A Reflection on the Relationship between Technology and Teacher Education: synergy or separate entities?

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ABSTRACT The basis of this paper is the observation, supported by various international surveys and discussions, that much of the 'education' teachers receive concerning the applications of computer-related technology has occurred not only apart from a direct relationship to research about information technology and its learning impact on students, but also outside of the mainstream teacher education system itself. In this essay, an historical perspective is used to consider the relationship between information technology (IT) and teacher education (TE) to support the argument that there has been little substantial symbiosis between the educational technology community and the teacher education community, and that the 'computers in education' movement has further splintered rather than integrated these communities. The argument is also made that developments such as the on-line provision of new forms of teacher education offers additional challenges to the mainstream teacher education community. The essay argues that synergy rather than fragmentation or even competition is needed among the many players involved with information technology and teacher education.

Introduction: reflections on a relationship
During the last decade in countries throughout the world a considerable amount of effort and expense has been spent on teacher education relative to computer related technologies. In France, for example, in 1989 more than one quarter of all resources available for the in-service education of secondary teachers was allocated to "new information and communications technology" (Eraut, 1990, p. 153). Courses and training relative to teaching and computers, or information technology, or new technologies, or other
associated titles involve large numbers of teachers, in Europe, North America, Australia, and throughout the rest of the world including developing countries (see, for example, Hawkridge & McMahon, 1992, for an analysis of 23 Third World countries; Pelgrum, 1993, for an analysis of European Community countries). National projects in many countries involve teacher education related to computer related technology, and books, conferences, journals, and analyses proliferate relative to teachers and their use of computer related technologies. Among many examples of associations related to teacher education and new technologies are the International Society for Technology in Education, based in the United States, and the UK based Association for Information Technology in Teacher Education. Among the new journals is this one, the Journal of Information Technology for Teacher Education.

But what is the relationship of this plethora of activity to the broader discipline and community of teacher education? Reasonably, teacher education relating to technology should be an integrated part of the total teacher education system, grounded in the overall theoretical discipline of the system and interrelated with its various core areas of expertise. However, there are various indications this has not generally been the case with respect to educational technology and teacher education and in particular with respect to computer related technology. Despite the activity that is occurring, it is the premise of this paper that the majority of teacher education makes little or no reference to computer related technology, and that much computer related teacher education is stimulated and delivered by persons without an academic background in teacher education.

Lack of Integration

Two examples illustrate this lack of integration. The first is the following: The 1989 International Encyclopedia of Educational Technology (Eratt, 1989) contains among its 114 sections no specific entry relating to teachers or teacher education and only a handful of references to teachers or teacher education in its exhaustive, cross-referenced subject index. Parallel to this, the International Encyclopedia of Teaching and Teacher Education (Dunkin, 1987) presents a similar situation relative to technology (there is only one cross-reference to educational technology in its subject index, and only a few, limited cross-references to particular technologies). It is as if the two communities do not refer to each other, as both volumes represent the leadership of their respective fields.

A second example of the lack of integration of technology with teacher education is the observation by Willis (1992) that of the “thousands of dissertations produced in the field of education” in the USA and the United Kingdom whose abstracts were published in Dissertation Abstracts
International between January 1989 and June 1991, only 12 dealt with information technology and teacher education. Willis reflects upon this:

A surprisingly small number of students who complete a dissertation in teacher education choose to study a topic related to information technology. This is in spite of the current high level of general interest in educational technology....In addition, there were no universities where more than one student completed a dissertation in the area during the period studied. That suggests there may not be many, if any, doctoral granting universities where systematic research programs in the area of ITTE are underway. (Willis, 1992, p. 144)

Premises of this Reflection

This essay is a reflection upon this lack of integration. First, a historical perspective is applied to place the current IT and TE relationship into a broader framework by considering it within the scope of educational technology and teacher education over the previous four decades and into the next. The status of this relationship between educational technology and teacher education relative to the descriptors 'isolated', 'parallel', 'competitive', 'integrated', and 'synergetic' is considered; and the potentially serious implications of a non-symbiotic relationship are suggested.

Definitions

The full meaning of 'technology' is the systematic application of behavioral and scientific knowledge to the solution of problems (see for example, Anglin, 1991; Verhagen & Plomp, 1988); the "complex, integrated process involving people, procedures, ideas, devices, and organization, for analyzing problems and devising, implementing, evaluating, and managing solutions to those problems involved in all aspects of human learning" (AECT, 1977). Such a definition involves more of a focus on process than on the instruments used to carry out the process. However, outside the educational technology community, the word 'technology' is generally used in the more narrow sense as meaning instruments. Furthermore, the public in general now tends to think of 'technology' in terms of 'high tech', the subset of instrumentation having some connection with computer technology. Thus for economy in this reflection, when the word 'technology' is used, this narrow, instrument focused meaning of the word is generally intended.

Within this focus, further definition is still necessary, as the meaning of 'computer related technology' also needs clarification. Many different frames of reference are possible, ranging from the perspective of a single microcomputer to that of a 'virtual on-line community' where one's personal computer is networked to other computers, to video and audio sources (such as with interactive video and other so-called multimedia), to human networks,
and to electronically organized resource collections including electronic books, on-line information sources, and software collections. (See Sawyer, 1992, for a visualization of this expanded meaning of 'computer', where communication support features as strongly as information related aspects as functions of the system.) This interconnected view sees the user's computer as a component of what is called 'new information and communications technology' (NICT) and this term is becoming more frequently used, replacing NIT, IT, and computer as adjectives to describe this category of electronic technologies with educational applications. NICT, for example, is used as the term of reference throughout the report of the Sixteenth Session of the Council of Europe's Standing Conference of European Ministers of Education (Eraut, 1990). While NICT may be the most accurate term, it is only recently becoming prominent and still requires definition before its use. Thus, in this reflection, the phrase computer related technology rather than IT or the more cryptic NICT will be used, but with the same intended range of reference.

**Historical Perspective on Pre-computer Technologies and Teacher Education**

In this section, using a historical framework, the limited integration of technology within the mainstream program of teacher education is discussed and the parallel and even competing programs relating to computer technology are considered relative to their relationship with the larger teacher education community.

Books and other print material have long been instruments in the educational process. By the nineteenth century the category of instruments for educational use expanded to include chalk and slate and picture materials. During the twentieth century, these technologies (note, the word is used in the instrument sense) were augmented by other kinds of technologies for use in the classroom - such as overhead transparencies, slides, filmstrips, film, audiotape, language laboratories, radio, video, television, computers, and now, multimedia, and telecommunications (see Saettler, 1990, for a comprehensive overview). Film and radio were technologies of particular interest in the 1920s and 1930s while television captured much attention in the 1950s and 1960s. Computer related technology has been a focus since about 1980. Multimedia and telecommunications applications are more recent interests.

Prior to the 1960s the technologies studied within teacher education were generally text and audio-visual media. Gradually courses in 'audio-visual teaching aids', often with an emphasis on practical skills associated with handling these media, became part (although often peripheral) of many preservice teacher education programs. For example, courses related to Teacher Education in Visual Instruction, involving both theoretical
considerations and production techniques, began as early as 1918 and were a
frequent component of pre-service teacher education curricula by 1950
(again, see Saettler, 1990, for a detailed history).

*Educational Technology as a Profession*

*Separate from Teacher Education*

Between the 1940s and the 1960s, a new educational occupational category,
which came to be called educational technology, came into existence,
stimulated in part by war-time needs for instructional training media such as
film, filmstrips, and slides. “Educational technology came of age during
World War II ... training devices became the major medium of instruction”
(Saettler, p. 193), but outside of any formal involvement of education
professionals. In association with professionals involved in film, radio, and
television production, a new type of educational specialist emerged, a
professional perhaps without first-hand teaching experience but with the task
of providing audio-visual resources for use by educators. Some of these
professionals also gradually took on the role of providing teacher education
relative to the use of their audio-visual resources. However, the backgrounds
and orientations of these specialists were generally in relation to the
resources themselves – not to the larger perspectives of the teacher
education community. The pre-computer technologies and those who were
specialists with them tended to remain at the periphery of interest in teacher
education, although courses relative to the production of ‘smaller’
audio-visual aids found a niche in some pre-service education programs.

However, at the same time as technology failed to capture much
interest in mainstream teacher education, ‘educational technology’ as a
separate discipline or at least a separate study program began to grow in
higher educational institutions, sometimes within education faculties but
many times outside of them, often in psychology or communications or
information science faculties (see Ely, 1989, for an overview). This occurred
in the United States, in Canada, in the United Kingdom, in Australia, and to a
lesser extent in other parts of the world.

*Parallel, but with more Isolation than Integration*

Thus, the relationship of technology and teacher education, at least prior to
the introduction of computers, could be categorized as only marginally
integrated, with most growth proceeding in isolated and parallel paths.
Certainly, not all aspects of educational technology have direct relationship
with teachers, and not all aspects of teacher education are involved with the
resources teachers use, but there is a significant overlap in the interest areas
of the two systems. This overlap becomes much greater if the larger meaning
of technology, relating to the process and methodology of educational
problem solving, is considered. The limited integration within the overlap areas of educational technology and teacher education not only appeared to be far from the synergetic level but could even be described as being characterized by a lack of cross-referencing, communication, or awareness.

The Special Case of Computer Related Technology

Computers entered the educational scene in the 1960s, largely through the work of behavioral psychologists and learning theorists working in the area of programmed learning who directed attention to a new approach to the design of learning materials. (See Atkinson & Wilson, 1969, for a review of the 'first ten years', which shows clearly the absence of teacher educators as pioneer contributors). By the 1970s, mathematicians with access to university computers also became involved, from the point of view of using computers to accompany teaching of some aspects of mathematics or logic or statistics. Despite a dubious flirtation with teaching machines, work continued around some large-scale educational computing projects, most if not all of them outside of faculties of education or teacher education and many of the projects primarily involved with technical issues, such as the development of authoring systems. Thus the investigation of computers as an educational technology in the 1960s and 1970s took place not only outside the teacher education community, but also outside the emerging educational technology community and outside the audio-visual courses already established in some teacher education pre-service programs.

This could be seen as a nothing more than a repetition of other situations relating to the difficulties involved in trying to integrate some new technology into the educational frame of reference (see Cuban, 1986) if the scale and momentum of the computer education wave had been more modest. But this scale and momentum quickly became the opposite of modest.

In the early 1980s suddenly and throughout the world the idea of computers in education exploded, in many different sectors - social, cultural, economic, and even political. Pressures came from a variety of sources, including parents and politicians, that urged the rapid development of teacher education about computer related technologies and their application in education. (See, for example, Hersh, in 1983, warning Americans not to let their children become a “nation of technopeasants”.) Hawkrige (1990) gives an analysis of social and political pressures urging computer introduction into education in third world countries, and Collis and Oliveira (1990) give a more general international analysis of the motivations behind policy for computer use in education.

Unlike other previous calls for technological solutions to educational problems, the introduction of computers in education involved both top-down and bottom-up pressure. For example, the computer scientist, Papert, became
an educational guru in 1980 with his visionary writings anticipating a radical
change in educational organization as we now know it and more significantly
in the inherent way children learn and think, all because of the use of
computers on a broadscale basis. Parents responded quickly to the call –
their children should and must become ‘computer literate’ – and writers in
popular magazines (with no background in education or teacher training)
were predicting dire consequences if teachers and students alike did not
quickly take part in new courses and styles of education involving computers.

What separated this surge of enthusiasm from others before it was its
magnitude, pervasiveness, and political power. Suddenly governments
around the world, listening partly to parents, partly to industry, partly to
Papert-type visionaries, were calling on their educational systems to make
students ‘computer literate’ (this was stated with different words in different
countries) and as a logical companion to this, calling for every teacher to
have education with respect to computers. Computer use and applications
were to be part of every teacher’s training (see, for example, Cerych, 1982).
However, it was not the teacher education community but groups such as
the Organization of Economic Cooperation and Development (OECD) that
were telling ministers of education that “we need to train, as rapidly as
possible, the entirety of the teaching profession to use the new technologies”
(OECD, 1986).

Because it was generally launched by persons and pressures outside of
the mainstream of teacher education, with little or no reference to the
existing educational technology or teacher education communities or to the
educational audio-visual specialists coming from audio-visual, film, radio, or
television backgrounds, ‘computers in education’ was seen as a new area,
requiring new courses and new initiatives for teacher training. Fuelling this
‘new field’ orientation further was, in many cases, the implicit belief that
computers offered a new dimension to education, that they were unlike any
other preceding tool, and even that they had the innate power to revolution
learning and the organization of education (see Collis, 1989, for an analysis
of these assumptions).

Consequently, national or regional projects relating to computers in
education were launched in many countries, with major players coming out
of university (frequently psychology or computer science disciplines and
often sharing a background in mathematics or science) or the educational
software development field or the computer field (see Hawkridge, 1992).
National plans often involved the bundling of hardware and software issues
with teacher training initiatives, and teacher educators were not typically
among the major architects of the composite national plans.
Implications of the Separate Development of Computer Education

This background has led to a major issue for teacher education which still has implications in the 1990s – the fact that computer related technology as a content area in teacher education was strongly influenced by specialist expertise outside the field of education, specialists who tended not to be even familiar with specialists in other areas of educational technology or with teacher education specialists (Eraut, 1989, p. 142). A number of sub-issues are related to this early separation of computer related teacher education from the mainstream teacher education or educational technology systems – issues relating to the structure, objectives, content, and delivery of teacher education concerned with computers (and subsequent new information and communications technology), and also issues relating to the appropriate background for teacher educators delivering instruction in this area.

Issues Relating to Institutional Organization

A major issue for teacher education relating to computers is the structure under which such education is offered. One question in this respect is where and how does computer related technology fit into the organization and delivery of ‘methods courses’ in the general content areas in teacher education? The general response to this is that it has not been well integrated, but instead has been manifested in new courses added to the teacher education curriculum. These courses were also typically separate from the traditional existing courses in educational technology which were already in place in the pre-service curricula. An early survey in Canada, for example, in 1984 (Collis & Muir, 1986) found that of the 43 Canadian faculties of education, all but three already had some sort of required computers in education course added to the pre-service timetables, but most of these were new, stand-alone courses whose content and execution was very much a product of the vision and experiences of the person, who through personal interest, became the instructor. The backgrounds of these instructors, and the departments in which the computers in education courses were lodged, showed wide diversity. More recent surveys in the United States (Brownell, 1990; Lintner et al, 1991) indicate that not much change has occurred in this overall pattern, with some sort of computers in education course still being taught as a separate course for pre-service education within most colleges or faculties of education but manifested in many different ways.

More internationally, the recently completed IEA (International Association for the Evaluation of Educational Achievement) Computers in Education survey in 19 educational systems found that the most frequent form of in-service experienced by teachers relative to the application of
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computers in education was an introductory, stand-alone, computer specific course, followed by a variety of other types of computer specific courses (Pelgrim & Plomp, 1991) rather than by the integration of computer applications within other in-service courses. The recent French initiative for large scale teacher education within the plan Informatique pour tous (begun in 1985) is a typical example of this kind of approach – a 50-hour short duration course, independent of other teacher education programs. Many other countries now have similar short term ‘computers in education’ in-service courses, most of which were stimulated from outside of the established teacher education or educational technology systems.

Calls for Integration

Many educationalists, however, began calling for a shift away from this kind of isolated computer-centered course to courses in which computer related applications are integrated with curriculum and instruction issues in the traditional content areas such as mathematics, mother tongue, and science. (See, for example, Hunter, 1983, as an influential early example.) A current example of this integration at the pre-service level is in Japan where ‘computer applications’ are included within the new nation wide pre-service education for mathematics and for science (Sakamoto, 1991). The IEA 19 country survey shows that such integration does occur (it ranks in sixth place with respect to the type of in-service experience teachers have had), but the general purpose introductory computers in education course is still well entrenched and computer specific courses rank first to fifth in the IEA survey of types of in-service experiences in which teachers have participated.

Thus, as a general trend, experiences in teacher education relating to the use of computer related technology have most typically developed from a computer focused orientation rather than an orientation which sees computer related technology as one of a spectrum of technologies available to the teacher as educational tools and resources and among which the teacher should make a critical selection. The separate ‘Computers in Education’ course, both at the pre-service and in-service levels, reinforces this isolation.

Content and Delivery Issues

There are many issues that have been debated as to the content of teacher education courses relating to computers (see, for example, Luehrmann, 1984). As a generalization, it appears that these content related issues have been more discussed by persons outside the mainstream teacher education community than within it. In many countries, computer scientists dominate curriculum decisions (Hawkridge, 1992). A major issue has been the amount of computer specific knowledge and technical skill a teacher should acquire
as a baseline for effective application of computers in teaching. Another major controversy related to programming – should teachers learn something about programming and if so, what? Debates also occurred over content relating to the history of computing, social issues relating to computing, and the amount of training a teacher should receive in the use of general purpose applications software such as word processors or spreadsheets as part of teacher education courses (Collis, 1994). According to the IEA 1991 survey, the categories ‘Applications of Computers’ and ‘Problem Analysis and Programming’ are the two major topic categories being dealt with in in-service teacher training from an international perspective. Word processing as an application of computers tends to be the most common component of teacher education courses worldwide (Pelgrum & Flomp, 1991; UNESCO, 1991). There is little evidence that these emphases evolved through any overall examination of teacher needs and how these can be most effectively met in teacher education programs.

**Delivery of Computer Related Teacher Education**

Among the major issues related to how teacher education for computer applications should be organized are (a) the amount of hands-on practice the teacher needs; (b) for in-service education, the balance between off- and on-site courses and between courses and on-going support as delivery strategies; and (c) who should instruct such courses and what qualifications these instructors should have. The way that each of these issues has evolved demonstrates again that less than optimal dialogue takes place between computer oriented teacher educators and teacher educators. For example, there is considerable awareness among teacher educators of various strategies for the improvement of in-service teacher education (see for example, Hall et al, 1975) yet the majority of in-service computer education courses at least in their first delivery rounds, violated many of these principles. (In a review by Thijssen et al, 1990, it was found that the majority of computer education in-service courses internationally were offered as undifferentiated, one shot courses, with no follow up, and typically by someone with no classroom experience. These are all practices long counter indicated in teacher education research.)

This last point relates to a final issue of considerable significance for teacher education: appropriate qualifications for the instructors of computer related teacher education. Since the field is so new, very few professional teacher educators have had personal experience learning with, or teaching with, computers themselves. This has been labelled as a major bottleneck by the European Council of Ministers of Education (Eraut, 1990) and will also continue as a problem for years to come, given the continual emergence of new forms of technology such as multimedia and telecommunications (Moonen & Collis, 1991). Subsequently, one common model that has
emerged in many countries is that classroom teachers who have become enthusiastic computer users 'move up' to become in-service providers and leaders. However, typically these persons have not had the formal academic and theoretical background required of teacher educators in the mainstream teacher education system of a country or region. A consequence of this is that in a number of countries, ministries of education often make stronger use of such teachers than of university associated teacher education specialists when new system wide in-service programs involving computers in education are developed, but that such specialist teachers reach a ceiling in the contributions they can make to the larger view of planning and policy. There is opportunity here for healthy synergy between theory and field, but the effect in some settings at least has been a ghetto-ization of computer related in-service activity from 'serious' teacher education research (as may be part of the explanation for Willis' 1992 finding of minimal doctoral level work being done that relates to both teacher education and information technology).

As illustration of this, the IEA 1991 survey shows clearly that university faculties of education do not have a leading role in in-service teacher education relating to computers in the majority of countries (16 of the 19) reporting to the survey. Most frequently a mixture (often uncoordinated) of different agencies are providing in-service teacher education relating to computer applications, ranging from ministries and local education authorities, through associations (sometimes teachers' associations, sometimes computer science associations); business and industry (computer manufacturers, software developers); educational support institutes (such as national curriculum centres, local resource centres); teachers themselves; parent groups; and also universities and teachers' colleges. The pattern of this mixture varies from country to country. Who has the leadership position and how quality and continuity are monitored in this sort of conglomeration are critical issues for professional teacher education. The mainstream teacher education community does not in general have a leadership position.

Conclusions Relative to (Computer) Technology as a Content Area in Teacher Education

In an analysis of information technology in UK teacher education, Benzie (1991) notes that "given the high profile that IT enjoyed in education throughout the 1980s" through groups of enthusiastic teachers and a series of major government initiatives, "it is remarkable how little attention was paid to developing the role of IT in teacher education for the greater part of the decade" (p. 181). The parallel but only marginally integrated relationship between teacher education relative to computers and teacher education more generally not only has missed opportunities for symbiosis, but has been costly, and in some cases led to competitive situations similar to what Ely
et al, (1989) call the “turf battles” taking place within the field of educational technology.

Technology as a Tool and Delivery Channel for Teacher Education

Another perspective within a reflection on computer related technology and teacher education relates to advances in the use of technology as a tool within teacher education, not in conjunction with learning about technology and its applications, but as a tool for purposes which may have nothing to do in themselves with technology. This component might be called “technology as a tool and delivery agent in teacher education”. This can be discussed around two major headings: the use of computer related technology in non technology related teacher education courses, and its use in the distance delivery of teacher education.

Use of Computer Related Technology as an Instructional Tool Within Teacher Education Courses

Outside of courses whose goal is to learn about the applications of technology in the teaching and learning process, to what extent are teacher educators themselves using computer related technologies for educational delivery? Comprehensive data on this are difficult to find but the general impression is that the educational use of computers as instructional tools within teacher education is very limited. (Of course, faculty now routinely use word processing and more and more are using electronic mail for communication, but it is doubtful that these practices are being seen by students as models for didactical practice.) There are examples of interactive video being used in faculties of education as a tool in the teacher education process, for example, for experience in responding to student difficulties in learning mathematics (Galen et al, 1991; Goldman et al, 1990). Interesting examples can be found of the use of telecommunications to broaden and enrich the experience of preservice student teachers (see, for example, Harris, 1993; Meadows, 1992; Owen, 1993).

But despite these examples, it seems in general that the use of computer related technology as a teaching and learning medium is employed much less in teacher education than would be expected, given what is being taught about its value to education in technology related teacher education courses (UNESCO, 1991). The opportunity for pre-service teachers to experience models of computer supported instruction before they try to manage it themselves is seldom available, another consequence of the lack of synergy between computer education specialists and mainstream teacher education faculty.
Technology for Teacher Education at a Distance

An exception to the last statement is one rapidly growing variation on the delivery of teacher education - the movement toward flexible and distance delivery of some of its aspects. This is most relevant for in-service teacher education, where the benefits for the teacher of being able to stay at his or her workplace rather than move to a course setting fixed in its time and place of delivery have practical, organizational, and pedagogical aspects. Practical aspects are clear - the time and costs involved in attendance at an in-service course can be considerable and even insurmountable for teachers far removed geographically from an in-service delivery institution.

Bringing in-service instructors to the field is a response to this problem, but of limited application, in that costs and time remain a problem - on this occasion perhaps more for the in-service delivery institution than the teacher client. However, educational issues relate not only to finding the time and resources to get teachers and instructors to a course, but also to providing more flexible and ongoing professional development support to teachers after an in-service course is completed. (See Rhodes & Cox, 1990, for a summary of four years of research relating to this sequencing in the UK.) From these perspectives, the application of the distance education paradigm to in-service teacher education is becoming more and more compelling, accelerated by new technological developments that improve the communication and interactive aspects of distance delivery.

There are many examples internationally of the use of telecommunications to support teachers in distance participation for teacher education. These can be grouped in two general ways - those relating to course delivery at a distance; and those enabling teachers to participate in a variety of other aspects of professional education, such as special projects or activities that provide "just-in-time" or on-going opportunities for teacher education (see, for example, Kelly, 1993; Wright, 1993). Central to these distance opportunities are various kinds of technologies - telephone; cable television; radio and television broadcasting; audio and video recordings; video, audio and computer conferencing; other forms of computer mediated communication; and audiographic technology (Van den Brande, 1993).

Course Delivery at a Distance. Examples of in-service courses being delivered at a distance entirely or partly through a computer steered telecommunications channel can be found in many countries. For example, the LEARN Network in Denmark has developed and delivered a number of in-service courses via telecommunications to Danish and Norwegian teachers, all of whom could remain at home and work while participating in the courses (Larsen & Malmberg, 1991). Many other examples could be cited, all of which share the common feature of being made possible through
telecommunications used as an educational technology. Examples include Knapczyk (1990), Simon (1992), and Stowitschenk et al, (1986).

Special Opportunities for Professional Development. Outside of the framework of special in-service courses, many other opportunities for teacher in-service education are occurring through the medium of telecommunications. The PLUTO International Network Project is a noteworthy example (UNESCO, 1991). The Project has used a telecommunications infrastructure to connect European teacher education institutions. It (in 1991) linked teacher educators, pre-service teachers, and classroom teachers in 10 European countries to identify, experience, and reflect upon new forms of internationally oriented classroom activity made possible through telecommunications. The Project, which describes itself as “collaborative distance learning” combines in-service, pre-service, research, and student use opportunities, as participants work together on projects relating to comparisons of their respective countries, international examinations of weather and environmental issues, and purposeful practice in foreign language use. The Project is also occupied with the development of lesson materials for trans-European use and is anticipating extension to Eastern European countries.

Many other examples of projects can be cited in which telecommunications are allowing new forms of in-service teacher education to develop, generally outside the framework of the traditional teacher education system in a country. (The PLUTO Project was an exception to this, as it deliberately involved teacher training institutions.) Some of these projects include the Kalmar Project, for teachers in Sweden; the AT&T Learning Network Project, which provides lesson planning support and other support to teachers in countries throughout the world; the European Schools Project, in which teachers from over 20 countries work together on on-line lesson development and evaluation; and the GEONLINE Project in The Netherlands, involving teacher education in geography instruction. (All of these projects and over 20 other European projects of a similar nature are summarized in a report for the Dutch Ministry of Education, Collis & de Vries, 1991.)

Just-in-time Support and Information. In addition to these special projects, there are many other examples of how the concept of in-service teacher education is being expanded, not only in terms of delivery and organization, but also more fundamentally, away from the situation where a teacher education institution decides on an appropriate sequence and timing of in-service education and toward a teacher choice ‘just-in-time’ model. Throughout the world, information networks, accessible through telecommunications, are giving teachers access, when they wish it, to collections of instructional materials, to dialogues with computer educators.
and with other teachers about particular educational issues (not necessarily involving technology), and to large amounts of pedagogically relevant information. In the United States, for example, the Educational Native American Network connects teachers in schools for Native American students with each other and also with a wide range of informational and teaching resources as well as resources specifically aimed at teacher education. A similar on-line communication and information service, the Campus 2000 Network, operates in the UK, with targeted services for special education teachers as well as teachers in general. In The Netherlands, the PTT (the national telephone utility) cooperates with the National Curriculum Institute to provide a similar 'electronic bulletin board' as an information and communication service to teachers.

Other examples could also be cited, together showing that the distinction between 'teacher education' and on-going teacher support and professional development is rapidly blurring. Thus professional education services are becoming available to the teacher 'just-in-time', when she wants them, in her own home or school, through the medium of new communications and information technologies and without reference to traditional teacher education institutes. These on-line services are generally not being offered by mainstream teacher education faculties, another step in the further fragmentation of leadership among the various players involved in teacher education.

**Implications for Teacher Education**

The emergence of new technologies - computer related, multimedia, telecommunications - are presenting new challenges and opportunities to teacher education. Although some integration of computer applications within methodology and curriculum courses occurs in mainstream teacher education, each wave of new technologies, such as multimedia and telecommunications introduces a new wave of 'experts' from outside traditional teacher education backgrounds and training. How to work with these 'competing' teacher educators, from both institutional and conceptual perspectives, is an on-going challenge for teacher education professionals.

There is more to motivate this integration than the conceptional benefits of cross-fertilization. There is a ceiling on the amount of time and energy available for teacher education in a system; as more and more teacher education occurs outside the mainstream teacher education system, that system runs the risk of being seen as less and less relevant to practice. And, even within the teacher education system, resources spent on computer related pre- and in-service activity means less resources available for other aspects of teacher education. This too suggests a practical reason for better integration of computer related teacher education with more general courses in mainstream teacher education.
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Perhaps, however, the most serious long range concern among these issues relates to the question of where the leadership in teacher education is seen to reside by teachers in the field. How to lead rather than lose control of quality in-service teacher education when new information technologies and telecommunications can bring more and more resources and personal control of in-service options into the hands of teachers as 'on-line shoppers' could well raise an organizational and professional problem of great magnitude in the next decade. The 'just-in-time' on-line access to resources and teacher education expertise through communications technology could change patterns of response to traditional teacher education in-service courses. Just as the teacher may no longer be able to be considered the primary source and organiser of his or her students' learning in the information society of the 21st century (see, for example, Sawyer, 1991), neither may the traditional teacher education institutions be able to adequately provide or control teacher education.

How can this be anticipated? How can the changes which may occur relative to teacher access to professional expertise be channelled in as positive direction as possible? It would seem that a commitment to a more synergistic relationship among the many diverse players interested in teacher use of computer related technology is important. Opportunities for cooperation should be explored, but with the initiative taken from within teacher education rather than from those operating from technological push. The teacher educators who are also computer applications specialists, and the number is growing, must also take the initiative to make connections with other partners, not only from the traditional educational technology community but also from new players such as the information sciences community, the computer supported cooperative work community, and the human resources management community as more and more use of on-line communication and information services becomes part of educational practice.

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