedagogy, by project-based learning, and by greater public-private partnership and community involvement in education.

The challenge consisted of providing enough information in an introductory course that would move learners (and institutions) from stages of technology entry well on their way to innovation. All this needed to occur in a development setting without assuming that technology would be awaiting these student teachers in their rural schools. Thus, while inquiry and constructivism were the dominant themes of the module series, CATT-PILOTE's end point was fixed on the development of instructional designs. These designs needed to be (1) project-based, and (2) if the product of the project was multi-media, then project-based learning *(pédagogie du projet*) could apply to the process of producing more polished multi-media products. CATT-PILOTE then planned backwards to inquiry-based learning using the Internet, to evaluation criteria of multimedia, to skills development in .html, the construction of knowledge through communications, and to basic skills – in keeping with the MNE's training design. The objective sought was, in this case, to favour depth (by providing breadth and context in education technology, over depth by providing intermediate skills training).

The design was exploratory and engaging, and assumed that what could not be taught in a tight time frame could be learned in class or made the subject of further inquiry – supported by the multimedia centres, as well as the work of the Morocco Education for Girls (MEG) Project.

The teachers and student-teachers in the teacher training colleges were the focus of the project activity and the intervention. The project recruited young, unemployed and semi-skilled multimedia centre advisors. The implicit goal was to foster the creation and growth of a collaborative team – heterogeneous in nature – that would dissipate the ingrained role divisions between technician and educator, instructor and student teacher, teachers and students. By breaking down these divisions, mentoring, co-training/teaching and peer-to-peer exchanges would thrive. Moreover, by training a larger group of educator-trainers, CATT-PILOTE hoped to assure a larger multiplicative effect of the intervention and coverage for longer periods of multimedia centre operations. By spreading the training, the additional burden of assuming education technology responsibilities would not fall heavily on the shoulders of one individual, but lightly over a larger group. The programme thus rested in the hands of the faculty of educators, rather than in the hands of the project or in the hands of the administration.

Preliminary results

The CATT-PILOTE intervention turned out to be a rather complicated intervention, made more so by the administrative and contractual procedures associated with managing the USAID contract and the terms of the memorandum of understanding. Consensus building and mobilization within the ministry required up-front investments in the first 7 months of the project as plans were formulated and equipment procured. Consequently, CATT-PILOTE reaped less than a full year of experience and enjoyed a mere 2 months in which all 7 centres were connected to the Internet. Nonetheless, there are a number of results that have been reported by the MNE, USAID and CATT-PILOTE's external evaluator in 2001:

- The combination of staffing, contractual support through MTDS, and the equipment itself permitted the local area networks to continue operation with very little down time. Cobalt Qube 2 servers, used extensively in French and German education systems because they can be managed by non-technical educators, were able to be remotely administered and monitored. They were stable and permitted centre administrators to spend less time troubleshooting and more time assisting centre clients.
- The basic skills training modules – Module 1 – developed in Arabic was approved by the Curricula Department for use in all Moroccan educational institutions.
- The profile and job description for instructional technology advisors was adopted by the MNE for future staffing and system development. A total of seven multimedia centre advisors and some 32 members of the technology core training groups directly trained approximately

2,500 learners, and between 3,000 and 4,000 individuals accessed the multimedia centres.

- External evaluations and visits provided qualitative data suggesting that the morale within the colleges had improved, collegiality and collaboration had increased through the creation of the teams, and most groups and stakeholders felt a sense of ownership in the project.
- The MNE members of CATT-PILOTE's joint commission signaled that CATT had been one of the most successful development assistance projects, and a model for other development assistance efforts.

Case 2: CATT-Namibia: ED'S Net

In Namibia, the post Independence education philosophy adopted by the SWAPO-led government circa 1991 was a progressive form of social constructivism. The Government of Namibia charged the education establishment, i.e. the Ministry of Basic Education and Culture, with the formulation of policies advocating basic education for all and improved systems for tracking educational inputs and outcomes. The Ministry was also able to quickly upgrade educational quality by lowering student/teacher ratios and upgrading the credentials of its teaching corps. Four goals explicitly expressed in the Ministry's drive to better serve all of Namibia's youth were: *equity*, *access*, *quality*, and *democracy*.[9]

As with many cultures, Namibia has chosen investment in its youth as a primary vector for the remedy of social ills. In this case, the damage from an apartheid system that explicitly encouraged its citizens to adhere to a system that relegated individuals to their place in a social pecking order based primarily on race and physical characteristics. Namibian learners, therefore, come to school from households where the adults are nearly as unfamiliar with concepts of democracy, self-reliance and problem solving as the children. Further, both the adults and children come with the psychological baggage accumulated from years of experience in a fragmented society that once actively and now passively informs the majority of its citizens that, at best, they are second-rate with little capacity for improvement or hope for advancement.

9. Ministry of Education and Culture, Towards Education for All: A Development Brief for Education, Culture and Training (Windhoek, Namibia, Gamsberg Macmillan, 1993: 32).

In 1999, the Ministry convened a task force to evaluate progress made by the post-Independence education system and propose recommendation for continued improvement and reform. Their report, the *Ten-year plan for educator support and development in Namibia*, called for the creation of an Educator Development and Support Network to provide and encourage strong, early and continuous professional development for Namibia's education professionals (Ministry of Basic Education and Culture, 1999). It also recommended that the National Institute for Educational Development (NIED) lead the creation of this network. NIED had been originally conceived by the SWAPO government in exile to serve as the nerve centre for educational reform, innovation, experimentation, research and development in Namibia (Angula, 2000). The objectives of CATT/Namibia were to:

1. establish an information and communications network for education professionals;
2. develop the capacity at the NIED to develop multimedia teacher training materials;
3. develop model teacher training materials for online and CD ROM delivery;
4. develop a cadre of technology champions;
5. provide IT policy support to MBESC.

In general, the project was seen as a mechanism to support the Ministry's ongoing efforts to raise the qualifications of the many teachers remaining in the system who, 10 years after Independence, had yet to meet the minimum standards for teacher preparedness. It was also designed to help support the development of an Educator Development and Support Network. It was recommended in the *Ten-Year Plan* that the network be co-ordinated by NIED and located within the already existing network of Teachers Resource Centers (TRCs). In theory, this network of centres would grow to include all of the nation's advisory teachers and provide ongoing support services to classroom educators, and begin the process of encouraging continuous professional development (CPD).

NIED and other project partners encouraged the project to implement its interventions in a manner that not only conveys constructivist theory but also models a constructivist approach. One frequent theme was that, while Namibia had enthusiastically adopted the theoretical concepts of constructivism, this adoption was unnecessarily complicated. Too few education professionals had experiences in environments that model participant-centredness, democratic development of purpose, and social construction of meaning. One foreign consultant, when informally interviewed, half-seriously asked, "How many articles and lectures on learner-centred education does this [country] need before it will understand these reforms?"

Indeed, Namibia's education sector has been experiencing the growing pains that normally accompany change. These have been compounded by more serious issues associated with the Government's embrace of education reforms that have sought to sweep away a highly prescriptive education system and replace it with a system based on a dramatically different world view. The new perspective not only suggests that the old rules were wrong but asks the constituent units within the system (e.g. learners, teachers, schools, principals, teacher training colleges) to construct their own definition of what the new rules mean. It has been somewhat akin to approaching a cook that, for years, has been asked to make one dish following a very precise recipe, and telling her that it is much better if she allows the food to tell her what it wants to become. Then, when she asks how to do this, continue to provide her with ever more in-depth explanations and books on why this approach is important, but never once provide her with a demonstration or hands-on experience with the process.

Wherever possible when developing implementation plans, project collaborators have attempted to take this advice to heart. In this regard, they have struggled to develop methods that model constructivism. They have also tried to allow the Ministry and its partners to lead the project's implementation. While the project is largely confined to activities that address its five objectives, most of these objectives have proven somewhat flexible. In general, the project's greatest successes have been in areas where it has helped develop space for project partners to determine the project's activities. It has been less successful in areas where it has been forced by the project objectives to be more prescriptive and directive.

Other objectives provided greater flexibility in allowing the project to develop more constructivist approaches. Objective 4, in which the project was asked to encourage the development of *technology champions*, provides an example. In developing its approach, project staff, once again, turned to project partners for guidance. Some of the advice was, first, that these technology champions should attempt to bring various groups of education professionals together to discuss issues surrounding the use of IT in education. Second, the approach used to train these professionals should model learner-centred and reflective approaches. Project partners also wanted to develop an approach that would model what it means to be a technology champion. From the project's perspective, a technology champion is proactive, likes to tinker with new hardware and software, develops creative uses for technology, and shares his insights and experiences with others. In considering this job description, though, project partners came to believe that *any* training approach that remotely resembled a transmission model could seriously undermine the effort to develop champions. After all, champions should be active acquirers of technical competency and creativity, not consumers passively waiting for the next round of technology training. The approach finally developed by the project for this purpose was OSSIAR.

Short for *open, shake, share, imagine, act!!!, and ... reflect*, OSSIAR is both the conceptual framework for the project's latter training designs as well as a model of the process a technology champion follows when actively experimenting with new technology. *Open* is the starting point; literally taking the new technology out of the box and getting started using it. *Shake* is the experimentation phase where the champions push all the buttons and explore the new technology to find out what it can do. *Share* suggests that champions can and frequently do develop communities of like-minded experimenters who informally share insights and suggestions with one another. It also demands that they share their ideas and understanding with friends and colleagues. *Imagine* is where the champions ask, 'So what?' or where they say, 'Aha, we can use this to ...' *Act!!!* implies that the champions move from the 'aha' moment to active experimentation in applying the technology to a given purpose. Finally, *reflect* asks that the champion reflect upon both the learning experience as well as the application of the new technology. Not surprisingly, the model for this process was a mental exercise trying to imagine what children would do if given a box with a mystery puzzle inside.

Armed with this new approach, the project sought to operationalize the concept into a training approach. This was not difficult as it seemed obvious that the best method to train people to follow this approach was to simply use a sample technology that would allow them to experience the approach. Essentially, the project would initially provide a new technology along with a very short set of instructions describing how, to 'open' the technology and then allow the trainees to follow the steps, encourage them to help each other and share experiences, ask them to consider the technology's utilities, encourage them to try it in their jobs, and facilitate individual and joint reflection.

Realizing that the level of comfort with the technology would be varied, the project chose the first meeting's theme to be 'overcoming fear.' As such, the first technologies used with the OSSIAR approach were *Discover Windows 98*, *Mavis Beacon Typing Tutor*, and learning about web-based e-mail service. The only materials brought to these meetings were four *One Page Introductory Sheets* (OPIs) designed to show the team members how to open the programmes needed to start these applications. Beyond this, project staff made sure they were nearby to answer questions and provide support, but only when specifically asked. This support was seldom requested ... the silence was deafening. All of the users were asked to work with the applications to decide how helpful they would be in helping their colleagues learn about computers and overcome their fears of technology. As such, the experienced users worked through the applications with this in mind, while the new users used the programmes to teach themselves how to use the computers and these basic applications.

After each team was given time to work with one of the applications, the facilitator would bring the team members together to reflect upon their experiences and talk about how useful the tool would be in assisting one of their colleagues to gain confidence in using computers. The answer was quite obvious as all of the team members had managed to learn the new tools with very limited input from the project facilitator. A second question asked was, 'How could this application be useful in your job?' In two and a half days, the project managed to 'train' a heterogeneous group of education professionals how to manoeuvre around an operating system, begin upgrading their typing skills, use a web browser, and access and use e-mail. Further, the team members felt empowered to work with their colleagues, clients and learners to help them acquire these same skills and began providing their own answers to the question, 'For what can this technology be used?' Essentially, the team members were in control, learned at their own pace, asked for assistance only when they wanted it, got just-in-time answers to their questions, shared their experiences and ideas with other education professionals, and experienced the acquisition of several basic competencies in a learner-centred environment.

Preliminary results

At the time of this writing, the CATT project in Namibia is three months into a six-month extension that gives the project a 22-month lifespan. The project is generally appreciated by the Ministry and other project partners. Listed below are a few of the more interesting preliminary results and outcomes of the project's activities.

- The four centres have been in near continuous operation since opening. They have all become key centres for providing IT training to educational professionals at NIED and in the regions.
- The project has been able to leverage significant support for local education technology, SchoolNet/Namibia.
- The centres now have a combined total of over 900 registered users. All four receive some revenue from use by users not affiliated with the education system.
- The centres are still managed by the original Education Technology Trainees trained by the project. These ETTs continue to gain valuable knowledge and experience and seem to professionally grow in their positions daily.
- The Regional Education Technology Teams are blossoming. In one case, two RETT members in one region teamed up to train over 90 faculty and staff from the local Teacher Training College largely using the materials and approach they experienced during their first meeting with project staff.
- The ED'S Net website has received several thousand hits including just under 500 that have lasted over 30 minutes. The site currently houses over 40 professional development modules covering basic teacher training topics, management topic, and HIV/AIDS education. The project has plans to train more NIED staff to provide content to the site.
- Using project input, NIED has recently procured sufficient workstations to provide small computer centres in ten additional TRCs around Namibia.

Conclusions

The experience of Morocco and Namibia suggests that education technology programmes to strengthen teacher preparedness and professional development can enhance the quality of professional training.

Appropriate and appropriated technology can also strengthen education reform processes. In the context of reform, education technology pilot projects can become creative disturbances that involve teachers not only in the acquisition of tools, but in the ownership of the educational reform project itself.

It has been our contention that inquiry technology in education, or $e^{(y)}$, is somewhat different from what we think of as computer-assisted instruction (CAI) or training. It integrates institutional considerations into the project design and it offers teachers the opportunity to participate actively in their own learning. By focusing primarily on technologies, inquiry and the tenets of constructing meaning and knowledge through action, Ibtikar and ED'S Net in Morocco and Namibia respectively create educational community and public goods. In so doing, technology training programmes become metaphors for the types of pedagogical changes desired in the classroom. It is our view that education technology programmes funded through development assistance have a better chance of generating multiplicative effects if donors and implementers fuse participatory, learning process approaches to implementation and training programmes that are enhanced through technology. This not only augurs for a less techno-centric approach to education technology but a much more dynamic process of institutions and institutional change, in which stakeholders take responsible risks in educational innovation.

There are many reasons why the $e^{(y)}$ approach, is not likely to be adopted widely. In general, donor organizations are risk-averse – even in reform. They are often not ready to admit that an approach like $e^{(y)}$ might have repercussions that would require institutions to change the way they do business or how they conceptualize and measure development. By and large, central ministries and donor agencies do not often allow pilot projects the flexibility to delegate authority down to the level of the learner in ways that allow them to begin structuring inquiry itself. But as the external evaluation of CATT-PILOTE in Morocco found, active involvement and participation of a large number of teachers and student teachers is perhaps the most important factor ensuring that a project is sustained and institutionalized.

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Chapter 9

Technology and educational change at the local level: the case of the Campana schools network in Argentina

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This chapter presents the early achievements of the Campana Schools Network (CSN), a project that is creating school networks using new information and communication technologies in the city of Campana, Argentina.

The CSN project was launched in a situation marked by tension between the effects of educational decentralization (linked to economic policies intended to reduce the educational budget) and educational policies aiming at regulating the education system as a whole and promoting educational quality and equity (Braslavsky, 2001; Carnoy *et al.,* in press; Tedesco and Tenti, forthcoming). Following the decentralization policies carried out by the military governments in the late 1970s and early 1980s, the national education system of Argentina moved towards a more heterogeneous federal system. As the schools gradually became integrated into this new system, the tension between two contradictory pressures (the 'authoritarian' and the 'liberal') increased and was strongly felt at the school level. On one hand, schools were supposed to be more autonomous. On the other hand, principals and teachers were afraid of the consequences of being left on their own.

The democratic governments of the period 1984-2001 pursued the process of decentralization with the ultimate aim of reinforcing the federal nature of the education system. They also created opportunities for democratic procedures, set up measures for the regulation and promotion of more equity in the unified national education system (despite its federal nature) and succeeded in reducing the gap between public and private schools, urban and rural schools, and those located in rich and poor provinces. They have not succeeded, however, in mobilizing all the schools in the country to strive for improved quality of education.

The progress made between 1984 and 2000 in educational policies (both at national and provincial levels), is not likely to be sustained, due largely to the depth of the political and economic crises that the country is presently experiencing. Given the problems at the national level, it became important to design educational policies at the local level.

The origins of the Campana project

With more than 8.5 million inhabitants, the Province of Buenos Aires is the largest and most heavily populated in Argentina. Campana, an average-sized, but affluent town enrols approximately 25,000 of the almost four million pupils in primary and secondary education in the Province of Buenos Aires. It benefited from the Argentine industrialization wave after the Second World War.

From 1994 to 1998 the schools of Campana received more than US $9,000,000. Of this, US $2,200,000 was in regular funding from the provincial government, through the municipality, and US $7,122,000 were additional funds from special local sources, mainly the industrial firm SIDERCA/TECHINT. Supporters believed, although never explicitly stated, that these contributions would lead to a higher level of achievement among Campana children and adolescents.

Since the expected change in achievement did not occur, SIDERCA/TECHINT, together with the provincial department in charge of schools, decided to conduct an external evaluation to determine the reason for the apparent lack of success. The office of UNESCO's International Institute for Educational Planning (IIEP) in Buenos Aires conducted the evaluation. The main conclusions of the study (Tedesco and Morduchowicz, 1999) related to the provision of educational services were that:

- nearly all of the financial contributions had been spent on new buildings and classrooms;
- these buildings and classrooms enabled a significant increase in new enrolments (due to migration) to be accommodated, to the great satisfaction of the community. It also allowed children to spend more years at school;

- this additional financing was *not* spent on improving the quality of educational services through improvements in the teaching and learning processes.

The effect on student achievement was more complex:

- There was a general decrease in the gap in educational achievement between Campana and others parts of the province. In part, this was because results varied a lot among the schools in Campana itself.
- Differences in school achievement were associated with differences in school cultures in high achieving schools of Campana. Thirty eight per cent of the teachers in high achieving schools believed that pupils' learning achievement was the responsibility of the teachers. In schools with the lowest achievement, only 16 per cent felt that they had any responsibility for student achievement. These findings seem to confirm the ideas put forward by Carr and Hartnett (1996) according to which none of the stakeholders in the educational process attribute much responsibility for achievement to the teachers.
- In schools with above-average achievement, the teachers reported that the pupils were joyful, had confidence in their capacity to discuss community rules and the criteria for evaluation, and felt they could propose new themes and activities. Pupils felt secure and thought that they received fair treatment. Teachers and principals worked better together, and were more able to accept suggestions and criticism. Teachers were also more ready to meet with parents, though they did not want parents to participate in school management. (In this respect, there was no difference between teachers in high- and low-achieving schools).
- Parents of children in schools with below-average achievement assigned higher priority to the learning of foreign languages – especially English – (45 per cent) and computer skills (20 per cent). Parents who sent their children to higher-achieving schools favoured an emphasis on traditional school disciplines, such as the national language (Spanish) and mathematics. This difference in parental demands was probably influenced by the fact that the higher-achieving schools concentrated on teaching cognitive skills linked to these disciplines, such as understanding, story-telling, and constructing abstract models.
- Schools with above-average achievement were also more open to participating in organized activities with other schools or institutions in Campana.

In view of the outcomes of the study, IIEP-Buenos Aires proposed a series of actions to improve the quality of education. These included direct measures to enhance the teaching-learning process through the use of ICT. At the same time, a group of the town's political and community leaders were busy establishing a Strategic Plan of Education for Campana. The proposal had remarkable similarities with the recommendations of the evaluation study, i.e. strengthening the training of principals and teachers, including the use of information and communication technologies, and developing the exchanges between the schools and the community.

These circumstances created a golden opportunity to negotiate new plans for the schools, to be financed by the municipal authorities and the firm SIDERCA/TECHINT. However, this assumed that satisfactory solutions could be found to two issues: (1) how to link the proposals of the evaluation team with the suggestions in the Strategic Plan of Education in order to ensure a coherent project and (2) who should carry out the suggested activities. The team responsible for the evaluation did not have the professional skills to undertake this new task. Even if they had the skills, there would have been considerable resistance to the idea that an institution that has conducted an evaluation also becomes responsible for preparing and implementing the reforms that they themselves had suggested.

For these reasons, an invitation to become involved in the project was extended to an international centre specializing in educational contents, methods and curriculum development, namely UNESCO's International Bureau of Education (IBE) in Geneva. In order to design a project to improve the quality of learning in low-achieving schools of Campana, IBE launched a series of exchanges. These addressed conceptual and strategic issues among the local authorities, the principal firm involved in the financial donation, the provincial educational authorities and the two UNESCO institutes (IBE and IIEP). During the discussions, it became obvious that the main financial partner was particularly interested in promoting the use of new technologies, both because of its vision of Campana's economic future and of its own needs as one of the most important employers in the region.

The proposal faced two main questions: (1) would the introduction of computers and learning with applications be an objective in itself or an 'instrumental', intermediate objective? and (2) should one start with the pupils or with the teachers?

Given the situation that prevailed in Campana in 1999, the conclusions were that: (1) the introduction of computers and the learning of computer skills should *not* be objectives in themselves and (2) the work should commence with the teachers. Furthermore, the project approach should be indirect. The project would start by arousing the teachers' interests in the new information and communication technology, and then link it to the objectives of the project.

The risk in stressing computer education was that funding technology would replace other initiatives aimed at improving instruction, and ultimately could result in a widened gap among schools. Following the arguments by Cuban (2001), one could predict that the high-achieving schools would incorporate computers in a school culture oriented towards the quality of learning (and with the teachers feeling responsible for it), while the low-achieving schools would be less likely to do so. In any case, in Campana it soon became clear that the proposal to learn about the new information and communication technologies was *not* a sufficient incentive to modify the school culture, particularly in the low-achieving schools.

As a result, it was decided that promoting the use of new information and communication technologies would be part of the process of empowering the teachers and principals and that this would facilitate the spread of a culture of educational quality across schools in Campana.

This strategy would involve designing and launching a school's network with the explicit purpose of promoting curriculum development and in-service teacher training. The in-service teacher training would be locally-based and integrate the construction and use of an information system on student learning, with the development and application of new information and communication technologies.

The IBE team and their local colleagues jointly prepared a methodological strategy, characterized by a move away from the traditional educational models to a new one focused on networking (OCDE, 2001). This involved setting up a network of schools that worked in a co-operative and supportive manner to promote improvements in the quality of instruction for all pupils. This network of schools was conceived as a lattice of social interactions between individuals and groups within and across institutions. It was seen as the opposite of a mere pool of machines and of a pile of telephones lines.

The proposal to create a network of schools with these characteristics assumed, on one hand, the introduction of new ways of managing curriculum development and on the other, the emergence of a new type of educational professional. The latter also assumes a very different conception of in-service teacher education (Goodson, 1995; Hargreaves, 1994; 2000).

After one year of implementation of the project, the present authors are in a position to offer initial observations about constructing a network of schools using information and communication technologies. It should be emphasized that this network of schools is located in a particular setting, namely, a local community faced with the risk of de-institutionalization in a context of a deep political, economic and social crisis (Castells, 1996).

The construction of local school networks

Though the idea of creating school networks is fashionable (Harasim *et al.*, 1998; Palloff and Pratt, 1999), these networks are only a tool. Without a reliable conceptual foundation, the network risks becoming commonplace, to the point that it may lose its potential to bring about concrete change. The reason to introduce change is not to accommodate the technology. Rather, the issue should be addressed the other way round: technology provides a means of introducing new educational practices.

From the community and state models to the networking model

In Latin America, there is a profound dissatisfaction with the quality of basic education. The causes are both situational and structural. This could mean either that it is felt that schools are operating in an unsatisfactory way, because the curricula, teaching materials and facilities are inadequate, or because the teachers do not have the necessary skills. In the view of the present authors, teachers' roles are linked to a particular model of schooling and to two models of educational management – the community model and the state model. Both models are in crisis and need to be replaced.

The community model is found mainly in the UK, the USA., the Netherlands and other contexts where parish churches and, later, municipalities set up schools in close harmony with local life. In the Community model, the decision-making used micro-political processes

(Ball, 1990; Barisa Ruiz, 1997). Each school made separate decisions about what and how to teach with little input from political authorities. These could be described as the bottom-up model of educational development. The state model was most popular from the eighteenth century onwards in nations like Spain or France. According to the state model, the state decided what should be learned and how, and the schools implemented (or did not implement) those directives. This could be described as the top-down model *(Figure 1)*.

Figure 1. The advantages and disadvantages of the State and Community models

	State paradigm	Community paradigm
Strengths	Benefits from a feeling of belonging to a greater whole, linked to a sense of national citizenship.	Local relevance and better possibilities for creating a sense of local belonging. Better opportunities for creativity, more attention to cultural and personal diversity.
Weaknesses	Constrains educational creativity, and less attention to cultural and personal diversity.	Lacks conditions and incentives to encourage the advancement of equity.

Nearly all the founding elites of the Latin American education systems wanted to create basic models where the most positive aspects of each of the two paradigms were selected. The elites of Argentina were no exception. They believed that the education system should receive a strong impetus from the central government, but that schools should also benefit from local participation. However, co-operation among schools was not even considered by the Latin American elites, and the existence of the relatively strong and dynamic nation-states, compared to communities and market economies, led to a clear domination of the state paradigm.

The state model has been associated with such achievements as the high rate of expansion of schooling and the building of national integration and social cohesion. However, this positive image reached its limit in the 1970s when, for different reasons, everyone began to criticize the model. The neo-liberals criticized it for its inefficiency while the libertarians criticized it for being authoritarian. Critics argued that there was a need to promote school self-management and school autonomy. Both proposals have been, in one way or another, inspired by the community model, which was the only real known alternative to the State model.

The time has probably come to avoid the trap of discussing the relative merits of top-down and bottom-up models. The technical means leading to the construction of a networking paradigm exist, combining the best features and avoiding the pitfalls of each.

The applicability of the state paradigm is in a situation of great inequality and weak civil societies. It fosters a feeling of belonging to a greater whole, associated with national citizenship, while obstructing the possibility of introducing educational creativity designed to cope with cultural and personal diversity. The situation in Campana was problematic because the province as a whole was experiencing the impact of a long-standing process of de-industrialization. The population was migrating to cities like Campana where, despite the crisis, some economic activity continued. The problem was that the government was not able to supply enough new schools nor provide adequate support or supervision of the existing ones.

On the other hand, in applying the community model, more attention would be given to individual diversity. It would not, however, bring more equity in situations of great socio-economic inequality and weak civil societies. In the case of Campana, applying the community model resulted in higher enrolment among boys and girls from poorer groups of the community. However, in the absence of appropriate benchmarks and possibilities of sharing experiences, it was not possible to improve quality in an equitable manner.

Applying the networking model would signify greater interaction among several levels of management, i.e. co-operative, non-hierarchical processes linking the existing institutions into one productive system. In such a networking system, the national, provincial and municipal authorities, the schools and other institutions would each have their specific role and, together, encompass the complexity of educational management and progress. One way of beginning to move towards a networking system is to set up local school networks, which would become true learning communities, and which would tackle in a joint manner the shortcomings of each institution.

In the case of the schools network in Campana, the objectives were to:

- create a feeling of belonging to the community as a greater whole; of being involved in public life that goes well beyond the immediate group of families sending their children to the same school;
- introduce in the school culture of the community external parameters of reference that are much broader in scale and that can be used by teachers and principals;
- learn together as a way of learning to live together;
- tackle common problems from many different approaches and points of view, so as to provide the participants with the possibility of conducting democratic discussions;
- collect and disseminate good educational practices, so as to contribute towards improving the pupils' retention of learning and the school climate;
- create better working conditions for all those involved in an educational institution;
- improve teaching skills by participating in in-service teacher training courses on curriculum development (oriented more specifically towards encouraging teachers to co-operate and engage in innovations and production of new curricula). This would ultimately allow them to retain effective pedagogical practices and enrich existing ones.

From this list, one conclusion is that it is possible to have networking systems without new information and communication technologies. A second conclusion is that it is possible to have new information and communication technologies without achieving a networking status. For instance, even if every single teacher obtains a computer and is taught how to use it, there is no guarantee that all teachers will decide to participate in networking. However, a networking system is only possible with teachers who are working in a way different from the hierarchical traditions reflected in the state model.

The promotion of educational networks, the curriculum and challenges to the teachers

In theory, teachers can be considered as: (1) uncritical implementers of the prescribed curriculum; (2) active implementers; or (3) adapters and promoters of alternative versions of the curriculum (Randy and Corno, 2000). In practice, teachers of all the three categories are participants in curriculum development, since they take decisions about what, when and how to teach and evaluate. Even when a prescribed curriculum exists at the national or provincial level, teachers re-interpret the meaning of the prescribed curriculum, that anticipates desirable educational processes at the national and local levels.

Teachers need to operate as potential innovators, though certainly not all curriculum development that arises from teachers may be labelled as innovative. In order for a curriculum development process to be considered as innovative, it should contribute something new to teaching. The teachers should be aware of this novelty and incorporate it as such in their teaching practices.

Furthermore, not all innovative processes necessarily lead to an improved teaching and learning processes. Innovations may exist but without making any contribution at all to improving teaching or learning processes. In fact, each teacher is a professional who develops his or her particular working methods in a particular institutional context, which may be, at the same time, a source of knowledge and ignorance, of innovation and repetition, or of improvement and deterioration.

To sum up, the following conclusions can be derived:

- The process of setting up school networks, going beyond the State and Community models, would be facilitated if a relevant national or provincial curriculum existed.
- The existence of a relevant national or provincial curriculum is a necessary condition for unifying the education system and giving political authority to proposed changes. However, this is not a sufficient condition to promote educational quality.
- Regardless of the process adopted for creating school networks aimed at improving the quality of learning, there needs to be an efficient process for curriculum development.
- An efficient process of curriculum development requires that teachers be considered as active participants and potential innovators.

This approach to educational change is not always adopted in the policies, programmes, plans and initiatives for teacher training in Latin America (Braslavsky *et al.*, 2001). Rather, most training programmes are aimed at preparing teachers within a traditional professional profile. Little attention is given to preparing them to work in educational institutions whose missions are not yet clearly defined within a knowledge society undergoing constant change. The emphasis of the training is more on preparing teachers to handle the immediate day-to-day problems in schools than on managing the process of change in the school. It is in response to this concern that the Campana Schools Network (CSN) was developed. The CSN can be considered as a 'designed experiment' (De Corte and Verschaffel, 2002) that draws upon teachers' potential innovative capacity to promote networking among the schools.

The role of ICTs in the construction of a networking education system

Replacing the conventional schools with the virtual schools or with home education, introducing far-reaching educational decentralization, and substituting new professional roles for teachers, are examples of significant proposals in recent years to change the model of the school, the way of managing the education system, and the role of teachers (Halstead, 1994; Meighan, 1995; Petrie, 1995).

The virtual school would consist of a series of computerized sites through which information is received and skills are developed. It would be a school without walls, with no physical location and no direct social interaction. One could imagine an extreme case of education decentralization that would lead to the disappearance of ministries of education and, ultimately, to all educational authority responsible for the content of teaching, maintenance of quality and equity. The new educational professionals would be the producers of content through information-providing sites, with the help of facilitators, such as parents (Attali, 1996). The initiatives advocating home education and coaches instead of schools is gaining ground.

In this context, according to a survey conducted recently in Argentina (Tedesco and Tenti, 2000) a considerable number of teachers felt deeply threatened by the new technologies. Twenty per cent of the teachers thought that the new technologies could replace their work in the classroom; 24 per cent believed that the new technologies would dehumanize teaching.

However, the availability of the new technologies will not necessarily lead to the disappearance of the school as a space for directed social interaction in which adults introduce younger generations to knowledge and skills that require deliberate learning and personal interaction (Gardner, 1983). In fact, whether the present form of schools will continue to exist does not depend entirely on the current technologies, but on the vision of the type of education that is desired. If there is a deeply felt need for harmony among people of different generations as a fundamental dimension of the learning process, schools will continue to exist, even if in a form different from the present. Hence, rather than being seen as a threat, the emergence of new technologies could be seen as an almost unique opportunity for schools and teachers.

The extent to which teachers do take advantage of this opportunity depends, above all, on the attitudes they adopt. Faced with a rapidly growing information base, some teachers may feel overwhelmed. Other teachers may have a completely different reaction and see this as a way of helping them to take up their new tasks in educational reforms aiming at *cultivating humanity* (Nussbaum, 1998).

Television is the technology that has most impressed and influenced teachers in their professional activities. However, the adoption of television in Latin American schools has been a rather slow process compared to the time taken for other innovations: it took almost 50 years before television became widely used by the teachers (Tyack and Cuban, 1995; Brunner, 2000). Also the use of computers and networking systems is not likely to spread as rapidly as one would wish – at least in the absence of policy measures for overcoming fears among teachers.

The schools network in Campana

The first version of the Strategic Development Plan in Argentina included four priorities for action: (1) in-service training of school principals; (2) in-service teacher training; (3) the introduction of new information and communication technologies; and (4) strengthening the relationships between schools and the community.

Following the release of the Plan, IBE and the Campana Strategic Plan team jointly analyzed the existing capacity to achieve these objectives and then prepared a plan to promote local curriculum development. During this joint work, it soon became clear that there was a need to establish, from the very beginning of the project, a reference point for the evaluation of its short and long term outcomes. Priority was given to the process of evaluating student learning achievement across all the schools of the province. The proposal was to evaluate the value added, that is, the increase in learning observed in each school, rather than comparing across schools.

The Campana Strategic Development Plan finally adopted was structured in a way that made the relationship to curriculum development more clear. The final version included the fifth line of action that introduced the above-mentioned system of evaluation and follow-up of student achievements. The design and implementation of the activities progress through the stages summarized in *Figure 2*. Based on this systematic sequence of actions, information was gathered for decision-making and learning concerning how to (1) involve the directors and supervisors; (2) conduct exchanges with the teachers; (3) make information known; and (4) modify the activities in accordance with the results and experiences communicated.

Figure 2. Stages of Campana team activities

Stage	**Activities at this stage**
Diagnostic stage	Identifying the problems, analyzing and determining expected outcomes of learning (as provided by the provincial system for evaluating educational quality), and establishing the priorities for action.
Design stage	Finalizing proposals and defining lines of action. Establishing inter-institutional agreements with the authorities in charge of education and with the other community institutions. Designating activities and distributing resources.
Execution stage	Teams of teachers from different schools participating in different lines of action and activities. For each line of action and activity, curriculum and materials are developed for use in the network.
Awareness-raising stage	Systematic processes for peer training being organized. Awareness-raising materials being distributed to the community.
Redefining action stage	Proposal to continue the project based on the evaluation of outcomes and revisions to programme based on evaluation findings.

During the preparation and implementation of the schools network in Campana, the team gained several useful insights. Among them:

1. The introduction of new information and communication technologies was slower and more difficult than anticipated.
2. The feasibility of successfully introducing such an innovation depended on the fulfilment of at least three conditions: (a) ensuring a real involvement of all the main stakeholders in the global planning process, (b) ensuring active feedback throughout the planning and implementation processes, and (c) encouraging teachers to produce concrete products before attempting to tackle intangible processes, such as pupils' learning outcomes.

The process of incorporating new information in an on-going planning process was relatively easy. The fact that each school worked with its own results and that these results were not published was extremely important in promoting an initial shift towards a culture of information use within a system that had absolutely no experience in doing so. The introduction of new information and communication technologies was not the result of a direct and isolated activity but of a comprehensive process of change aimed at locally-based curriculum development through the involvement and participation of many different actors.

A national study carried out by the National Ministry of Education of Argentina in 1998 stated that the availability of ICTs in the country was unequally distributed – schools with many students faced a particularly unfavourable situation. More than 50 per cent of the schools in the Province of Buenos Aires and of the capital (the largest city of the country) were provided with computers while less than 20 per cent of the schools in the northern provinces had computers. Access to computers in private basic education (grades 1 to 9) schools was more than twice as high (71 per cent) than in public schools (31 per cent) (Ministerio de Educación, 2001).

In the Campana schools, there were approximately three computers per school at the beginning of the project. Though the number of computers was well above both the national average, the level of equipment was below the minimum required to use new information and communication technologies in instruction. Computers were not evenly distributed. Schools with many students were at a disadvantage. Furthermore, 17 per cent of the machines did not work, and there were budgetary problems concerning their repair and maintenance.

In general, the few machines available were located in school offices and were used solely for administrative purposes. Only nine schools had classrooms devoted to the use of computers, and only two schools had staff responsible for overseeing the use of computers for teaching and learning. In spite of the obvious infrastructure constraints, the situation in Campana was considered better than the average, hence a good setting in which to carry out the project on the development and use of a school network to improve the quality of education.

Many teachers viewed the introduction of new technologies as a luxury far removed from their day-to-day concerns. Examples of questions continually asked were: "Why are we supposed to be trained in the use of new technologies when the telephone does not even work?" "How do we integrate the new technologies into the teaching process with so few machines?" "What is the point in having computers when there is no way of repairing them if they break down?" The demoralization and resistance among a certain number of teachers and principals were also linked to their lack of knowledge about the possibility of exploiting the new technologies in the teaching process and of working in teams.

Faced with this situation, the IBE and Campana project team chose not to insist on the general need for introducing ICTs. The arguments emphasized the facilitating role of the computers in the curriculum development work, especially through the professional exchanges among the teachers and between the teachers and the IBE team. The project strategy adopted comprised of a series of interrelated activities summarized below.

- *Raising teacher awareness*: Several introductory workshops were organized for language and mathematics teachers on the use of new information and communication technologies (Internet, e-mail, Powerpoint), directly linked to the contents and methods of their disciplines.
- *Offering examples*: The professionals from the IBE and the General Directorate of Schools in the Province of Buenos Aires used visual aids that were prepared using computers. Also, teachers were introduced to software for analyzing and presenting data from the initial evaluation of the pupils.

- *Deliberate demonstrations with a dramatic impact*: This consisted in carrying out a video conference between the teachers of Campana and a similar project in the Canton of Tessin in Switzerland. The teachers thus saw how far they could go in using new technologies, interacting with Swiss colleagues and learning about new ways of employing this tool.
- *Generating open spaces in the community*: Since most of the schools did not have access to the Internet, an agreement was reached with the National Technological University to make the server of this institution available to the teachers so that they could carry out their own distance education. However, even here difficulties arose. Since the teachers could not leave their classes during the day, they had to connect with the university in the evening after they had finished their work. Many teachers continued to give classes during the evenings, while others had to look after their own children who were at home during this period. All this considerably reduced the opportunities to participate. Only ten teachers enrolled in the distance language course and only four in the mathematics course. Apart from these difficulties, many teachers expressed doubts about the working method used and indicated their preference for learning through personal contact and one-to-one relationships. For this reason, most of them enroled in courses with a tutor present.
- *The use of electronic mail:* Despite all the difficulties indicated, ICTs were installed for the development of team teaching. Twenty-seven teachers were involved in the development of a curriculum for mathematics; another 36 did the same for language teaching. These teachers engaged in intense e-mail correspondence from their schools, the Technological University, from their homes, public telephones and the headquarters of the Campana Strategic Plan. The 36 teachers produced two high-quality programmes that were subsequently distributed to all the teachers in the network through printed newsletters and a web page (www.utenet.com.ar/planestrat) (Educación, Soñar Campana and IBE-UNESCO, 2002).

This experience suggests that, even in situations with serious infrastructure problems, it is possible to introduce ICTs in education by placing them at the service of teachers who will find ways of how to use it best and how to work together.

The strategy of the second project phase (to be implemented by autumn 2002) gives priority to the following activities:

- *The design of an Intranet* to connect the schools. Priority is given to institutions that are far from downtown Campana, especially to those located in the islands of the Parana river and to some rural schools also belonging to the Campana district. These schools are usually among the low performing ones and have certainly more difficulties, not being connected, in incorporating the production of the curriculum materials.
- *The continuity of the teacher training activities* emphasizing some applications, especially text processing needed to take part in joint curriculum development activities and productions. The local technological university will provide the training and offer Internet access to the participants.
- *The introduction of special software to manage the school libraries*. This software does not require Internet access and can be used by the teachers, the librarians – where they exist – and students in the final grades of basic education.
- *Improving teacher capacity to select specialised software on each subject matter.* This software is being sent to the schools to promote the use of ICTs.

Preliminary conclusions

- Principals and teachers are extremely committed to the School Network Project. For instance, at the beginning of the 2002 school year, teachers in the Province of Buenos Aires decided to go on strike as a result of the economic crisis when they were not receiving their salaries on time. It was amazing to note, however, that, at the same time, they requested that they should be allowed to continue with the different activities planned within the Campana School Network project. In fact, the most important incentive in their commitment was to see their names or the names of their colleagues appear in a curricular product addressed to all the teachers of the town, and even adopted by the educational authorities of the entire province and distributed to schools located in other towns.
- Teachers are participating in the same joint activities with parents and other community members, and the participation in activities

involving other institutions in and outside the town of Campana has increased considerably among the teachers.

The bonds and cultural ties prevailing in the Argentine society typically places individual interests above collective interests. In view of this, was the project strategy proposed for the Campana Schools Network (CSN) counter-cultural? The response of the CSN was that in a society like Argentina today, which is going through a process of disintegration, stimulating co-operative attitudes and behaviours among educators is a fundamental goal, perhaps even more important than improving educational quality (at least in the traditional, narrow sense of the word).

Teachers taking part in the Campana School Network felt that they were true adapters and promoters of alternative versions of the curriculum. They felt that they were involved in an important process of reinventing educational development (Randy and Corno, 2000). There is no doubt that educational processes in Campana are changing, slowly but surely, not simply because a school network has been created and new technologies have been introduced, but because teachers are involved in developing a high-level curriculum in which they believe they are able to try out in their work with students.

By being involved in producing educational materials, teachers are finding a new way of contributing to re-institutionalizing society at the local level and gaining access to information, knowledge, and recognition (Rifkin, 2000). The experience of CSN supports the idea that the inclusion of new technologies can strengthen teachers' and principals' motivation and engagement – and that of the community.

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Chapter 10

The pedagogical uses of web-based chat: the Brazilian experience

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This chapter describes an experiment led by teachers and pupils from cities across Brazil to explore the pedagogical uses of web-based chat. Web-based chat is a form of synchronous chat communication using software that is part of a web page. This form of chat does not require users to download any special software and can be used successfully in low bandwidth situations.

Background

Educators around the world are making extensive use of computers and the Internet to enhance teaching and learning. For over 4 years, the ProInfo programme in Brazil, in collaboration with teachers and multipliers across the country, has been seeking ways to help educators integrate these technologies into learning activities. Much of ProInfo's work focused on using a variety of basic software applications including MS-Office, paint, etc. in school computer labs established by the programme, to enable teachers and students to develop interdisciplinary projects. To build on this solid foundation and to expand opportunities for using computers and the Internet in learning, staff from the US-Brazil Learning Technologies Network[10] (LTNet) and ProInfo launched a pilot project in collaboration with a group of Brazilian teachers and multipliers (teacher trainers and

10. The US-Brazil Learning Technologies Network (LTNet) was a project funded by the Latin America and the Caribbean bureau of USAID (contract number: HNE-I-00-96-00018-00 T.O. #7) and administered by the Academy for Educational Development as part of the LearnLink project. LTNet was started as part of the US-Brazil Partnership for Education, a bilateral partnership between Brazil's Ministry of Education and the US Department of Education. This partnership created an environment of co-operation that enabled LTNet to collaborate effectively with ProInfo on a variety of innovative activities. Department of Education.

educational technology specialists) to explore the pedagogical uses of web-based chat. This pilot had three main objectives:

- to test the use of a simple web-based chat tool in collaborative educational projects;
- to identify effective strategies for integrating the use of Internet chat into Brazilian curricula;
- to learn what impacts, if any, Internet chat may have on teaching and learning and in carrying out interdisciplinary and collaborative projects.

This chapter discusses the technologies and approaches that were used in the project, describes the different project activities, presents an analysis of project results, and discusses the lessons that were learned from the Chat Pilot Project. Specifically, the paper describes how the project team used web-based chat with the teachers and students in the four schools listed above in the following ways:

- collaborative discovery;
- online seminars and interviews;
- professional orientation;
- professional development;
- chat with handicapped and special needs students.

The paper concludes with a brief description of how educators across Brazil can use web-based chat to enhance their project-based learning activities.

Participating schools

A project team composed of the Pedagogical Consultant from ProInfo, multipliers and teachers, assisted participating teachers and students in five schools in four cities across Brazil to use the chat software and explore the different uses of using web-based chat in teaching and learning. Multipliers are education technology specialists who train teachers to integrate the use of computers and the Internet into daily teaching and learning, and co-ordinate and support ProInfo activities in Brazilian schools. Multipliers work in teacher training resource centres, called NTEs (*Núcleos de Tecnologia Educacional*) that were established under the ProInfo programme and distributed across Brazil.

Project collaborators

ProInfo is an educational programme administered by the Brazilian Secretary for Distance Education (SEED) of Brazil's Ministry of Education. This innovative programme works in partnership with all 27 Brazilian states to establish computer labs in public schools and to set up a network throughout the country. Several features of ProInfo help to make it an effective programme. One of the most important is that ProInfo has made a significant investment, about 40 per cent of the programme's budget, in human resource development and teacher training, prior to distributing computer hardware to schools. This training also focused on educational practices, not just on developing 'how-to' skills with using computers and software. Also, even though ProInfo is directed by a skilled and dedicated team at the Ministry of Education in Brazilian, the programme's day-to-day implementation is managed by teams of skilled educators at states, municipalities, NTEs and schools. In addition to these critical roles, ProInfo also promotes innovation in the use of computers and Internet technologies in education and collaborative efforts with projects outside of Brazil. This Chat Pilot Project is an example of ProInfo's efforts to stimulate and support innovative action research and collaboration with other initiatives.

Project technologies

Internet chat is a form of synchronous online communication that uses software to allow two or more people to engage in real-time discussions by typing. Unlike many Internet chat applications in common use, the chat software used in this pilot activity, *Ralf's Chat*, was embedded in a web page in the LTNet web site. This made it possible for users to participate in synchronous discussion, or to *chat*, without having to buy, download or install any special software. This software also saves a copy of the chat discussion as a log file. This log file, which proved to be one of the most important pedagogical tools of this pilot, was used by the project co-ordinators, teachers and students to reflect on their discussions after they were completed. A more detailed description of the importance of the log file is presented later. Participants in the project only had to have access to computers connected to the Internet and to use a recent version of Internet browser software such as Microsoft Internet Explorer or Netscape Navigator. The simplicity of this software allows schools with even very slow connections to the Internet to actively participate in collaborative projects using chat. The chat room is displayed in the user's browser just like a regular web page. Because the software runs on the Internet server and only text files are posted on the Internet, it is possible to participate in chat discussion using a basic dial-up Internet connection.

As with all forms of Internet chat, the software used in the pilot allowed people from different locations to engage in discussions by typing their messages. Internet chat allows people to remain anonymous if they choose. They often use nicknames or even take on new identities when chatting. These characteristics of chat are largely responsible for chat becoming one of the most common and entertaining uses of the Internet.

These same characteristics are also responsible for many educators believing that chat has little educational value. As mentioned earlier, an important aspect of the software used in this pilot activity helped overcome this concern by maintaining a digital record of the chat dialog, in the form of a log file, so that the project co-ordinators, teachers and students could study the text of the exchange after it was completed. This enabled them to reflect on aspects of the discussion, to identify errors of expression they may have made, and to expose questions for further discussion and research. The log file also helped teachers overcome one of the most challenging aspects of project-based education – identifying and responding to students' needs. These log files were also used to plan future chat sessions and help keep participating students from using rude or inappropriate language.

The software is also very easy to learn to use. Participants only need to register a user name and password and then enter the room. There is a space to type their messages and then by typing the return/enter key or clicking on the 'post' button, the message appears in the main part of the screen. Users can also change the color of the text they use to post their messages so that it is easy to tell the difference between the dialogues of different users.

- Pilot activities – Internet chat used in educational projects

As mentioned earlier, the pilot project focused on using Internet chat within the context of different educational projects and themes. This was done to test the effectiveness of Internet chat under different conditions and for different groups of users. To help evaluate the effectiveness of Internet chat, the pilot's activities were organized into the following five main categories. It is important to note that these five uses are not the only ways that Internet chat could be used in education. Other educators are encouraged to be creative in the use of chat and to apply this communications tool to their specific needs.

Many of the activities in which Internet chat was tested in this pilot project involved collaborative interdisciplinary projects. The premise of this pilot effort was that using Internet chat in collaborative projects could be a powerful way to make project-based education more dynamic and interesting.

One of the cornerstones of constructivist education and project-based learning is that teachers should seek to respond to the real interests, needs and problems of students rather then impose their perceptions of need. Internet chat was expected to be a useful tool in helping teachers discover students' interests, needs and problems. Unfortunately, discovering students' *real* needs and desires is one of the most difficult parts of effective project-based educational activities. However, as the co-ordinators of the Chat Pilot Project discovered, the students themselves naturally exposed their educational needs and desires as they engaged in Internet chat discussions. And since these needs were preserved in the form of the log files, teachers were able to follow-up and guide student efforts to satisfy their natural desire to discover answers to questions and doubts raised during the chat.

During Internet chat sessions, project co-ordinators carefully observed the behaviour of students and teachers and the way they related with each other. The research co-ordinators analyzed the digital records from each chat dialogue to learn more about the dynamics of this environment. The co-ordinators also compared the behaviour they observed in the classrooms using chat with that of students and teachers in conventional classrooms. The rest of the chapter will briefly describe each of these uses of Internet chat and assess the benefits to teaching and learning. Only a few examples of chat activities are used to illustrate larger categories of classroom activity undertaken in the Chat Pilot Project.

■ Collaborative discovery

A group of 14 and 15 year old students from a school in Novo Hamburgo, a city in the southernmost state of Brazil, Rio Grande do Sul, met in a chat room with students from a school in Montes Claros, Minas

Gerais located in central Brazil. Mediated by two instructors, the focus of this chat was to allow students to explore the differences and similarities between the two regions of Brazil where the students lived. During their discussion, they compared the climate, vegetation, industrial production, life styles and traditional festivities.

During this chat session the students of Novo Hamburgo became very curious about why the people of Montes Claros would celebrate a festival for *Pequi*, a fruit that they had never heard of. This sparked an animated discussion about *Pequi* and the importance of this fruit to the economy and culture of Montes Claros. In another exchange, when the students of Novo Hamburgo mentioned that their economy was based on leather, a student in Montes Claros stated that the production of insulin was central to Montes Claros' economy. Questions were raised about insulin that none of the students could answer and as a result one of the Montes Claros students started, with his teacher's help, to do research about insulin. It is unlikely that the student would have been as eager or done as complete a job, if the teacher had assigned this research topic. This result illustrates how useful Internet chat can be in exposing students' educational interests and topics for learning projects and to stimulate self-managed project-based learning.

- Online seminars and interviews

A second example was a chat session between a group of high school students from Antônio Canela School in Minas Gerais and a psychologist at the Regional Superintendents office of Montes Claros. This chat session focused on student projects about early pregnancy among adolescent girls. Chat was used as part of the project because the teacher felt that the questions being asked by the students required more specific and scientific responses than she could provide.

A similar interview chat session took place among 11 to 14 year old youths in Belo Horizonte, Minas Gerais, and a team of specialists from Gurupi, Tocantins, a state in the north of Brazil. The science teacher in Belo Horizonte was developing a project with her students on adolescent sexuality. Early in this project the teacher realized that the students wanted to know more specialized information about adolescent sexuality than she was capable of providing. To meet this need, she and the local school's multiplier decided to use the Internet chat to allow the students to have a virtual interview with experts in this field. A psychologist and a science teacher from another school were invited to join the students for this seminar. The students were curious about many topics including, a boy's first ejaculation, the first menstruation, methods for preventing HIV/AIDS, affectionate relationships, and the process of learning about their bodies and discovering sexuality. They had a very open and animated discussion and the psychologist and science teacher were able to provide the students with accurate and detailed information without any of the embarrassment or silliness that can often accompany such discussions. This virtual seminar also allowed the psychologist and teachers to discuss other important topics such as the negative impact of early pregnancy on young women and to ask the youth to reflect on their actions. Without Internet chat, these experts would not have been able to participate in this discussion since the distance between the schools was too great. It is also likely that in a face-to-face meeting, the discussion of this topic would not have been as open as it was with Internet chat. The teacher in Belo Horizonte commented after the chat that during class discussion her students had not been able to be so open about the topic or ask so many detailed and follow-up questions.

- Professional orientation

In another example, 16 to 18 year old high school students from Montes Claros, Minas Gerais participated in a chat with the co-ordinator of a technical business course at the University of Montes Claros. This chat focused on the students learning about different career opportunities and the education required to prepare for those careers. This chat session provided the students with a rare opportunity to speak directly with a university professor about different courses, fields of study and related carreer opportunities. This provided the students with critical information, important in making decisions about which courses to take and the challenges they would face at college. Presently, few students have access to this first-hand information through conventional channels. Internet chat allowed the professional at the university to spend a short period of time from the convenience of his office to meet with a group of students and engage in a lively discussion. It is unlikely that a face-to-face meeting for this purpose would have been possible, and if it had taken place it is likely that the youth may have been timid and reluctant to talk openly.

■ Professional development

In this example, teachers from three schools met in a chat room to discuss how interdisciplinary projects are developed using computers and Internet technologies. The discussion focused on the important roles of interdisciplinary studies on effective learning. The teachers talked about different teaching methods that can be used when working collaboratively in an interdisciplinary way. During this chat, teachers shared their doubts, fears and experiences while working on interdisciplinary projects at schools with computer labs. Since the Chat Pilot Project was completed, the benefit of Internet chat has become very popular in training activities across Brazil. For example, during a training activity in Santa Catarina where over one thousand teachers and principals learned to use computer and Internet technologies for project-based learning, Internet chat contributed greatly to the experience. At one point, participants engaged in an Internet chat with Doctor Lea Fagundes, a national expert in this field from the Federal University of Rio Grande do Sul and the author of an article about the learning project that they were studying. Doctor Fagundes was able to answer questions and provoke a lively discussion without having to travel to the training site and the programme did not need to spend scarce funds for air fare and hotels to make this possible.

■ Chat with handicapped and special needs students

One of the most remarkable chat experiences of the entire study occurred when one of the project co-ordinators, Ieda Castro, joined an ongoing chat activity. A group of students from Montes Claros was in the chat room talking with students from Novo Hamburgo. When Ieda joined their chat session the students became curious about who she was and where she was from. As the discussion progressed the conversation became very animated and diverse and they all started asking specific questions about Gurupi, Tocantins, Ieda's hometown, and comparing conditions in their communities. Since this was an informal chat, the conversation was mingled with personal tastes and preferences; some even spoke about courtships, and the discussion flowed naturally and enjoyably.

At one point, the multiplier from Montes Claros sent a private message to Ieda explaining that the Montes Claros students were special needs children with a mixture of mental, visual and hearing disabilities. This was a surprise to the co-ordinator who later remarked that, in spite of one of the girls having shown a lack of attention, nothing else seemed to be different from having a conversation with students without disabilities. A few months after meeting the students in the chat room, the co-ordinator visited Montes Claros to attend a conference. This time she visited the school and met the students with whom she had chatted. However, in contrast to the open and dynamic chat discussion, when she met the students in person they became very shy and spoke little. Also, since the co-ordinator did not know sign language and the children were deaf they could communicate very little. This example illustrates the power of anonymous dialogue and the use of Internet chat to enable people with disabilities and those without, to participate fully and openly.

Soon after this chat session started, a deaf girl from Montes Claros began shaking. The teacher quickly moved to her side to see what the problem was. The girl explained with sign language that there was no problem, she had just become overwhelmed by being able to communicate for the first time in her life with someone who lived far away and the fact that she did not need anyone else's help to communicate effectively. Internet chat had provided a means for her to communicate with children who were not deaf and who did not know sign language. Suddenly, opportunities for her to learn and share with others had grown from the confines of her home and school to the rest of Brazil and the world. In short, her worldview and perception of herself and the future had been transformed.

Assessment and lessons

What impressed the participants the most in this project during the chat sessions in this pilot activity was the great expression of fondness and friendship that emanated from the online conversations even though most of the participants had never met. Initially, the project co-ordinators had expected the chat sessions to be dry and emotionless. From this it can be concluded that people participating in chat-enabled collaborative learning environments can share emotions as well as information, and develop friendships as well as constructive new knowledge.

Another important factor, observed clearly by teachers during the chat sessions, was related to the possibilities for deaf and other special needs students overcoming certain difficulties they encounter when trying to communicate with others, especially at a distance. The teachers and the project co-ordinators were also surprised to learn that participating in the chat environment enabled the deaf students to gain a better understanding of how prepositions and articles were used in writing. When used in isolation, prepositions and articles have little intrinsic meaning, and deaf students have a difficult time understanding how these words should be used. During the chat, the students had a chance to see these words being used in written conversations and they started asking questions about them and discussing the usefulness of these words with the teachers and other students. This example suggests how helpful guided chat activities can be in helping students become more reflective about language and the challenge of writing clearly so that others can understand.

Even though the participants in the chat sessions were not completely anonymous (since they used their real names and everyone knew where each person was from) they did not see the faces of the other participants during the discussions. This situation allowed the participants to feel anonymous and discussions were less inhibited. This was especially true when younger students were talking with adults. Usually, students are relatively shy when talking with teachers or adults they are not familiar with and will rarely ask questions or talk about topics that may be considered as personal or controversial. In the chat sessions, however, discussions were animated, open and free flowing regardless of who was involved. Students who usually exhibited very shy behaviour in face-to-face situations or who usually did not speak up in class were uncharacteristically candid and talkative. This allowed topics that might normally not be talked about, to be openly discussed. As a result, information and opinions was easily exchanged and all participants were able to communicate equally.

Because the dialogues were written rather than spoken, the participants had to spend more time thinking about their questions and comments than they would in verbal discussions. They were also able to read what they had written and then edit their sentences and expand on ideas. This combination of factors contributed to discussions that were thoughtful and meaningful. The focus on written communication also highlighted for the students the importance of good spelling and proper grammar.

Internet chat is often characterized by a very relaxed approach to spelling and grammar. However, when used in educational environments, especially among participants from different locations, it is possible to focus students' attention on the quality of their communication. Similarly, students became quickly aware of the need to very accurately and completely, describe things to other participants in the chat. Since facial expressions, hand gestures and the tone of voice could not be used to aid communication, the participants were required to be more accurate in the use of written language. At the same time, students' formulation and use of questions over the course of a chat session showed signs of becoming more focused and accurate. The Chat Pilot Project did not, however, examine the extent to which changes in the use of written communication used during chat sessions had an effect on students' overall writing skills.

Teachers involved in the Chat Pilot Project commented that they consistently have difficulty getting students to write and students regularly complain when asked to do writing assignments. However, students were eager to participate in chat activities in which they had no choice but to write and to be concerned about the quality of their communication.

As mentioned earlier, the log file created during the chat session provided a digital record of the discussion that students and teachers could study on their own and as a group. The importance of the log file, especially to the students, surprised the project team. At one level, the students showed great pride when reviewing the log file (which was often posted on the classroom wall) with others and pointing out what they had written and what questions they had asked. At another level, students became very reflective when reviewing the chat log file and started to identify inconsistent spelling and grammar. Many participating students, without being told by their teachers, quickly turned to dictionaries and other books to learn which spelling and usage was correct. And overall, they showed much greater interest in proper Portuguese.

Studying the log file also helped the students discover topic areas that arose during the discussion, which they knew little or nothing about. This realization was often followed by a personal quest for additional knowledge and information – a quest that would have been unlikely if the teacher had assigned it.

The pilot project demonstrated the power of Internet chat in connecting people of different age groups and from distant locations. Experts and specialists who would not have been able to visit distant schools for conventional face-to-face meetings, were able communicate from their offices with students in distant schools. Similarly, teachers with limited opportunity to participate in professional development activities or to network with peers from different schools, discovered that Internet chat allowed them to explore new educational ideas and practices and to share challenges and skills with colleagues across the country.

The Chat Pilot Project also showed that the quality of discussions could deteriorate if there are too many participants. The pilot did not seek to determine the optimum number of participants in a chat environment, but it seems that if more than 15 people are actively chatting at one time and in one room, quality suffers. It is possible, however, for part of a group of students to chat actively while the others observe and offer suggestions about what to type. Halfway through a chat session the students can switch control of the keyboard so that their partners can type. In one school, for example, students are organized into groups that are named after the planets. Each group logs into the chat room under its planet name and the members of the group take turns typing responses and questions generated by group members. This not only makes it easier for participants to follow a chat discussion but it also helps students develop good teamwork skills.

Conclusions

The Chat Pilot Project clearly demonstrates that Internet chat can be a powerful pedagogical tool that can enhance teaching and learning in different ways. Achieving the educational benefits of Internet chat, however, requires that educators carefully plan and moderate chat events. It is also important that teachers take a long-term perspective with using chat so that students are able to follow up on topics that are exposed during early chat sessions. Chat becomes a more powerful tool when combined with other tools such as e-mail and a listserv. This combination of communication tools allows for more complete and in-depth discussions. For example, during a chat, questions and ideas are quickly raised requiring more time and more writing to treat fully, than is available during chat sessions. In the pilot project, participants often exchanged e-mail addresses so that they could follow up with more thoughtful and detailed discussions on topics raised during the chat. This extended and expanded learning opportunities and strengthened relationships among participants.

The pilot also showed that teachers and students quickly learn to use the chat tools and that they greatly enjoy the dynamic discussions that occur. The pilot also showed that even with a slow Internet connection, chat could be done successfully. Also, when computers and Internet access are already available, Internet chat is essentially free.

It is important to note that Internet chat is not a perfect tool and that it should not be used to replace face-to-face activities. Talking and meeting with people face-to-face has unimpeachable benefits that cannot be replicated in virtual environments. When face-to-face meetings are not possible, however, chat may be the only affordable way to allow people to exchange ideas and learn from each other.

There is still much to be learnt about the use of Internet chat in different educational environments, and how best to integrate this tool with other computer and Internet technologies and classroom teaching. This pilot project has only exposed the tip of the iceberg. As more and more teachers and multipliers across Brazil start using Internet chat as a routine part of education, we will learn more about the pedagogical power of this exciting communication tool.

End notes

This paper uses some information that was originally presented in a research paper on the Pilot Project, "Internet Chat: An Educational Activit" by Vera Suguri, Lourdes Matos, Noara Castro, Ieda Castro, Lurdes Marilene Jung and Eric Rusten.

Chapter 11

Utilizing technology in a rural teacher certification programme in Iceland

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This chapter describes the use of technology in the delivery of a teacher certification programme in a sparsely populated country. The programme – at the University of Akureyri in Akureyri, Iceland – was created in 1994 in response to a persistent shortage of teachers in the region served by this university. The programme admits students with college degrees, many of whom are employed full-time as primary and secondary school teachers and are pursuing their degrees on a part-time basis. The programme involves students in a combination of learning activities through the use of e-mail, regular mail, telephone conversations, video conferencing and intensive study periods during which students meet to work in groups with the instructor.

Secondly, this chapter discusses the teaching methods used by instructors in the programme and how these methods have developed to include greater use of technology. Finally, it discusses students' response to the programme and examines how the Iceland experience may illustrate issues that educators in other countries need to consider in their own move to greater technology use in instruction.

The context

Iceland is a sparsely populated country with less than 300,000 inhabitants on an island of 103,000 sq km. The vast majority of the people live in close proximity to the capital city of Reykjavík, while the rest (less than 100,000) live mostly around the coast (Jóhannesson, 2001; *The educational system in Iceland*, 1998).

Akureyri, with a population of 15,000, is the largest town outside the capital city area. Traditionally, Akureyri has been an industrial and education centre and the informal capital of the north and northeastern parts of the country. In 1987, a state university was established in the town which, by 1993, offered programmes in four areas – business administration, nursing, fishing sciences and teacher education. The university continued to grow in both enrolment and in the range of programmes it offered. By 2001, the University of Akureyri had 188 full-time employees and 939 students, 369 of whom were enrolled in distance education programmes across three of its academic departments.

The need for distance education

In 1994, the teacher certification programme was added to the already established Faculty of Education. The original intention of the government was that college graduates would complete a pre-service certificate programme, apply for licensure from the Ministry of Education, and then find teaching positions. In practice, a teacher shortage led a number of primary and secondary schools to hire unlicensed teachers on a provisional basis, with the expectation that they would complete a licensure programme and then obtain permanent certification. Only 84 per cent of primary school teachers and 73 per cent of secondary schools teachers were licensed during the 1999-2000 school year (Baldursdóttir, 2001; Iceland Bureau of Statistics, 2002). This created the demand for a certificate programme that students could complete while holding a full-time job.

The teacher shortage was further exacerbated by changes in government regulations that progressively extended the length of the school day in primary schools by nearly 30 per cent between 1994 and 1999. This created a demand for yet more teachers (*Lög um grunnskóla*, 1995). The situation was most severe in rural parts of the country, though all parts of the country experienced shortages.

The organization of the teacher certification programme

Since 1999, the University of Akureyri's teacher certification programme is divided into six five-credit courses, three each year – educational psychology, curriculum theory and design, teaching subject matter, education and society, schools and school development, and short courses. Short courses consist of modules that include lectures and visits to schools to observe teaching, and speaking with teachers and principals. The offering of short ICT courses needs to be developed, both as distance education tools and as devices that the students will use in their teaching. The next step will be to add the use of interactive web site programmes to the programme as a whole.

The first year is focused largely on coursework while the second year includes field experience. The teaching is organized in short study periods where students meet with the instructor on campus during the summer and selected weekends. Between these study periods, students read the textbooks and work on different projects assigned to them by the instructors. Very few courses involve a formal final examination but, rather, rely on assignments. Much of the teaching is organized so that the students spend considerable class time discussing and working in groups and presenting group conclusions to the whole class in discussions.

Even though half of the students in the teacher certification programme do not live in or near Akureyri, the programme was not defined as a distance education programme until 2001. However, it became clear that technology was needed to maintain contact with the students, given the full-time employment of even those students living in Akureyri. Since many students are working full-time while taking a half-load academic programme, students use late afternoons, evenings and weekends for studying when instructors are normally not available.

This has led to an increased use of information and communications technology (ICT), albeit at a low level. Instruction has increasingly employed regular mail, telephones and, eventually, has included e-mail, web pages, and video conferencing. While instructors and students generally viewed the programme as a distance education programme, it was only formally recognized as one during the 2001-2002 academic year (Gunnarsson, 2001).

In the early 1990s, the university was poorly equipped to move in this direction. In 1994, for instance, the university did not have an e-mail system and regular mail and phone conversations were the primary tools of communication with those students off-campus. This changed rapidly. By 1997, e-mail and the World Wide Web (WWW) were available though relatively few students had access to them or knew how to use them. By 1999, almost everyone had access to e-mail, but there was still a need to teach many students how to use it. By 2001, access to e-mail and the web was nearly universal and most of the 60 students were proficient in the use of the web and of WebCT (a programme for delivering online instruction).

Incorporating ICT in instruction

An examination of how ICT was incorporated in one course, Curriculum Theory and Design, offers a perspective on the practical issues encountered in online instruction. The Curriculum Theory and Design course in the teacher certification programme was designed to provide students with (1) historical insights into curriculum design and textbook writing; (2) theoretical knowledge of different methods of teaching and evaluation; and (3) training in writing goals and objectives. As part of this course, students were expected to design a curricular unit.

In redesigning this course for use within a distance education programme, course materials were organized so that students could photocopy an edited draft of the instructor's lecture notes. Study periods, when students met as a group, were scheduled for three occasions during the semester (August, October and November). After the October period, students completed a take-home test. The main assignment, the design of a curricular unit, due in mid-January, gave students an opportunity to integrate what they had learned in the course.

Since students in the 1997 group believed they would have benefited from an assignment prior to the take-home test, such an assignment was created for the 1999 group. Students were allowed to work together on preparing the take-home test, though the results were graded on an individual basis. Four to six students were randomly assigned to work on the same question. Students received little supervision for these assignments, but instructors did respond to e-mail questions.

In designing their curriculum unit, students selected a topic and worked together in dyads or triads if possible. These working groups typically met face-to-face. To encourage students who are geographically dispersed to work together, they were given extra points (for making the extra effort).

During the curriculum unit design, especially for students living outside Akureyri, ICT has become increasingly important both for student-to-student and student-to-instructor communication. Students consult with the instructor 2-4 times while working on the design assignment. These communications are typically by e-mail, telephone, including conference calls, or, more recently, via web site. However, e-mail is by far the most convenient and effective ICT tool.

In structuring the course, students are given options. They can select a final examination or, alternatively, three smaller assignments to fulfil 50 per cent of the grade requirements, though everyone has to design a curricular unit. Lecture notes are made available on an open web site (e.g. one in which access does not depend on having a password). Student access to lecture notes allows the instructor to use the study weekends for group discussions rather than lectures. The open web site also allows students to download materials from it as soon as they know they are enrolled in the programme, therefore not having to wait to receive a password for a restricted site.

Training as a distance educator

Distance education is hardly new in Iceland. Radio instruction in foreign languages and correspondence courses in many content areas have long been used. Students taking lessons by radio or correspondence could take tests to demonstrate their proficiency and get credit for their distance work once they arrived at college. Consequently, the idea of distance education was not entirely new to the instructor who taught the Curriculum Theory and Design course. Nonetheless, his move into teaching a distance course was incremental. When he began teaching in the teacher certification programme in 1997, he had not previously used distance education techniques. He knew how to use e-mail, but he had little other background in the design and delivery of distance education courses.

When the university began to promote distance education, it offered short courses for instructors in using distance education techniques. The instructor began by taking a 20-hour distance education course in which he learned how to create a web site (Jóhannesson, 1998). The following academic year, he placed his lecture notes and assignments for the Curriculum Theory and Design course on this web site. Over time, he attended additional short courses on the use of video conferencing and on creating an interactive web site using the WebCT programme. Use of these techniques eventually led the instructor to try using video conferencing to create a one-day study periods (e.g. virtual meetings of class members). This gradual phasing in of techniques allowed the instructor to expand his knowledge of distance techniques at his own pace.

An important element in the success of ICT is that instructors and students establish some level of personal relationship. Even though the class meets face-to-face only occasionally, there is a sense that the instructor knows the students and cares about their progress in the course, a finding that is confirmed by the experience of other programmes as well (Macdonald *et al.*, 2001).

Student evaluation of their online experience

Formal and informal evaluations of the online programme have been conducted (*Nám í uppeldis- og kennslufræðum til kennsluréttinda*, 1996; *Sjálfsmat*, 1997; *External Assessment*, 1998). Annual course evaluations indicate that the overall design and organization of the courses in this teacher certification programme are well received. Students are pleased with most of the teaching and the positive attitudes of faculty and staff.

The evaluations also indicate that group work during the study periods (when students and instructor meet together as a group) is a particularly important feature to the students. Students learn from each other and operate as a support group for one another. The students indicate that the opportunity to socialize is an important dimension of the course experience.

The move to distance education has led to changes in instructional strategies and delivery methods in the Curriculum Theory and Design course. Some students report that at the beginning they were suspicious of teaching methods that included so much group work as was included in this course. Students were more accustomed to lectures. While most students have come to appreciate group work, it is not yet a universal sentiment. This may change as newer technologies make group discussion easier. For example, over the last 4 years, there has been an increased interest in the use of web pages and of interactive web sites for class discussion. Students offered a mixed response to the idea of using video conferencing. Most students said it would be all right to use it a little, while others said they did not want it. It was the only distance education technique that did not receive enthusiastic support from this group of students.

One of the criticisms that students report in the evaluations is that the workload is not consistent across semesters or among courses. This, however, is also true of on-campus courses and is not a criticism unique to distance education programmes. Another student concern is that online classes often require students to do more advanced preparation for class discussions. This, however, is one of the accommodations that may be necessary if the online component of distance education courses is to work effectively.

Perhaps the greatest disadvantage in the distance version of the teacher certification programme is the lack of field experiences. Field experience is difficult to organize and expensive to properly supervise. When students remain geographically scattered, other means may be necessary to address this element of certification programmes.

Lessons from the Iceland experience

The distance education teacher certification programme has helped resolve a key problem in Iceland. Uncertified teachers in widely dispersed locations needed to earn certification to maintain their employment, but leaving the schools for an on-site university programme would leave the schools without adequate teachers. The distance education programme described in this chapter has provided a solution to both problems. Organizing teacher certification programmes in this way allowed rural and remote communities to hire unlicensed teachers when they were unable to find fully licensed teachers and they did not need to let unlicensed teachers leave. Teachers also gained from this arrangement. This teacher certification programme gave individuals the opportunity to earn a teaching degree while they continued to hold their teaching jobs, regardless of their geographical location. These benefits came at a cost – both university instructors and students needed to learn new teaching and learning techniques.

There are several lessons arising from this case study that have relevance to the efforts of other countries moving toward greater use of technology in teacher training. Student evaluations and instructor experience indicate that combining group meetings with distance instruction is important. Study periods provide an opportunity for instructors to use demonstrations and group work to consolidate information obtained from online instruction. However, these group meetings (when students and instructors get together face-to-face) need to be well prepared and well organized. When students come long distances to meet, they expect their time to be well used. In the Iceland case, repeating information that was already available in lecture notes posted on the web or distributed by e-mail was not regarded as effective use of group time. This confirms the experience of other distance education programmes (Macdonald *et al.*, 2001).

1. Distance education tends to place new learning demands on students. It is not enough for instructors to repackage lessons in new ways; they need to anticipate the demands the new pedagogy will place on students and consider how they (the instructors) can help students cope with these new demands.

2. To the extent that distance education places new demands on students, it raised the complexity of the learning task. As complexity increases, there is a real risk that students will lose interest. There are essentially two ways to respond to this loss: (a) reduce the complexity of the task or (b) increase student incentives for undertaking the task. For example, one way to lower the complexity of the learning task is to ensure that students know how to use the technology through which the instruction is being delivered (e.g. providing adequate training and convenient technical support). One way to increase incentives is illustrated in the Iceland example: Instructors wanted students to combine distance and face-to-face learning activities so they gave extra points to student teams that made the effort to meet as small work groups.

3. Instructors also need to give students time to adapt to the new pedagogical demands of distance education. For example, students in the Iceland course were initially sceptical about posting lectures on the web and later about video conferencing. Part of their resistance was merely lack of familiarity. As they used these techniques, resistance began to crumble. This strategy builds on a well-recognized principle in the diffusion of innovation: the opportunity to try a new technique in small doses before being expected to adopt it more fully (Fullan, 2001).

4. There are advantages to using diverse methods for instruction. Different distance techniques appeal to different students. Consequently, using a variety of methods helps maintain learners' interest, allows a wider range of instructional strategies, and recognizes that not all students learn in the same ways. The Iceland course provides a useful example of the integrated use of multiple modes of instruction.

5. One of the criticisms sometimes levelled at high-technology based distance education is that it depersonalizes the learning process. The

Iceland experience provides an example of how mixed methods of instructor-student contact were combined in a way that still allowed the creation of a learning community among 50 to 60 students. Despite the distance education format, students felt connected to the instructors and to each other. A contributing factor was instructors' speed in responding to student questions. In the Iceland course, the instructors generally answered all e-mail inquiries within 2 to 3 days, and often within 24 hours.

6. Not everything will necessarily work in any given setting. In the Iceland teacher certification course, video conferencing, so far, has not been particularly successful. Not all schools or communities have the necessary equipment and, given the wide dispersion of these students around Iceland, it was difficult to use video conferencing effectively. Also, the video conferencing equipment at the university was not advanced enough to successfully broadcast it to multiple places at once. Video conferencing may work better in situations in which students are clustered at a smaller number of remote sites. Video conferencing is also relatively more demanding for the retraining of university instructors than the study period and e-mail arrangements. Serious initiatives to move to online delivery of instruction may need to incorporate several delivery mechanisms, in case some turn out to be less successful. Using diverse methods also gives teachers and prospective teachers living in remote and rural areas opportunities to judge and evaluate the different distance education methods and techniques. This means that even though, for instance, every student does not favour video conferencing, it serves some demonstrative function by giving students an opportunity to experience it.

7. Instructors need to be adequately prepared and supported in the use of the technologies they select to use. In the Iceland experience, instructors were advised to use only those ICT techniques they were confident with. Even then, the availability of adequate technical support for the university instructors was important, especially as instructors moved from using e-mail to using interactive web sites as primary modes of instruction.

The organization of the teacher certification programme in Iceland with a large distance education component gives individuals possibilities to study towards a teaching degree while they are working, regardless of where they live. This means that they can live in rural areas – villages along the coast or countryside communities – holding on to their teaching positions and securing their job for the future. Organizing teacher certification programmes in this way means that rural and remote communities can hire unlicensed teachers when they cannot find fully licensed teachers. Students in such programmes learn new ideas and different teaching methods through the use of ICTs and are able to experiment with those techniques in their schools.

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Chapter 12

Integrating technology into education: the Czech approach

Bozena Mannova

This chapter presents an analysis of the current Czech policy promoting the integration of Information and Communications Technology (ICT) into schools. The core of the argument is that, in order to maximize the benefits of technology in the classroom, the technology must be relevant to teachers, students and lifelong learners. Addressing the needs of all stakeholders in accepting ICT into the schools increases the motivation to overcome the challenges associated with its integration into the curriculum. Successful implementation depends heavily on the actions of teachers. To that end, it is crucial for education authorities to support teachers through in-service and pre-service teacher education that stresses the value of ICT.

Introduction

Information and Communication Technologies have influenced our world significantly in the last years. They are a catalyst for change in education, helping to bring about the new revolution in teaching and learning. Technology can also be a barometer of that change, providing a perspective of what is working and what is not. Learners are just one of the stakeholders in the current education system. For the revolution to succeed, the needs of all stakeholders must be addressed, or they may very well remain opponents of change. Learner-centred design addresses the need for learner engagement, but other stakeholders need a design that addresses the issues of effectiveness and viability.

In 1922 Thomas Edison wrote: "I believe the motion picture is destined to revolutionize our educational system and that in a few years it will supplant largely, if not entirely, the use of textbooks." Similar quotes on the potential educational impact of TV and computers abound. However, it is safe to say that electronic technologies have not revolutionized education and, in fact, have had little – if any – impact. However, this time it will be different; this time ICT will go beyond telling stories and presenting information to support individual and group activities. As ICT becomes more commonplace in the classroom and helps mediate student and teacher activities, the integration of instructional support into the fabric of moment-by-moment classroom activities will become the norm. In doing so, the vision in Edison's quote finally may come closer.

Similar to this situation in the other Eastern and Central European countries, ICT in the Czech Republic entered the schools with 8-bit black and white computers in the mid 1980s, with strong emotions, great expectations and mixed results. This proved to be an advantage, as the government of that time equipped nearly every school with an 8-bit computer laboratory. It supported complex out-of-school activities with computers, and established informatics as an obligatory and separate subject in secondary schools. From 1986 informatics was established as a compulsory subject in the first year of secondary school. Centralized management also had some disadvantages. The process of introducing technology lacked its own natural development, and some insensitive decisions were made which later worked against the integration of ICT. All teachers had to pass the elements of a programming course without understanding the reasons why or how this would improve their ability to teach such subjects as geography or English. This led to a prevailing negative attitude and a tendency to underestimate the role of educational software.

The use of ICT in education has always followed the development of technology:

- At the end of the 1960s, electronic data processing was growing in popularity. Students (mainly in universities) were acquainted with the principles of computing machines.
- The 1970s emphasized algorithms and active use of programming languages. The main motto of this era was "Every Czech should be a programmer."
- In the 1980s, access to computers exploded. Computer literacy for everyone was the main aim of the people interested in computers.
- Current practice integrates computers in many school subjects. This might be referred to as the "information technology cross-curriculum".

In 1986, it became compulsory for secondary schools in the Czech Republic to teach a one-year Information Technology course to all students. However, the schools were poorly equipped to do so at that time and there was a distinct shortage of teachers trained in computer science.

The situation changed dramatically during the 1990s. The schools are now better equipped and there are specially trained teachers. There are secondary schools throughout the Czech Republic which have good computers in reasonable quantity and connection to the Internet. However, most of the schools in the Czech Republic do not yet have this opportunity. There are two reasons for this: (1) there are still not enough well prepared teachers; (2) there is not enough financial support for these activities.

This chapter describes the Czech educational system and ICT in schools, and presents an overview of the use of Internet and video conferencing in Czech classrooms to engage learners and motivate teachers. It concludes with an overall analysis of Czech teachers' motivation to use ICT based on research conducted in 1997-2000.

Czech educational system and ICT at schools

The educational system in the Czech Republic is similar to the German system. Education starts for children at six and is compulsory until 15 years of age. There are approximately 4,000 elementary schools, 370 gymnasiums (e.g. general secondary schools) and 770 specialized secondary schools. Most schools have some computer capacity, but there is considerable variation in quality and Internet connectivity. All secondary schools teach a compulsory course on *Informatic* (e.g. computer literacy). One problem with ICT at schools is the diversity of technology at schools. Each school may have a variety of ICT. This is because the schools do not have money to buy everything at once.

In 1998 the international survey SITES (Second Information Technology in Education Study) was conducted in 26 countries to determine computer use at the school level. As *Table 1* indicates, schools in the Czech Republic are slightly below-average for computer use at the basic school level and above-average for use at the secondary school level. *Table 2* indicates the number of pupils per computer and documents the increasing access to computers between 1995 and 1998 (SITES, 1998).

Table 1. Percentage of schools with computer technology by level of schooling for selected countries, 1998

Country	Basic schools	Secondary schools
Belgium	73%	74%
Bulgaria	19%	70%
Czech Republic	**72%**	**90%**
France	100%	100%
Italy	79%	89%
Average from 26 countries	**83%**	**89%**

Source: SITES, 1998

Table 2. Change in student access to computers from 1995 to 1998, in selected countries

Country	Number of pupils per computer in basic schools	
	in 1995	**in 1998**
Belgium	29	25
Bulgaria	?	238
Czech Republic	**63**	**34**
France	29	17
Italy	?	16
Average from 26 countries	**68**	**48**

Source: SITES, 1998

These data reflect considerably increased student access to computers. Student access is even greater at the secondary level *(Table 3)* and exceeds the level found in many industrialized countries. Internet connections are most widely available at the secondary level *(Table 4)*. The findings of the SITES survey in 1998 and the MOE study in 2000 reflect variations in the methodology used and changes during the intervening 2 years between these studies.

Table 3. Number of pupils per computer in upper secondary schools, 1998, in selected countries

Country	**Number of pupils per computer in upper secondary schools in 1998**
Belgium	26
Bulgaria	54
Czech Republic	**10**
France	7
Italy	14
Average from 26 countries	**28**

Source: SITES, 1998

Table 4. Average number of pupils per computer overall and with Internet connection in Czech Republic

Type of school	**Schools with computers**	**All schools**
Number of pupils per computer		
Basic school	41	50
Gymnasium	23	23
Professional secondary schools	10	10
Vocational schools	11	12
Number of pupils per computer with connection to Internet		
Basic school	268	323
Gymnasium	37	36
Professional secondary schools	22	22
Vocational schools	45	40

Source: Ministry of Education, 2000

ICT in educational standards and curricula

Presently in the Czech Republic, there are three national educational programmes for elementary schools: *Narodni škola* (national school), *Obecna škola* (general school) and *Zakladni škola* (basic school). Each elementary school can apply one of the programmes or it can even suggest its own programme. If the Ministry of Education approves the programme, the school can implement it. The common element among the programmes is that they all should satisfy the Standards of Elementary Education, in which educational aims and the minimum standards for each educational branch is stated.

The Ministry has established the following goals for the teaching and learning of information skills at the primary school level. These goals are described in more detail in the individual subject curricula:

- to teach children of the appropriate age to find, process and use information;
- to form a communicative personality, which is able to listen to the ideas of other people; to learn the art of tolerance and collaboration.

A similar scheme is used at the secondary school level. There are two standards, one for general secondary education and one for the specialized secondary schools.

The following are some of the specific aims for the subject of informatics taught at secondary schools:

- to learn the basic concepts of informatics, as a scientific discipline of the rules of the origin, transmission, recording, transformation, presentation and use of information;
- in an era of ever increasing information, to be able to find one's way in information resources, and to learn how to select the substantial from the insubstantial;
- to learn the principles of scientific work, which consist of the gathering, sorting and evaluation of information;
- to develop algorithmic reasoning and a systematic approach to problem solving;
- to learn to use the computer as a working tool by using common software packages.

These standards are quite general. Each school has many possibilities for fulfilling these criteria. While this level of generality is adequate for experienced teachers, less experienced teachers need more help and guidance.

Teaching and learning process

One goal of education at all levels in the Czech Republic is that students become involved as dynamic rather than passive participants in the educational process. One way to do this, is to allow them to participate in the solution of complex problems from the real world by undertaking class projects, often working in teams. One strategy that class projects try to emphasize is 'just-in-time' teaching. Students learn new concepts at the time when these concepts arise in the project.

The major elements of the 'just-in-time' teaching/learning paradigm are:

- a long term and complex information technology project;
- a collaborative project team;
- the development of 'just-in-time' learning modules for students;
- a project unbounded by semesters;
- continuous measurement of the effectiveness of the paradigm toward project solution and learning goals.

Technology projects can be helpful in promoting this type of pedagogical practice. There are a number of experiences that can be taught through a project approach. However, the use of student projects is not well defined or as well understood as more conventional approaches to teaching.

Example of the project in the Czech Republic

Using complex projects in education and the implementation of the 'just-in-time' teaching model can be a positive contribution to the classroom learning environment. An environment that focuses on the student as an active, collaborating and contributing member of the teaching/learning process provides a superior way to achieve meaningful and lasting learning.

The Net-r@il project is an example of the Czech international projects that attempts to create such an environment. The project was initiated under the Net-d@ys European Union (EU) project in November 1999. The Net-r@il project involved 13 secondary schools, 38 teachers and more than 700 scholars from five European countries: Czech Republic, England, Northern Ireland, Portugal and Republic of Ireland. Objectives of the project were to (1) promote the use of information and communication technology in school; (2) encourage good practice in the use of Internet and take advantage of its pedagogic added value; (3) promote electronic exchange among schools of several European countries; (4) make students aware of Europe's cultural identity and diversity; (5) promote the spirit of local citizenship integrated in a European dimension; and (6) stimulate the relationship between the student and his region.

The web site of the project was created to represent all participating schools. The main language for communication was English, but Portuguese and Czech languages were also used. There was great interest in Czech language lessons at one Czech school site. The home page had 2,878 'hits' in one week alone.

Internet and video conferencing in teaching

Elements of effective ICT use in education include the use of the Internet and video conferencing. The Internet not only offers the possibility to search for information, but it can be an effective way for people to meet and work together. It is recognized today as an important communication tool. The main uses of Internet in the classroom are to promote the ability to work in teams, to get used to the method of co-operation from a distance, and to promote multi-national co-operation and understanding of diverse groups of people. Four examples of using Internet based communication are presented in this chapter.

The potential in video conferencing lies in creating greater opportunity for dialogue that can facilitate more effective learning than working in isolation. The dialogue may be between tutors and learners or amongst learners. However, the success of video conferencing may well be dependent on factors other than the technology, such as institutional issues, cost, and student attitudes toward the technology. The technology is in a transitional state and many are still uncertain about its utility for education. This makes video conferencing highly challenging and exciting to some, and a nightmare to others. As with the telephone in the past, users must learn how to make best use of video conferencing. It may well be the next mode of communication to be universally accepted.

New communication technologies are blurring the distinction between traditional and distance teaching. They have potential uses in both situations. The main pedagogical issue is to understand where the new technology will have the greatest impact on learning effectiveness. Technology allows the constraints of time and distance to be greatly lessened by bringing the power of small group, face-to-face teaching to the individual desktop, in the home or at the office. However, the reasons for using video conferencing in traditional and distance teaching are quite different.

Desktop application brings video conferencing into focus. However, the frame rate and the tiny picture window make it an uninteresting application. But when it is used in conjunction with other collaborative software, such as whiteboards, shared screens, and shared control, there is adequate functionality to entice users. This type of video conference is most useful when the documents and information to be exchanged are stored on the computer. Information can be shared and discussed quickly over the network, cutting out the time and cost of a courier.

Reasons for the use of video conferencing in different types of educational settings are presented in *Figure 1*.

Figure 1. Comparison of reasons for video conferencing in different instructional settings

Traditional education	**Distance education**
Increased access to students	Social contacts
Broadening of the learning experience	Telepresence
Distributed, virtual classes	Group coherence
Increased access to experts	Increased access to teachers and experts

Four examples of the use of Internet based communication and video conferencing in education help illustrate their value as instructional tools. The examples are drawn from efforts underway to increase the opportunities for in-service education for teachers. The goal is to create a relevant, responsive and information-rich learning environment for teachers. Video conferencing is one of the real-time communication tools used. It helps to develop a virtual community linking teachers to information technologies.

■ Example 1: Global co-operation project in computer programming courses

The Common Programming Projects (CPP) involved a collaboration between the Czech Technical University (CTU) in Prague and the North Hennepin Community College (NHCC) in Brooklyn Park, Minnesota, USA. Students worked in global teams consisting of participants from both countries working together to solve common programming problems.

The social goals of the project were for students to create personal contacts that would foster future co-operation, practice a foreign language, experience a different mentality, and increase student involvement in the course. The professional goals of the project were for students to collaborate in the distribution and completion of teamwork and learn how to use the Internet as a collaborative tool. While this worked on software projects, the concept is general and can be used with other content as well. The basic timetable of the project was:

- preparation and first video conference – with an introduction of participants, formation of teams, programming project analysis;
- implementation and testing of software, documentation of results;
- final video conference – with a presentation of results.

For the video conference sessions, the team used Internet Microsoft NetMeeting and PC cameras. Such an approach required minimal cost and technical background. Programme developers also considered other options, for example using ITV (interactive television) rooms. However, the cost of using the other technology is so much higher that it would have significantly limited the total time the students could use it.

■ Example 2: In-service teachers training – Tempus project

The Tempus project *Implementation of Telematics in Education* was implemented from 1997 to 2000. Co-ordinated by the Czech Technical University in Prague, the partners included Charles University in Prague, University Ostrava, University of Helsinki and the London Institute of

Education at the University of London. The experience of the UK and Finland in designing, managing, organizing, delivering and evaluating teacher in-service courses in Telematics served as a guide. The purpose was to create a system of in-service teacher preparation courses for the Czech Republic. Courses were designed partly as face-to-face and partly as online courses. The ICT support for courses included video conferencing.

Courses were delivered in different locations across the Czech Republic and often used video conferencing for presentation of projects and for class discussion. The end of project evaluation indicated that participants were generally positive about the use of video conferencing for presentation and meetings. Some of the teachers also started to use video conferencing in their schools.

- Example 3: Distributed programming contest

The ACM International Collegiate Programming Contest is an activity of the ACM professional organization that provides college students with an opportunity to demonstrate and sharpen their problem-solving and computing skills. The contest is a two-tiered competition among teams of students representing institutions of higher education. Teams first compete in regional contests held around the world from September to November each year. The winning team from each regional contest qualifies to advance to the ACM International Collegiate Programming Contest World Finals, typically held the following March to mid-April. Sixty-four teams of students from 2,700 teams representing 1,079 universities in 70 countries on six continents competed for bragging rights and prizes at the World Finals of the 25th Annual ACM International Collegiate Programming Contest held on 10 March 2001, in Vancouver, Canada. Among them was one team from the Czech Republic.

To choose the best team for the regional contest, a national contest, called the CTU Open, was run from two sites – the Czech Technical University in Prague and Ostrava Technical University in Ostrava. The best teams from the main universities in the Czech Republic competed. The contest was run online and throughout the competition day there was contact between both sites also by video conferencing. This was used not only for the teams' presentations, but also for presentation of the correct solution at the end of the contest. The sense of real contact was usually very good.

Example 4: Teaching of senior citizens

The educational system in the Czech Republic is undergoing rapid change. One important change is the emerging emphasis on lifelong learning. As a part of a lifelong learning system, the Third Age University (U3) for senior citizens was introduced in the Czech Republic. As part of U3, the Czech Technical University in Prague offers a course on 'Basic ICT Skills'. The course is designed for two terms. The seniors use computer laboratories at CTU, and have an account number and e-mail address like other university students. Because most of the participants have no previous experience with computers, and many are afraid to use computers, considerable attention is given to motivating them to use the technology. The course covers the use of World Wide Web search, writing letters, using e-mail, and creating web pages. At the end of the course there is a public presentation of the participants' projects.

This course is different from other IT courses. The older learners need more support during laboratories, but they work harder and their results are good. The topics for their projects are often linked to their professions (e.g. doctors, lawyers, writers). They feel that education keeps them younger and can help them in their work. What may be most important is that they feel like a part of society. A lot of them have said that they value the ability to have better contact with family members. With frequent emails, their relationship with the family improves dramatically.

Video conferencing was used in the Basic ICT Skills course to link together older learners in Spain and the Czech Republic and, on another occasion, to link older learners and high school students in Prague. The discussion between those two groups took 4 hours and covered many topics. While the older learners had used video conferencing before, it was the first time for high school students.

Teacher training

Computers can be a catalyst for change in classroom instruction, though the pedagogical issues are still being explored. At the same time, there are often problems. When teachers are faced with pupils who are more knowledgeable about the technology than the instructor, it can undermine the teachers' authority. Resourcing is also a problem, as teachers are not usually given computers as part of their job. Without ready access to a computer, teachers can feel underskilled. Reading and writing skills are no longer adequate. New teachers also must master computer literacy, networking, and media literacy.

There is a lot of in-service training in ICT available for teachers in the Czech Republic. The training is generally delivered by universities, some of it online. In the Czech Republic there are also different forms of pre-service training in informatics. This difference can be problematic. Before 1989, teacher education was co-ordinated, with a unified curriculum and textbooks. Largely as a result of political changes in the country, that unity no longer prevails. A new university law has considerably reinforced university autonomy and the powers of academic bodies. At present, each university and faculty can specialize and offer different teaching qualifications for particular grades and subjects. Some of them prepare teachers just for upper secondary level, some for lower secondary, and some for primary. The length of study is 4 or 5 years.

Informatics teachers are trained in specialized faculties, for example in the Faculty of Mathematics and Physics at Charles University, in the Faculty of Informatics at Masaryk University in Brno, or in the Faculty of Science at the University of Ostrava. These teachers are prepared to teach mainly in secondary schools, where the subject of Informatics is obligatory. Elementary teachers are prepared at the pedagogical faculties of nine universities in the Czech Republic. The structure, organization and content of teacher training in the field of ICT are different at each university and, therefore, there is not necessarily a high level of consistency in the skill level of teachers in the field.

State information policy in education

In part to address this issue, in April 2000 the Czech Government ratified the State Information Policy in Education (SIP). Financial support to implement the SIP was then provided in the state budget. Implementation started in May 2000. While co-ordinated by the Ministry of Education, the project was split into three components:

- Education of teachers;
- Tools and information resources;
- Infrastructure (ICT) for schools.

The government's target is as follows:

All schools in the Czech Republic will have Internet and educated teachers to support the use of ICT in teaching and learning at all basic and secondary schools by 2005.

Most schools are interested in using ICT. However, the efforts of schools to acquire ICT vary considerably, from active schools that are well equipped, to schools with no state support that are waiting for government funding. The schools have ICT allies, both outside and inside the schools. Pressure for schools to utilize more technology is coming from local authorities, who themselves are using electronic communications. Headmasters, too, are assigning more importance to technology. *Table 5* reports the importance assigned by headmasters to different possible outcomes of technology training.

Table 5. Importance assigned by headmasters to selected outcomes of technology training (in percentage of headmasters selecting each response)

Selected outcomes	**Basic schools**	**Secondary schools**
To train pupils for future jobs	40	77
Improve pupils results at schools	12	13
Motivate pupils to learn	40	34
Individual approach to teaching	28	18
Team co-operation and projects teaching	9	12
To support independent learning of pupils	35	41
Practising and training	33	30
To make learning more interesting	40	30

Motivation of teachers to use ICT

There is a growing recognition that teachers are important in the process of introducing ICT into schools. However, in practice, many teachers still do not use technology in their instruction. To understand their resistance, a study was undertaken during 1997-2000 to assess the motivation of teachers to use ICT. The purpose of the study was to investigate the factors which motivate teachers to use ICT and to sustain their use of ICT in teaching. The factors identified would then be used to develop guidelines to better support the professional development of practising teachers in the use of ICT in their teaching.

Czech Miranda was a project founded in 1995, based on the British MirandaNet. MirandaNet is a non-profit international partnership in ICT, supported by industrial partners, consisting of teachers, researchers and industry representatives using ICT for professional development. The group concentrates on professional development programmes using face-to-face workshops, online tutorials, online conferencing, and web site assignments. The core aim of the *Czech Miranda* is to support lifelong learning using advanced technologies across social, vocational, cultural and political divides by providing a forum and supportive network for its members. Helping teachers to develop management strategies to cope with the changes required to use ICT effectively is viewed as an important part of the project's work. Reports, case studies and Internet communications have been collected over the years to document the experiences of the MirandaNet and *Czech Miranda* project members, and much of this evidence has contributed to the research in this motivation study. The objectives of the study were:

1. To identify experiences in using ICT that have motivated teachers.
2. To determine the relationship between teachers' motivating experiences and their perceptions of the advantages and disadvantages of using ICT.
3. To identify the most suitable teacher education strategies for increasing motivation.
4. To develop a framework for in-service education, embedding motivation strategies into teacher education.

A questionnaire was used to collect data from teachers on their ICT experiences, their use of ICT in teaching, their attitudes about the value of ICT in instruction, and the training they had received. A sample of Czech teachers who were linked with the *Czech Miranda* project completed the questionnaire. Consequently, the results are not representative of the average Czech teacher, but typifies a group of teachers advanced in ICT use. Questionnaires were returned by 61 educators, for a 61 per cent response rate (25 males: 44.6 per cent and 31 females: 55.4 per cent). The higher proportion of females may be due to the greater proportion of females among IT teacher in the Czech Republic.

Characteristics of the respondents

The age distribution of the respondents indicates that the majority was in the younger-aged bracket (13 per cent aged 20 to 29; 25 per cent aged 30 to 39). This finding is consistent with the broader literature that showed that ICT is mostly conducted by newly qualified and younger teachers. Respondents were about evenly split between primary and secondary schools, and there was almost the same number of teachers from both kinds of schools. Fifty-two percent of the respondents report that they are teaching mathematics, physics, technology, or electrical technology. Respondents were initially trained to teach a wide range of subjects and only one teacher was initially trained to teach IT.

Personal ICT use

The results show that 22 teachers (36 per cent) from the questionnaire sample did not have access to a computer at home. Respondents had a range of computer types for their personal use at home. The majority had a desktop PC (64 per cent). Only one teacher owned a laptop computer.

Respondents were asked about their basic IT skills. These findings show that the majority of the respondents were able to perform a wide range of computer tasks, indicating a substantial level of IT skills in relation to other teachers. The majority of respondents reported using many forms of ICT at home, including presentations, digital camera, music software, video conferencing, and scanning and image manipulation. However, the most frequently used application at home was word-processing. Few used WWW or e-mail at home. The main reasons for this were limited time and cost.

ICT use in teaching

While the majority of teachers used a wide range of forms of ICT in their teaching, the most common form were word-processing, CD-ROM, spreadsheets and subject-specific software. Results indicated that teachers were covering most of the themes in the ICT curriculum, i.e. communications, handling information, modelling and simulations and presenting information.

Respondents were asked to rate the extent to which they agreed with six statements concerning factors which made using ICT in their teaching more difficult. Most respondents did not view these factors as significant barriers to using ICT in their teaching, with two exceptions: (1) difficulties with hardware/software disrupting lessons and (2) preparation for lessons being time consuming.

Teachers were asked to rate the extent to which they felt they needed various forms of support in using ICT. The majority of respondents needed more support than they currently received. Half of the respondents were dissatisfied with the level of IT to which they did have access.

Previous research suggests that teachers are often persuaded to adopt innovations if they believe those innovations would have a positive effect on the pupils. Consequently, items were included in the questionnaire to assess the extent to which the teachers felt that using ICT in their teaching benefited the pupils.

Advantages and disadvantages of using ICT in teaching

Over 90 per cent of the respondents agreed or strongly agreed that using IT in instruction made lessons more fun for students, increased students' motivation to learn, and increased student learning. Other suggested benefits included greater autonomy for the learner and the ability for children to learn at their own pace. Teachers also perceived that IT enlarged the range of teaching strategies, reduced administrative workload, and made teaching more interesting for the teacher. The main disadvantage of using ICT in teaching was technical problems. Technology sometimes got in the way of teaching. Other disadvantages included inadequate or insufficient resources, expense and the extra time needed.

For societies like the Czech Republic that, in the past, have been isolated from developments outside the Eastern Bloc, there is the great hope that the Internet will help break down international barriers of status, class, politics and continents. Achieving this vision will require a partnership among the makers of new technologies, the sellers, the politicians and the educators. The initiatives described in this chapter are examples of how schools in the Czech Republic are moving forward towards membership in a global society.

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Chapter 13

The school online initiative in German schools: empirical results and recommendations to improve school development

Renate Schulz-Zander

This chapter discusses Germany's progress regarding the incorporation of Information and Communication Technology (ICT) into schools, focusing on secondary schools (general and vocational). Successful implementation of ICT into the schools requires updated policies, analysis of current use of ICT, discussion of the pedagogical objectives of the use of ICT, and evaluation of the attitudes and experiences of all stakeholders in the innovation process. Two research studies are discussed to show the progress of German schools towards the fulfilment of a *Schulen ans Netz* (School Online) initiative seeking to provide all schools with Internet access and sustainable innovation.

Background

According to the declaration of the Standing Conference of the Ministers for Education and Cultural Affairs[11] (KMK, 1997), Information and Communication Technology offers Germany great chances through the position of aid for the design and realization of teaching and learning processes. With ICT, important educational goals such as self-determined learning, project-oriented learning, co-operation and teamwork, interdisciplinary forms of learning and working, and multi-disciplinary

11. The Federal Republic of Germany comprises 16 federal states, which have exclusive jurisdiction in educational affairs. Their authority includes regulation of the curriculum, time schedules, professional requirements, teachers, school buildings, equipment, and recruitment of teachers. The federal states co-ordinate their educational policy through the institution of the Standing Conference of the Federal States Ministers of Education (KMK). Resolutions and recommendations only become legally binding if they are promulgated in the form of state laws, decrees or regulations by state authorities.

thinking can be promoted and worked with, decisively dealt with and experienced. The change of self-learning and group learning can increase the motivation for learning, and support the readiness for an independent and lifelong further learning. ICT also offers possibilities for meaningful pedagogic support to schools with special needs.

Because of this, successful implementation of ICT in schools requires full development and solid management of the innovation process, where interactions of technological innovations and existing procedures and structures are addressed and discussed by all the people involved in the school, and controlled by a qualified body of experts. These structures, though, have to be developed first, and existing oppositions have to be identified and overcome.

Policies regarding ICT in education

Since the middle of the nineties, Information and Communication Technology (ICT) – especially multimedia and telecommunications – has been an important topic in German policies on education, due to the enormous changes in society that are associated with it. In 1995, the German Telekom AG launched a nationwide initiative to prepare students for the information society and get the schools connected to the Internet. This initiative has played a decisive role in alerting the general public of the significance of multimedia and the Internet for teaching and learning processes in schools.

Several initiatives and funding programmes have followed to contribute to the forthcoming transformation from an industrial society to a knowledge-based society. Measures were taken for the equipment of schools, changes of curricula, development of material, further vocational training for teachers, development of learning software and also for advising teachers.

Considering the importance of multimedia, the Internet, and the World Wide Web in the society, the KMK has responded to the challenge that this new field of ICT represents. The declaration of the KMK (1997), entitled "New Media and Telecommunications in Education", serves as an orientation for the federal states in order to renew fields of education.

New media is considered to be the following:

- an object of teaching and learning;

- teaching aids;
- a field for vocational qualification;
- a medium for distance learning (KMK, 1997:1).

In the testing, research and implementing of ICT and telecommunications in the education system, KMK sees a deepening and widening of questions that have up to now been dealt with in the context of the ICT education on the one hand and media pedagogics on the other hand. That means that the declaration New Media and Telecommunications in Education is based on the 'General Framework for Information Technology Education in Schools and Education' of the Federal Government for Educational Planning and Research Promotion (Bund-Länder-Kommission für Bildungsplanung und Forschungsförderung (BLK)). This includes obligatory basic ICT education in lower secondary schools, ICT integrated generally into selected subjects, ICT as a medium in all subjects, and ICT in vocational schools. The declaration is also based on the recommendation 'Framework for Media Pedagogics in Schools', which describes a wide-ranging plan of action, aimed at reinforcing and developing media competences which have to be implemented in stages. Linking aspects of both fields, new media and ICT, is a decisive contribution to a comprehensive media competence, providing qualification for responsible and creative use of ICT.

The school online initiative

Based on a study of a commission of the German Informatics Society, the German Federal Ministry of Education and Research (BMB+F) and the German Telekom AG subsequently started a social initiative in 1995 to stimulate the implementation of multimedia technologies at general and vocational schools by establishing the association *Schulen ans Netz* (School Online) in April 1996. The aim of the federal association is to firmly establish new media and the use of the Internet as an integral part of day-to-day teaching in schools. The German Telekom and the Federal Ministry of Education and Research have provided 80 million euros in funding for the nationwide initiative which is also receiving support from the federal states. Forty eight million euros was provided by the Telekom. These funds were to be used to connect nearly all the 43,000 schools in Germany to the Internet by the end of 2001.

The nationwide initiative *Schulen ans Netz* was mainly aimed at providing support for establishing the technical infrastructure at schools.

Starter schools, pilot projects, and further training courses for teachers were promoted. The 'starter schools' were usually equipped with an Internet connection and a multimedia computer equipped with ISDN board, software (MS Office package) plus a charges credit. Schools with 'pilot projects' and already existing local networks were connected to the Internet via a server or router and were upgraded with multimedia workstations. Since February 2000 German Telekom has offered Internet access via T-Online to all schools at no charge. The accompanying federal initiatives have enhanced the equipment of schools with computers and Internet access. Regarding the expenses of the use of ICT in education, all federal states have launched their own ICT initiatives with separate budgets. The total budgets of these state initiatives often combine financial resources from the federal republic, the municipalities and local authorities, and private companies or supporting associations (in a public-private-partnership).

Evaluation of the initiative

The evaluation of the *Schulen ans Netz* initiative was carried out by the Institute for School Development Research (IFS) of the University of Dortmund together with three other partners at the Free University of Berlin and the Humboldt University, Berlin. It was commissioned by the association 'Schulen ans Netz e. V.' and promoted by the BMB+F.

For a few years now, the lack of embedding innovations of information technology at school, into the process of school improvement has been considered a decisive obstacle of sustainable implementation. The necessity of combining innovations with school improvement concepts is known by now in order to achieve a high-quality, effective use of new media in schools and teaching (Fullan,1996; Schulz-Zander, 2001).

One emphasis of the evaluation of the *Schulen ans Netz* initiative was aimed at the investigation of impeding and supporting conditions for the implementation of new media in the context of school improvement.

Since it can be assumed that the equipment should have improved immensely since 1998 and also the use of computers and the Internet has been extended in schools since 1998, a panel study was carried out by the IFS in 2001 (40 per cent of the schools that took part in 1998 in the computer co-ordinator survey participated in the follow-up research in 2001) (Preussler, 2002). Evaluation of the initiative follows (Hunneshagen, *et al.*, 2000; Schulz-Zander and Weinreich, 2000; Scholl and Prasse 2001; Schulz-Zander, 2001). Additional findings of other empirical studies are also presented.

Surveys

As part of the evaluation, the IFS conducted a survey of computer co-ordinators in 1998 and combined surveys of principals, teachers and students in 1999, including a quantitative collection of basic data concerning the use of the Internet in schools, access to networks and concomitant problems, pedagogical objectives, new forms of teaching and learning, motivation and attitudes, gender, and general questions relating to opportunities for implementing new media in schools. It should be noted that in Germany computer co-ordinators are teachers and not specialized computer administrators. In addition the IFS carried out 12 case studies in schools in six of the former West German states. Principals, computer co-ordinators, teachers and students were interviewed and classes were observed.

The survey of computer co-ordinators is representative of the group of schools supported by *Schulen ans Netz*. It has to be emphasized though, that this is a positive selection and that the data is not representative for the whole Federal Republic of Germany. The random sample was taken from 20 per cent of the 6000 schools that were supported in the end of the year 1997 by the nationwide initiative *Schulen ans Netz.* The returned questionnaires (N=520, 43 per cent) represent the sample in all major subjects, the only exception being a greater number of K-12 schools in the specific sample than in all German schools. The low participation of primary schools (5.8 per cent) is due to the fact that until the middle of the nineties the use of computers in primary schools could only follow after a special application, so, except in rare cases, no computers have been used in primary schools. But there have been intensive efforts in the past few years to implement computers into all German primary schools.

For the purpose of conducting surveys of principals, teachers and students, a sample of 105 schools was selected out of all the schools supported by *Schulen ans Netz* in seven German states in 1999. Forty-three schools (i.e. 41 per cent) submitted fully completed questionnaires. Twenty-nine schools (28 per cent) participated in all three surveys. The overall return ratios were: 29 principals (11 per cent female, 89 per cent male), 248 teachers (43 per cent female, 56 per cent male), and 943 students (42 per cent female, 50 per cent male) (aged between 13 to 15 and 17 to 19). These ratios do not permit any generalizations about findings but are significant because they allow for a representative sample of attitudes toward and involvement of ICT in the schools.

Within the group of German teachers, those surveyed represented a positive selection concerning the possession of ICT: 92 per cent of the teachers said that they own a computer and 52 per cent also have Internet access at home. A nationwide representative IFS study of teachers in 1999 showed that there are computers in about 80 per cent of the teacher households and that about 25 per cent of the teachers have Internet access at home (Kanders 2000: 30). Availability of Internet access of the surveyed teachers of this study is clearly higher than this comparative figure and thus shows a positively distorted sample in respect to the use of ICT.

Results of the studies

In the following, some of the major results regarding the incorporation of ICT into German classrooms will be presented and discussed:

- ICT infrastructure;
- general use of ICT;
- aims and objectives;
- attitudes and experiences in teaching using new media;
- main problems;
- impeding and supporting conditions for the implementation of ICT (Schulz-Zander and Weinreich, 2000; Hunneshagen).

For more information within the scope of the evaluation of *Schulen ans Netz*, see the research on questions of school organization in 18 grammar schools of the newly formed states of Germany (Scholl and Prasse, 2001):

- ICT Infrastructure at schools;
- Schools have decisive differences in technical equipment.

The ICT infrastructure and the Internet access varies among the different school types; usually primary schools have the least ICT equipment and the least Internet connections, while usually more than

90 per cent of grammar schools have access to the Internet. In general, schools in the former Western Germany have better access to ICT than schools in the former German Democratic Republic. There are a variety of different computer types and operating systems available in schools. This does not facilitate systematic technical support.

The findings from the representative computer co-ordinator study and panel study show the following:

- There is an average ratio of 36.5 pupils per computer workplace in 1998 (Schulz-Zander and Weinreich, 2000) with a considerable improvement of the pupil-computer ratio by 2001 (18.5:1).
- A majority of the computers in 1998 were situated in computer laboratories (81.3 per cent) and not in classrooms, with mobile computers in fewer than 15 per cent of the schools.
- 91.9 per cent of schools had computer laboratories in 2001 compared to 82.4 per cent in 1998; computers in special rooms 41.2 per cent, compared to 16.1 per cent; computers in classrooms 25.6 per cent, compared to 12.7 per cent, and mobile computers 23.2 per cent compared to 5.9 per cent.
- An average of 20.5 computers were linked to the Internet in the schools.
- There have been immense improvements in ICT equipment in German schools since 1998 (Preussler, 2002).
  - digital cameras (64.9 per cent vs. 18.5 per cent);
  - scanners (91.9 per cent vs. 75.1 per cent);
  - CD-ROM writers (76.3 per cent vs. 19 per cent);
  - video projectors (53.6 per cent vs. 20.5 per cent).
- 77.3 per cent of the interviewed computer co-ordinators in 2001 consider their schools to be well equipped with computers and having powerful computers (68.2 per cent).

Recent statistics of May 2002 based on all German schools (both general and vocational) show the student:computer ratio in primary schools as 23:1, in secondary schools as 17:1 and in vocational schools as 13:1. 92 per cent of the German schools were equipped with computers, 87 per cent primary schools, 98 per cent secondary schools, and 84 per cent vocational schools. More than 50 per cent were multimedia computers (41 per cent in primary schools, 61 per cent in secondary schools, and in vocational schools) (BMB+F, 2002). The equipped primary schools had on an average more than 3.6 classrooms or special rooms with computers. In 53 per cent of the schools more than one classroom or special room was equipped with computers. Twenty-seven per cent of the schools were equipped with more than one computer lab. Ninety-one per cent of vocational schools and 79 per cent of secondary schools used a server-based network. Fifty-eight per cent of all computers in German schools were linked to the Internet. On an average 3 computers in primary schools, 16 computers in secondary schools, and 49 computers in vocational schools were linked to the Internet. Seventy-seven per cent of the German schools used ISDN and 31 per cent of the vocational schools used an xDSL-access.

Regardless of the increase in equipment and facilities from 1998 to 2002, schools still do not have the technical infrastructure that is necessary to meet the various needs concerning the use of media in schools. For example, they lack the flexible use of computers in subjects without the need of a great organizational effort, alternative offers for individual work or work in small groups at different places in the school, a school network of the different fields of the school, and individual accessibility to ICT for teachers and students outside of regular lessons.

One of the main problems with the use of ICT in German schools is the need for technical support and maintenance, because schools only have a technical computer assistant in exceptional circumstances. And in general, a teacher holds the position of a computer co-ordinator. Different model projects with external partners (private companies, universities) try to develop sustainable solutions that provide more support and resources for ICT use.

Use of ICT at schools

- ***Schools are not really advanced in integration of new media in everyday teaching and learning processes***

Teacher and student use of computers: In Germany, a nationwide representative teacher survey (N=984; 48 per cent male, 52 per cent female) and representative student survey (age: 14-16 years old, N=2,222, 50 per cent male) was carried out by the IFS in 1998 and gave information on ICT use in the classroom. In these studies, information on the application of computers in teaching was given, broken down into the various subjects or fields of learning and in frequency. The use of ICT is usually restricted to a few active teachers. An average of roughly 10 per cent of the staff per school uses the Internet for instructional purposes. Regular use of computers in class is less than 10 per cent. An occasional use of the computers only takes place in the lessons of 10 to 20 per cent of the teachers. Only in mathematics and in natural sciences do a greater number of teachers and students, 31 per cent and 27 per cent, respectively, use the computer.

Ironically, at the same time teachers rate the significance of computer use for the school as very high: About 50 per cent said that they considered the use of computers to be very important and about 60 per cent indicated that computers were being used too seldom in teaching down the line. About 70 per cent of the students criticized the rare use of computers in teaching. In general it can be said that teachers and students from the newly formed states of Germany criticized the rare use of computers even more than the former West German students (Kanders, 2000: 34).

General Internet use: Internet use mostly means the deployment of the World Wide Web (1998: 82.9 per cent, 2001: 95.3 per cent) and e-mail (1998: 55.1 per cent, 2001: 60.2 per cent). Chat, discussion groups and other services of the net are in much less use. The activities most often mentioned as used by students and teachers are information gathering, e-mail contacts between teachers and pupils of different schools – mostly contacts with schools in other countries – and web publishing. According to the computer co-ordinator survey, the Internet is generally used in grades 11 to 13; in grades 7 to 10 more than 85 per cent and in grades 5 to 6 nearly one fifth of the schools indicate an Internet use.

Subject-related Internet use: According to the computer co-ordinators, the use of the Internet is concentrated on the subjects that are directly related to ICT, e.g. 'Basic ICT education' and 'Informatics' (*Figure 1*). Languages – foreign languages and mother tongue – are next, followed by subjects related to the social sciences, by mathematics and natural sciences, and media education (Preussler, 2002: 84). Fields in which ICT is least implemented are music lessons, the arts, religion and philosophy. The panel study of computer co-ordinators also shows that in 2001 there was a distinct increase of online work in basically all the subjects; with most significant increases in IT education, informatics, mathematics/natural sciences, social sciences and languages.

Figure 1. ICT use in subjects and learning fields
(Computer co-ordinator panel study 1998-2001) (N=211)

A survey from May 2002 shows that primary schools use computers mostly in the German language, mathematics, and in supplementary working groups. The Internet is used in working groups, in science instruction and social studies at primary level. In secondary schools computers and the Internet were mostly used in Informatics, in working groups, and in economics/technics (BMB+F, 2002).

In their case studies in the newly formed states, Scholl and Prasse (2001: 23) find that the quality and quantity of the realized Internet-projects vary from school to school. For the most part, the Internet is being used for smaller investigation – and e-mail projects (about four per school). High quality projects and innovative projects that use further options of linked working were rather rare – an average of one application per school. The building of data and information systems was only started in a few schools.

Intended pedagogical objectives with the use of ICT

Within the scope of the surveys carried out by the IFS, principals, co-ordinators and teachers were asked about their intended pedagogical objectives in the use of computers and the Internet at their schools.

Two-thirds of the principals asked, reported that ICT deployment and objectives are discussed openly by the staff of their schools. Twenty-seven out of 29 principals noted that a consensus relating to these goals was reached at least in part. The most important objectives stated were 'to make learning more interesting' (100 per cent), 'to support autonomous and independent learning' (99 per cent) and 'to support project-oriented learning' and 'individualised learning' (89 per cent).

Computer co-ordinators point out the following main goals for the use of ICT in classes:

- achievement of basics in information searching and information analysis (78.5 per cent);
- enhancement of pupils' motivation and interest (74.8 per cent);
- promotion of team-work skills (62.7 per cent) (Schulz-Zander and Weinreich, 2000).

Aims of Internet use: The findings of the teacher surveys by Scholl and Prasse concerning the aims of the Internet suggested the investigation of information as a primary concern, and media competence and competencies in handling the computer as a second aim. Other aims, such as the improvement of teaching methods or increased motivation, only follow at a clear distance (2001: 124).

ICT contributions to teaching objectives: The IFS teacher survey shows that ICT is considered to be helpful in many aspects related to the improvement of teaching:

- promotion of learning pleasure and motivation;
- information acquisition and analysis;
- self-directed learning, responsibility and project-orientated learning;
- interdisciplinary learning;
- students' control of their own success as well as team-work;
- improved problem-solving skills;
- general overall achievement.

On the other hand, the impact of ICT on the social aspects of learning, demonstrates the ability to reduce the gap between those students who perform very well and those who don't. The same applies to gender equity.

Experiences with the use of ICT

Positive results of ICT use: As *Table 1* indicates, teachers of the IFS survey experience a positive change in class by using new media. Students find classes more fun, classes are more student-centred and students are more attentive and co-operate better. Teachers continue to note that, with ICT, teaching itself is felt to be more demanding but also more enjoyable. The high number of no response is due to the fact that only teachers with experiences in teaching with ICT were asked to respond. Thirty six percent of the teachers (90 teachers) had no experience in teaching with ICT. The assessment that students find lessons to be more fun is in keeping with the findings of the student questionnaire.

Table 1. Teachers' experience of ICT use in class

To what extent do the following statements match your experience in class?	Categories: applies completely/generally (in %, N=248)	No response
Teaching is more student-centred than without computers and/or Internet	78	98
The role of the teacher is changing	83	99
Relations between students and myself have improved	39	102
Students are more attentive if computers/ Internet are used in class	64	100
Co-operation between students has improved	59	100
Preparing for class using computers/Internet is more demanding	63	101
Preparing for class using computers/Internet is more time-consuming	75	101
Teaching is more fun for myself	72	100
Classes are more fun for students	94	101
Teaching is more demanding	52	99

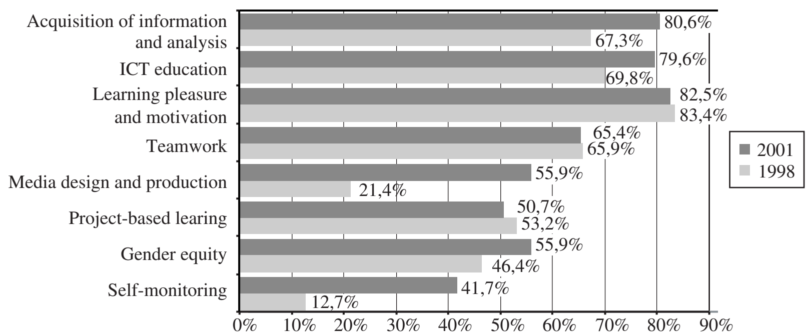
Source: Schulz-Zander, 2001: 98.

The computer co-ordinators were asked to assess the motivation of their colleagues and that of students. *One incontestable result is the high level of motivation of students and, by contrast, the quite low level of motivation among the staff.* Only half of them are considered to be motivated.

As illustrated in *Figure 2*, the co-ordinators claim having realized, above all, the aims of:

- information acquisition and analysis;
- imparting basics in information technology.

Figure 2. Experiencing ICT use
(Computer co-ordinator panel study 1998-2001) (N=211)



Teachers' attitudes toward teaching improvement by ICT use: There is a significant difference in attitude concerning the expected pedagogical change through the use of ICT in classes, between regular Internet users and less frequent users. Those teachers who use the Internet regularly, i.e. at least once a week, state much more often that classes are more fun and that they have more confidence in the pedagogical impact of the use of computers and the Internet *(Table 2)*. The assumption that relations between students and teachers have also improved is, however, not upheld by almost two-thirds of those interviewed.

Table 2. Changes in teaching as a result of the use of ICT in class

In using ICT at our school the following changes took place …	**Applies (in %, N=29)**
Break-up of 45-minute class rhythm	16
Break-up of normal classroom situation (decentralized learning locations, class division)	58
Testing of innovative teaching methods (e.g. team teaching, moderation techniques, etc.)	46
Cross-curricula instruction	80
Use of computers by students outside class, with supervision	69
Use of computers by students outside class, without supervision	35

Source: Schulz-Zander, 2001:98.

Principals, when asked what had actually changed in teaching at their schools as a result of the use of ICT, stated that an increase in cross-curricula teaching had been noted and that the regular classroom situation was being replaced by decentralized learning locations or class divisions. New learning methods are being tested in approximately half the schools, whereas dividing lessons into a 45-minute cycle is still practised at most schools. Every principal reported that they had established contact with at least one institution or organization outside their own school since ICT had been introduced.

Pelgrum, Brummelhuis, Collis, Plomp and Janssen Reinen describe the expected changes in education in the industrial and information society regarding the changed roles of teachers and students (Pelgrum and Anderson, 1999:6). Teachers in the information society are characterized as follows: they help students to find an appropriate learning path; they guide students' independent learning; they help students to assess their own progress; and they place considerable emphasis on communication skills. Students, on the other hand, are characterized as follows: they are more active; they learn both at school and outside school; they are capable of teamwork and participate in it to quite an extent; they ask questions and find answers to questions; and they have high interest levels.

Changes in the learning culture require changes in teachers' and students' roles. With ICT use and other innovations, the teacher is becoming less of a conveyor of knowledge and more of an advisor, coach and moderator.

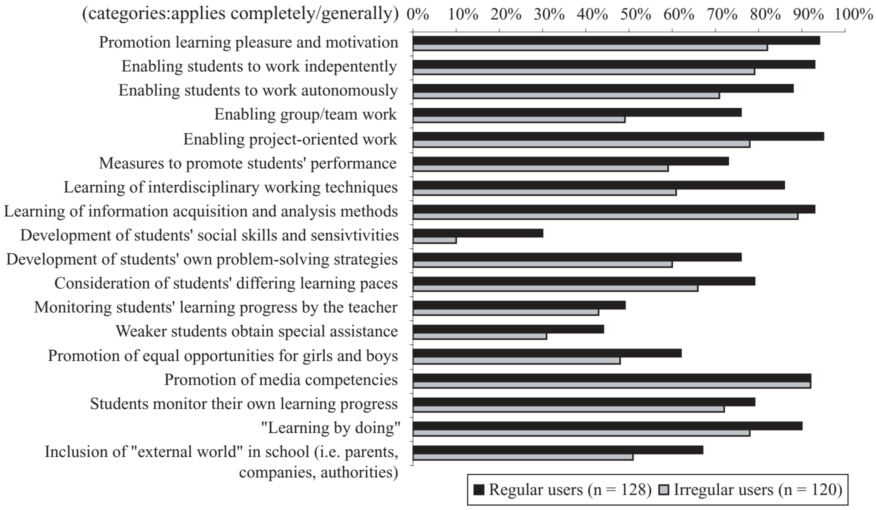
Computer co-ordinators and teachers state that their traditional roles have in fact changed. A striking feature is that support for other teachers is a role that co-ordinators are expected to assume. Support for other teachers mainly refers to colleagues at the co-ordinator's school, while consultation with colleagues from other schools takes a clear second place. The results obtained in the teacher survey are almost identical to the responses by the co-ordinators. The student survey shows that, although teachers and co-ordinators expect certain changes in their pedagogical role models, students do not experience these changes in class as yet (Hunneshagen *et al.*, 2000).

Teaching the teachers: In addition, researchers were interested to see the incidence of ideas like 'teach your teacher' at schools where new media were employed and the degree to which students participated in maintaining technical systems. The initiative *Schulen ans Netz* had taken up the 'teach your teacher concept' as a criterion for the funding of the schools. We asked the computer co-ordinators to state some tasks that students assume at their schools. In particular, male students were involved in instructing teachers, other students, and also in maintaining hardware and software. As far as assuming functions was concerned, the gender-specific differences were also apparent with students. This is particularly the case in maintaining hardware and software, which is done almost exclusively by male students. Significantly fewer female students instruct teachers or classmates (male or female) in working with computers. The panel study shows that in 2001, computer maintenance by male students (28.3 per cent compared to 22.9 per cent in 1998), and female students (7.1 per cent compared to 4.4 per cent in 1998), has even increased at schools. The instruction of classmates by classmates has increased as well. Instruction of the teachers by students decreased slightly between 1998 and 2001.

Professional development

It can be ascertained that the attitudes of teachers regarding the use of ICT in schools and lessons depend to a large extent on their previous experience with the Internet (Hunneshagen *et al.*, 2000). As *Figure 3* indicates, teaching staff who use the Internet at least once a week – referred to as regular users in the study – appreciate the pedagogical significance of new media more positively than those members of staff who use the Internet on a less frequent basis.

Figure 3. Teachers' attitudes towards teaching improvement by ICT use



Source: Schulz-Zander, 2001:97.

In particular, the extreme positive position ('applies completely') is represented much more frequently by these teachers. Teachers who use the Internet more frequently have more positive experiences with ICT in general. It is safe to assume that with increased use and extended knowledge, teachers are more motivated in the use of the Internet.

Apart from the technical equipment and access, the qualification of the teachers is a further important condition for an intensive and high quality use of the Internet. Schools that are considered to be of high quality have teachers that use ICT more frequently. This shows that the importance of qualification is even higher than that of the accessibility (Scholl and Prasse, 2001).

At most of the 18 grammar schools that Scholl and Prasse have evaluated, there was at least one short overall introductory ICT course for teachers. An in-school day of further training or an extensive Internet class for teachers was only offered at about 30 per cent of the schools. At about one-third of the schools, less than one quarter of the teachers had received qualification in ICT. In total, 80 per cent of the interviewed division heads stated that they did not have specific further training in the use of the Internet. About 30 per cent were not satisfied with the supply of in-school training. Concerning the qualification of teachers, there is an urgent deficit. This is also supported by the results from the questionnaire survey: approximately 60 per cent of the interviewees see the need for further training in the technical, methodical-didactical field and in the field of content and pedagogics.

About one-third of teachers surveyed use the Internet for preparing their lessons (Scholl and Prasse, 2001).

Scholl and Prasse (2001: 26) conclude:

- The use of computer laboratories is a special barrier for teachers. The fear that something would not work and they would compromise themselves in front of the class is especially high.
- A single course that explains the structure and the function of the Internet to the teachers helps only a little. Teachers need simple and recurring introductions concerning the concrete technical use at the particular school.
- Support of the teachers and qualification procedures should be conducted by people who understand the fear of technical contact and difficulties in handling a computer that PC novices encounter. In part, teachers of informatics do not fulfil this criterion.
- Further training must include teachers' needs for concrete situations in the classroom. General presentations of the development, technical details and the functioning of the Internet often deter teachers at first.

Gender aspects

Surveys of co-ordinators, teachers and students reveal that in German schools at present, significant differences between genders occur for most aspects of ICT use in schools. These disparaties are manifested in working with ICT, in the assessments of personal or general issues, as well as in statements concerning attitudes towards, and opinions about new technologies (Hunneshagen *et al.*, 2000). The results of all surveys relating to gender and the use of computers and the Internet showed a consistent picture of differences, which all pointed in the same direction. Males, be it teachers or students, use computers and the Internet more often than females do. Their experience is longer lasting, and they use ICT in more differentiated ways. Not all these findings reveal a significant difference in terms of statistics. As far as learning and teaching are concerned, it is significant that both female students and female teachers express less self-confidence than their male colleagues or peers and believe that they can handle the new technologies to a lesser degree. All differences that appear in questions of self-assessment relating to abilities in ICT use are highly significant from a statistical aspect (t-test, $p<=.01$).

Striking differences also exist in the participation of female and male teachers in school projects. First, only 14 per cent of the co-ordinators surveyed were females. Second, men are considerably over-represented in the teams that organize the implementation process of ICT. The concluding observation related to gender differences in the co-ordinator survey is that despite the empirical result of persisting gender differences, an attempt to provide equity in ICT access is on the agenda of only 27 per cent of interviewees. Female co-ordinators are considerably more sensitive to the problem, since this endeavour is of importance for 40 per cent of them.

In general, a lack of awareness concerning gender differences in ICT use at schools was noted. This is significant since results from other surveys of teachers and students undertaken within the scope of evaluation of *Schulen ans Netz* refer to the importance of ICT use in schools, especially for female students. The results of the student survey indicate that with female students, initial contact with and use of computers and also the Internet occurs to a considerably greater extent at school (31 per cent to 11 per cent). Furthermore, female students are less likely to own computers. They are also more dependent on schools in order to acquire know-how about ICT than their male counterparts, who have acquired their ICT skills to a much greater extent through trial-and-error techniques, the study of specialist journals, and by talking about ICT with their (male) peers.

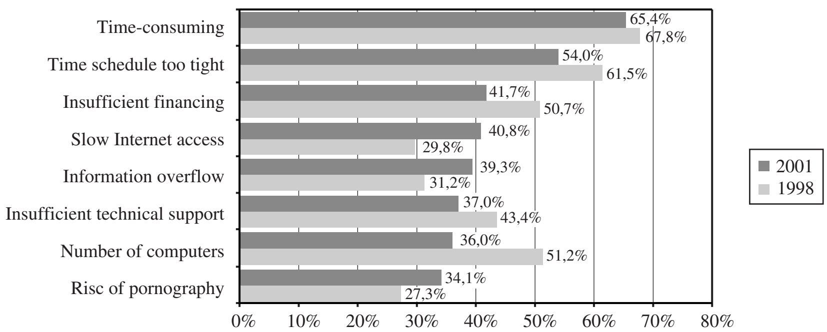
However, more recent surveys show that the differences between the genders concerning the ownership of a computer and the use of computers in everyday life are continuously decreasing. In 2000, 70 per cent of the 12 to 19 year old boys and 49 per cent of the girls used the computer every day or several times a week, respectively (Feierabend and Klingler, 2000). In 2001, the difference between the genders decreased again: 72% of the boys and 56 per cent of the girls stated that they used the computer every day or several times a week, respectively (Feierabend and Klingler, 2002: 13). In 2001, 56 per cent of the girls belonged to the group of intensive computer users, as did 72 per cent of the boys. The frequency of the use of computers is strongly dependent on the level of education. Only 49 per cent of the students of the extended elementary school belonged to the group of intensive computer users in 2001, but 73 per cent of the grammar school students; a differentiation in gender is not proven.

In 2001, 40 per cent of the girls and 58 per cent of the boys owned a computer (Feierabend and Klingler, 2002: 12). Every fourth youth stated he/she had individual Internet access, i.e. twice as many boys (33 per cent) as girls (16 per cent).

Main problems experienced using the Internet

What kinds of problems can be identified at schools when ICT is being implemented and what kinds of strategies can be developed to solve them? The answers of the computer co-ordinators to these questions are summarized in *Figure 4*.

Figure 4. Main problems in using Internet at schools



Source: Preussler, 2002:93

When asked what the main problems are regarding Internet use at schools, the computer co-ordinators mention the following:

1. Neither the personal time budget nor the class timetables allow adequate use of the Internet. Only 16 per cent of responding co-ordinators were granted a reduction of lessons in 1998.
2. The schools' finances are not sufficient to acquire an adequate quantity (nor quality) of computer equipment. The problem of the high cost of the Internet connection has however been solved since German Telekom decided to offer free access to the Internet.
3. Access to the Internet is often reported as being too slow.
4. Available technology is often unreliable and technical support is inadequate, should problems occur.
5. Information overflow and the danger of pornography were mentioned even more in 2001.

However, there has been progress in several areas. Fewer computer co-ordinators have criticized that the timetable of the lessons was too narrow, that there were too few computer work places, and that funding was too scarce. This may be that recently the high costs of Internet fees have been financed by German Telekom. Pedagogical problems are also perceived to a much lesser extent than previously, although this may be due to the fact that other problems are more prevalent.

Management and organization

Consequences of the innovation: ICT innovations affect teaching, change demands on the professionalism of teachers, change structures of organization and communications, and alter the self-image of the school and its task.

Adoption of the innovation: Typically, network activities and projects are usually associated with already existing structures and processes of the school. Internet use mostly takes place in informatics or special projects – as a priority in a project week or in supplementary study groups – and for the most part is not present in regular teaching.

Assimilation of the innovation: Sets of rules and structures are developed for Internet use, and it becomes a fixed component of the school. One example of this is the systematic integration of the use of media into the various subjects by means of a media-curriculum.

Accommodation to the innovation: The activities of usage can gradually change the structures and processes of the school by themselves. The promoters, play an important role in providing structures for new task fields and breaking through the innovation barriers of teachers 'not wanting to' use ICT and 'not being able to' use ICT (Scholl and Prasse, 2001).

Despite existing problems, ongoing work with the Internet is assessed by computer co-ordinators in the IFS survey as being generally satisfactory. The expectations of almost two-thirds of those co-ordinators have been met and the possibilities of Internet usage are, for the most part, considered to be from 'useful' to 'very useful'. However, it should not be overlooked that almost one-third of those surveyed are less satisfied with the status of Internet work. Almost all assessed the future of the Internet at their schools to be positive.

Satisfaction, opportunities, motivation and the future of the Internet:

- Schools where support is given by the principal are significantly more satisfied with Internet use ($p<=.01$). This also holds true for schools where more teachers are involved in planning.
- Schools which have established a project team for ICT implementation are significantly more satisfied with the respective project. Fifty-eight per cent of co-ordinators stated that a project team existed at their school; 62 per cent stated that they received support from the school principal; and 58 per cent even stated that such support was unrestricted.

Co-ordinators from schools with computers in the classrooms are significantly more satisfied with Internet usage in their schools. There is a significant difference between co-ordinators from schools where the principals use the Internet themselves and those where the principals do not. Staff members at schools whose principals use the Internet are also more satisfied with the possibilities provided by ICT use (Weinreich and Schulz-Zander, 2000; Schulz-Zander, 2001). The findings from the qualitative data of the case studies underline the positive effect of a supportive principal and a team of teachers. The school management is a crucial point in the implementation process of ICT. Also the development of ICT-plans and the integration of ICT and media education into school programmes had positive impacts (Hunneshagen *et al.*, 2000).

Importance of stakeholder acceptance of innovation: Scholl and Prasse (2001) conclude that the sustainable use of computers with an extensive effect in schools depends on promoters. Progress with Internet use in schools also depends on the number of promoters, who (1) bring in their pedagogical knowledge and skills, (2) organize processes, and/or (3) make use of the special options and authority of the principal for this purpose. These promoters, who distinguish themselves by a commitment for the spreading of Internet use that is above-average, are being complemented by active teachers who have caught the promoters' enthusiasm and drive and who demonstrate this in the school with their own Internet activities.

Influence of teacher responsibilities and tasks: In the case of a strong concentration of tasks on one or a few organizationally active teachers, the chances of spreading Internet use at schools are rather low. This shows that there are limits to solving several problems at once. It is more favorable when the tasks are spread among several people who either already have special knowledge in their field or acquire it in the course of their work. Teachers also request the establishment of project teams, where relevant knowledge is gathered again and again, and where the individual activities can be co-ordinated. The type of work organization – with the strong concentration of one person on the one hand and an integrated project team on the other – shows a very high, significant coherence with the quantity and quality of Internet use.

Recommendations for the implementation of ICT in schools

The evaluations of the *Schulen ans Netz* initiative reveal that with the implementation of ICT in schools:

- Computers have found their way into the life and work of teachers and pupils, though the use of Internet in schools is still in its initial phase. The use of ICT is still dependent on committed individuals.
- Female teachers using ICT are under represented.
- Most schools reported that they had insufficient equipment and that they encountered many technical problems that were time consuming for the teachers to resolve.
- The majority of the teachers were sceptical about using the Internet in their teaching.

- Many schools reported growing success in implementing ICT and the Internet. Success was significantly higher in schools where teams of teachers were formed to deal with the implementation and where the principals gave continuous support and encouragement.
- The effect of ICT use on the learning climate in schools was generally viewed as positive. Principals, computer co-ordinators, teachers and students found the use of computers and of the Internet in the teaching process to be motivating.
- According to principals and teachers the main advantage of computer and Internet usage is that it promotes independent, self-directed learning. Its effect on teamwork and collaborative learning is still less evident.
- Teachers believed that ICT use increased student motivation to learn.
- Teaching staff that use the Internet regularly estimate its pedagogical advantages to be significantly higher than teachers who are not frequent users.
- The results also indicate that structural, organizational and technical problems hamper the use of new media in everyday teaching practice. In German schools in general no technical staff is available for system maintenance. Rather, teachers have to perform this function. It is a source of additional work for which teaches are generally not compensated by a reduction in teaching hours.

The studies also indicated that the implementation process needs to consider the following factors:

- *School management and organisation:* Success in implementing large-scale use of computers and Internet requires an excellent school management. Principals can be the main driving force behind the process of IT-adoption and implementation in schools. They should support the innovation process actively. Measures to be taken include: developing a vision of innovative pedagogical practice under use of ICT; installing a team to promote the innovation process, also involving critical positions; setting up an IT plan; integrating media education as an integral part of the school programme, and promoting teachers, who use computers in their classes as the key persons to change teaching and learning. The relevant stakeholders should be involved in the innovation process.

- *Professionalization:* Success in implementing large-scale use of computers and Internet requires professional development. Teachers need competencies to use ICT for teaching and learning. Measures to be taken include teacher training:
  - to support competencies to use ICT;
  - to use ICT for innovative pedagogical practice with ICT;
  - to support students' self-directed learning which includes the awareness of changed teachers' and students' roles;
  - to support collaboration skills. A variety of training types including regional training and in-school training should be supported. Also the principals need competencies to use ICT and to develop visions for the innovative pedagogical practice under use of ICT, and management competencies to integrate ICT in schools. That means professionalization also includes training for principals.

- *Teaching and learning:* Success in implementing large-scale use of computers and Internet requires a change in the learning culture. Measure to be taken include:
  - to develop visions for the innovative pedagogical practice under use of ICT;
  - to promote dialogue among teachers;
  - to support independent, self-directed, and collaborative learning to integrate ICT into all subjects;
  - to create cross-curricula thematic approaches or projects with ICT;
  - to create additional forms of assessments;
  - to promote collaboration with partners outside class and school.

- *Technology:* Success in implementing large-scale use of computers and Internet requires easy access to ICT. Schools need to be adequately equipped. Measures to be taken include:
  - easy access to computers and Internet for teachers and the principal;
  - easy access to computers and Internet for students;
  - computer labs located in the centre, classroom computers, mobile computers;
  - IT resources to the specific needs of the school (according to the school programme, curricula);

– outsourcing of infrastructure installation and support or technical assistants for administration of the technical infrastructure.

Future directions

For ICT to become an integral part of classroom instruction, two issues need to be addressed. First is how schools will provide sufficient training for teachers to learn how to better integrate ICT into their teaching. A number of German schools have been entering into co-operative arrangements with private companies for help in training teachers. At present, initiatives of the federal states in the field of information technology are mainly based on private-public-partnership.

Second, there is a serious shortage of instructional software for classroom use. More material needs to be available for teachers' use. To this end, the German Federal Ministry of Education and Research has initiated the *Development of Teaching and Learning Software Programme*. So far, publishers have been reluctant to invest in the development of new software, fearing that they will be unable to recover their costs in such a limited market.

As these issues are addressed, it is likely that ICT use in schools will expand rapidly and that ICT will continue to play an important role in the up-coming school reforms. At the same time, it is hoped that, as programmes using E-learning become more widespread and effective, more funds will be allocated to this purpose.

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Chapter 14

Effective use of technology to improve education: lessons for planners

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The preceding chapters document a variety of strategies that countries have used for introducing and utilizing technology in classroom instruction in basic education. These include:

- Establishing a national plan or programme for countrywide deployment of technologies (Czech Republic, Germany, Palau).
- Implementing pilot projects as part of a broader education reform (Morocco, Namibia).
- Launching a bottom-up initiative (by providing computer technology to the schools) that has gradually spread nationwide and was adopted by central-level authorities (Jamaica).
- Implementing small-scale projects to meet regional or local objectives or as demonstration projects (Argentina, Iceland).
- Making use of broadcasting technologies, radio and television, to reduce educational inequalities and deliver improved content and pedagogy (Brazil, Mexico).

While each chapter is grounded in the social, economic, and educational context of a particular country and shaped by the experience, training, and vision of the immediate participants, together they offer a basis for nine cross-cutting observations.

1. *Technology is not a panacea. Ne*wer, more modern, technologies are not always better than past versions. The appropriateness of any specific technology depends on a school's physical infrastructure, local culture, available resources and teacher capacity. This point is well illustrated in the chapters by de Castro and by Bosch in their arguments that, radio, with a longer history of successful use, may be more appropriate than Internet-based instruction in some locations.

While not a magic solution, neither can it be ignored. The risk of falling behind in the education uses of technology has potential widespread consequences for other sectors of the economy, given the importance of technology in international commerce, communication and diplomacy.

2. *Newer forms of ICT offer the opportunity (and, for some, the threat) of fundamentally changing pedagogical practice at the classroom level*. With the effective use of ICT, teacher-centred lectures are moved to more student-centred, constructivist learning strategies in which students are expected to research information, analyze data, and draw their own conclusions. This shift in pedagogical practice is a source of school level resistance to technology. Over time, that resistance can be addressed effectively by involving the teachers in the change process, and through continued training and support for professional development. But those components need to be anticipated, funded, and well implemented.

3. *Technology can exacerbate inequalities*. While the use of technology in the delivery of instruction is often argued as a way of expanding access to schooling through its ability to reach hard-to-reach populations, it also has the potential of exacerbating inequities in education quality, as affluent communities are able to obtain the benefits of technology faster than the poorer districts. The positive contributions of technology in schooling will only be fully appreciated if implemented in a way that minimizes the negative effects. This can be difficult politically, as those decision-makers whose actions are needed to ensure equity are often affluent urban parents whose schools are the beneficiaries of existing inequities.

4. *The greater availability of technology in the schools opens new opportunities for cross-national sharing of instructional resource material, curricula, lesson plans, and teacher training*. However, these uses have to be undertaken within a wider appreciation of the political issues that sharing can provoke. Some countries worry about the influence of unwelcomed outside ideas; they fear losing control over their own national curriculum. Similarly, technology opens opportunities for new kinds of partnerships with a country – among schools, between schools and employers, and between schools and universities. These were well illustrated in the chapters by Braslavsky

and Fumagalli (writing about Argentina), Nekatibeb and Tilson (writing about Ethiopia), and Zander-Schultz (writing about the experience of Germany).

5. *Central and district level ministry staff need to stay abreast of technology to be able to understand and work effectively with school-level personnel on the front lines of technology use*. In many countries, the leaders lag in their knowledge of technology. In many countries there is already evidence that (a) students are getting ahead of teachers in their knowledge of computer use and (b) teachers are getting ahead of ministry officials. When this happens it can fuel resistance from the very levels of top leadership whose support is most needed, as those ostensibly in charge feel threatened by the very instructional tools that need their support.

6. *As with many innovations, the adoption of ICT in schools is often dependant on the actions of a broker or champion*. Such champions can rise from the schools and community (bottom-up) as in the case of Jamaica, or it can come from the government leaders (top-down), as illustrated in the case of Palau. In either case, these champions play an important role in articulating the need for greater technology use in the schools, suggesting strategies through which that might happen, and mobilizing wider support.

7. *The introduction of information and communication technologies at the primary and secondary levels of education raise a wider set of issues about how schools should be linked with activities underway in other sectors*. How might schools be linked with employers? In what ways might schools be linked to each other? How is the technology infrastructure of a country to be co-ordinated? Technology leads to opportunities and needs for multi-sectoral and multi-level co-operation that was not necessarily required in more traditional school settings.

8. *The use of technology, by itself, does not ensure improved quality of instruction.* ICT can be used to promote quality or speed mediocrity. Improved quality is achieved as technology allows students access to better designed instruction and the opportunity to learn in different ways (e.g. student initiated research). The impact of technology is limited by the quality of the instruction that is delivered.

Many of the principles of effective technology use are well-established and generally well-known. The problem, frequently, is the failure to implement what most people already recognize as good practice.

9. *Teachers are central to the implementation and effectiveness of ICT.* A common theme across the preceding chapters is the importance of the teacher in the successful introduction of ICT. Yet the literature is full of examples in which teachers resist new instructional practices, even when those practices have strong evidence of success.

One explanation for such resistance is the *teacher worklife complexity hypothesis* (Snyder, 1990; Chapman and Snyder, 1992; Chapman, 1997). Virtually all innovations increase the complexity of a teacher's worklife by expecting them to use different instructional materials, new teaching methods and learning new content. The increaseed complexity often leads to teacher resistance to the innovation. This resistance can be met in two ways: (1) the complexity of the intervention can be lowered or (2) incentives can be increased if teachers believe their extra effort is being rewarded (Chapman, 1997).

The complexity of an intervention can be decreased (1) by simplifying the innovation or (2) by providing more training for the teachers, thereby reducing the difficulty in using the new methods. While considerable progress has been made over the last decade in making computers that are simpler to understand and use, many classroom applications of technology are still daunting to teachers, many of who did not have such tools during their own education and cannot afford to have such equipment in their own home. This puts even greater importance on effective training and ongoing technical support. As some of the preceding country studies suggest, both of these components are often provided at levels inadequate to meet the real needs of the teachers.

Opportunities to reduce the complexity of ICT use for teachers are somewhat limited. There are basic computer skills that teachers need to develop if they are to be able to effectively use technology to organize and deliver instruction. Nonetheless, it is possible to reduce the complexity of using ICT in classroom instruction by ensuring that teachers have easy access to relevant lesson plans, pre-packaged lessons and teacher guides that allow them to deliver instruction through ICT without extra lesson preparation. These are expensive undertakings and often overlooked or under-appreciated in the face of tight budgets and the unbounded enthusiasm of innovation leaders.

Increasing incentives for ICT use by teachers is already factored into the strategies employed by many countries, though what leaders may think of as an incentive value for teachers differs from setting to setting and may be more firmly grounded in wishful thinking than in an understanding of teachers' needs. A frequent assumption is that a key incentive is teachers' own enthusiasm for new knowledge and new ways of teaching. Several of the case studies suggest that teachers are indeed enthusiastic about these new tools, but that such enthusiasm is hard to sustain after the novelty wears off. Despite teachers' initial excitement, the manner in which ICT has been introduced in many school settings requires them to work harder or for longer hours, often developing their own computer or Internet-based lessons or loading software needed for the lesson the next day.

For ICT to work effectively, teachers will need to receive adequate training and ongoing technical support. At the same time, there must be adequate incentives for teachers to be involved. While seemingly obvious, a number of country studies suggest the failure to attend to teachers' needs was a central constraint on the overall success of technology use in the schools.

Policy implementation and national planning

The preceding chapters highlight the systems' nature of change in education. Each change has consequences that ripple across the education system. Only as the introduction of ICT is planned in a co-ordinated holistic way is it likely to be successful. Increasingly, governments are becoming aware of the nature and magnitude of the planning needed to support the introduction of technology in schools. In various countries, this has taken the form of an IT Master plan (Japan, Republic of Korea), a specific Programme named in an Education Strategic Plan (Paraguay), or a National Action Programme (Sweden). In some cases, these plans address only central government efforts. Others consider the actions necessary to foster partnerships across levels of the education system and with the private sector as means of spreading the costs and improving the relevance of eventual technology-based instruction. Such master plans tend to address a set of common strategic elements, e.g. the necessary ICT infrastructure, teacher training, digital curriculum resources, and technical support. Across countries, the priorities given to each of these elements necessarily vary, in response to different national policy goals, social contexts and resources (Pelgrum and Law, 2003).

Financial issues in the adoption of new technologies

Perhaps the biggest concern of countries contemplating the wider use of technology in the schools is the cost. International experiences, to date, suggest that the introduction of computers in schools on a national basis is not possible without substantial increases in the educational expenditures (over the cost of more conventional instruction), a challenge many low income and transitional economy countries are unable to meet. Moreover, a recent World Bank (1998) study found that countries experience only limited economies of scale in widespread implementation of technology-based instruction.

In the country experiences reported in this volume, cost was handled in three ways: (1) nation-wide strategies financed mainly by central government funds (Czech Republic, Germany); (2) efforts supported heavily by external, bilateral, or multilateral agencies (Morocco, Namibia, Palau); and (3) initiatives financed mainly by non-governmental organizations, private institutions, private networks, or local municipalities (Argentina, Jamaica). There were few examples of private companies subsidizing computer use in the schools.

The reluctance of private firms in industrialized societies to invest in computer equipment and instructional materials for schools is widely documented (UNESCO, 2002; Nunes and Gaible, 2002). Indeed, the German case study in this volume illustrated the reticence of publishers to invest in the development of new software for school education, since cost-recovery in such a limited market was unlikely. However, there tends to be more willingness when the efforts of private organizations are part of a larger public-private partnership.

Regional collaboration

Regional collaboration has the possibility of lowering costs of teacher training and the development of instructional materials. In Latin America, for example, cross-national adaptation of existing instructional materials has proved quite cost-effective, since only relatively minor adaptations were required for school subjects common to several countries (e.g. Nicaragua Radio Maths Program, television-based instruction in Brazil and Mexico described earlier in this volume). Still, the sharing of materials and instructional programmes among countries raises issues about accreditation, quality control, and local capacity building (UNESCO, 2002). In general, three conditions have to be met for cross-national sharing of curricula and instructional materials to be effective (Haddad and Jurich, 2002):

1. Subject matter needs to be basic, such that the content would not be expected to change from country to country. This tends to be true in science, mathematics, and language subjects, less true in social studies.
2. Language of instruction should be the same or translation should be easily available.
3. Education ministries need to have clear criteria and procedures for accreditation and quality control of materials that are imported from other countries.

Good examples of regional collaboration are already developing. Among the examples of this is the recent proposal for the creation of a Virtual Centre of Specialization in Information and Communication Technology for members of the Organization of Eastern Caribbean States (OECS, Education Reform Unit, 2001). Another is the International Virtual Education Network (IVEN), a partnership of several Latin American countries that is developing Internet-based modules in mathematics and science for use in secondary schools. The materials development work and expenses are divided among all participating countries in a way that allows the development of new materials to be feasible and affordable for each of the countries (Haddad and Jurich, 2002). Each country contributes expertise to the collaborative development of educational modules. The country teams are multi-disciplinary teams consisting of specialists in different disciplines, and an instructional designer, a web designer, a programmer, and an information technology technician (Nunes and Gaible, 2002).

Conclusion

The application of technology to improve the quality and delivery of education represents one of the most dramatic innovations in education of the last century. While it is underway in virtually all countries, it holds particular promise in the context of low-income countries seeking to reach large numbers of students with extremely limited resources. The opportunities are enormous. At the same time, the challenges are significant. If the use of technology is not well planned and implemented, if intended benefits do not materialize, then the effort can actually undercut educational quality as it diverts funding from higher payoff opportunities. The education systems of many low-income countries are still at the frontier of technology use, particularly with respect to the use of newer technologies (personal computers, e-mail, and Internet). Nonetheless, while some doubt the problems of practice, few argue against the value, or doubt the inevitability of the role of technology in primary and secondary education across the developing world.

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