Using Computers in Multi-Grade Teaching

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Introduction

The term "multi-grade" class is used to describe any class in which students of different grade levels are placed together for administrative reasons. This includes multigrade classes in both multigrade schools, where multigrading is a response to the fact that there are less teachers than grade levels, and larger schools, where multigrading is a response to uneven pupil intake (Veenman, 1995; Mason and Burns, 1997). Several other terms may be used in the literature to refer to a multigrade classroom. These include combination class, vertically grouped class, mixed age class, split-grade class, and double grade class (the latter two terms for classes containing only two grades).

It is also necessary to distinguish between multigrade classes to which students cannot be selected on the basis of such things as ability or attitude (non-purposefully assigned) and multigrade classes to which students can be selected (purposefully assigned). Mason and Burns (1997) introduce these two terms to explain why many studies of multigrade settings find no difference in cognitive achievement when compared with monograde settings. Students are always non-purposefully assigned to multigrade classes in multigrade schools. Studies of the effects of multigrade classroom organization have not always made this distinction explicit.

Multi-grade Teaching in Context

A survey of the literature of multigrade teaching by Little (1995) reveals that multi-grade teaching commonly refers to the teaching of students of different ages, grades and abilities in the same group. It is referred to variously in the literature as 'multilevel', 'multiple class', 'composite class', 'vertical group', 'family class', and, in the case of one-teacher schools, 'unitary schools'. It is to be distinguished from mono-grade teaching in which students within the same grade are assumed to be more similar in terms of age and ability. However, substantial variation in ability within a grade often leads to "mixed-ability" teaching. There can also be wide variations in age within the same grade, especially in developing countries, where the age of entry to school varies and where grade repetition is common. This condition of "multi-age-within-grade" teaching appears not to have generated such universal recognition, perhaps because it occurs more often in developing than in developed countries. When references to multi-age teaching occur in the literature they usually describe educational settings in North America, where, because age and grade are congruent, the term is used synonymously with multi-grade teaching.

Several writers have pointed out that the first state-supported elementary schools in North America and Europe were un-graded. The school often consisted of one room only and one teacher taught basic literacy and numeracy to children from six to fifteen

years of age. In the US the “death knell of the one room school was sounded” after a visit by the Secretary of the Massachusetts Board of Education, Horace Mann, to Prussia in 1843. On his return he reported that:

> the first element of superiority in a Prussian school.. consists in the proper classification of scholars. In all places where the numbers are sufficiently large to allow it, the children are divided according to ages and attainments, and a single teacher has the charge of only a single class... There is no obstacle whatever... to the introduction at once of this mode of dividing and classifying scholars in all our large towns (Mann quoted in Pratt 1986).

Urban education administrators in the US were soon to recommend that schools be divided on the lines of age and grade , a development which was consistent with the division of labor in industry. The “principle of the division of labor holds good in schools, as in mechanical industry” (Bruck quoted in Pratt 1986). The model of mono-grade teaching, led by industrialization and urbanization, was to become a universal ideal in the late nineteenth and twentieth centuries and came to dominate the basis of school, class and curriculum organization used by central authorities.

With greater demands for education under depressed economies, multi-grade schooling became a worldwide phenomenon in most of the rural areas. Multi-grade teaching is organized as a “necessity model” or as a “ design model”. In the necessity model groups of children varying in age and numbers are combined together under the supervision of a teacher or two teachers to be taught as a class. This model may be a result of financial constraints, non-availability of teachers or lack of resources. Multi-grade classes of this type are commonly found in sparsely populated areas in rural settings or in areas with high student population but few teachers. Multi-grade teaching is also planned as a design with a rationale to meet student’s individual needs. In this model students are grouped together across ages in combinations most beneficial to their educational stimulation and success.

Thus according to Berry (2003), there are three important reasons why multigrade teaching may occur in both developed and developing countries.

First, multigrading is often associated with ‘small’ schools in remote and sparsely populated areas. In such schools, there may be only one, two or three teachers, yet they offer a complete cycle of primary education. If that cycle consists of eight grade levels, then each of these teachers must deal with multigrade classes. These ‘small’ schools are also sometimes referred to as ‘multigrade’ schools. Multigrade schools have attracted attention in the developing country context because of their potential to increase primary school participation rates. By bringing the school closer to the community, they encourage more children, especially girls, into school.

Second, multigrade teaching is also common in larger urban and suburban schools. In some countries, it is a response to uneven student enrollment. For example, a school with a two and a half grade entry may have to combine two grade levels to make up class sizes. Also, in countries where teacher absenteeism is high, and there is no ‘cover’, grades may be combined to avoid having a class with no teacher present. A single teacher then has to deal with two grade level groups together. While the latter problem is not well-documented in the literature, it is probably a regular occurrence in countries in both Africa and the Caribbean.

Third, multigrade teaching may be a deliberate response to educational problems. In developed countries, this is linked to the multiage perspective. Proponents of mixed age grouping argue that there are sound pedagogical reasons for placing students of different ages together in the same classroom. Mixed age classes, it is argued, stimulate children's social development and encourage greater classroom cooperation. These arguments are seldom raised in the developing country literature, although several commentators take the view that multigrade organized classes are potentially a cost effective means of providing quality education in difficult to reach areas.

In much of Africa, a major rationale for multigrade education is probably its potential to increase access to the full cycle of primary education in areas where this is currently not available. It has been used for these purposes in Zambia and Burkina Faso, for example. In the Caribbean, the question of access is not so crucial as in most of the region there is already full access to primary education. Rather, multigrading may be seen as an approach to increasing the quality of schooling by introducing innovative approaches to teaching and learning (World Bank, 1993)

Guidelines and pitfalls

When considering the implementation of multigrade programs for countries in Africa and the Caribbean, attention needs to be paid to the 'will' of teachers to implement. This is potentially affected by four factors (Beneviste and McEwan, 2000). These are *lack of faith in multigrade pedagogy*, *professional and social isolation*, *difficulties of teaching in a multigrade classroom*, and *'ownership' of multigrade teaching*. Each of these factors has implications for the development of multigrade teaching programs in developing countries. Let us look at them individually.

Lack of faith in multigrade pedagogy

Most teachers view monograde teaching as the 'normal' way to organize classes. Multigrade classes are viewed as an unavoidable 'nuisance'. Consequently, teachers may be resistant to the idea of being trained in multigrade teaching methods, and motivation may be low. There is a need, therefore, to convince teachers and other in the field of education of the merits of multigrade pedagogy.

In Colombia, this is reported to have happened by 'word of mouth', with those teachers who were participating in the program telling others about it. Certainly, programs need to be developed in a coherent rather than a piecemeal manner, and all stakeholders should be clear about the rationale for the introduction of multigrade pedagogy.

Professional and social isolation

Multigrade education often takes place in remote schools in difficult to reach areas. Teachers not only face the difficulties of dealing with a multigrade organized class, but also other constraints such as lack of resources, infrequent supervision, and poor living conditions. These conditions also make teachers resistant to the idea of multigrade teaching and reduce their enthusiasm for the task. It also makes it difficult to recruit teachers for these kinds of jobs, and to retain those teachers who are recruited.

Teacher recruitment and posting in isolated areas demands a coherent strategy from central government. In some countries, for example, there is compulsory teacher

assignment to rural locations. However, this latter approach does not solve the problem of low teacher morale, nor does it increase either recruitment or retention. One of the best strategies is probably the provision of specialized ongoing training, together with a policy of training and recruiting teachers from local villages.

Multigrade teaching is more demanding

There is no doubt that in a graded system of education multigrade teaching is more demanding than monograde teaching. Planning from the curriculum is more difficult because of the way in which it is structured, classroom management is more complicated because of the necessity of having more than one group on task at the same time, teachers may be required to write multiple lesson plans, and end of term tests have to be set for each grade level group. The head teacher of a multigrade school is also usually a class teacher, and this places greater demands on her time. Other staff members may have to fill a wider variety of duties than their counterparts in larger schools, including pastoral care.

For these reasons, graded systems need to move in directions that support the multigrade teacher, but also encourage more innovative teaching methods in the monograde classroom. One way in which this may be achieved is through curriculum reform. The graded curriculum model encourages teachers to view their class homogenously, so perhaps other curriculum models need to be considered. One example is the modular approach adopted in Colombia, which involves dividing the curriculum into specific objectives and producing associated learning materials. Another approach is to develop curriculum frameworks that are based around themes rather than subjects. With such curriculum reforms, there is also a need for changes in the types of instructional materials that are made available to teachers.

Ownership

The types of policy level changes described in relation to curriculum reform run the risk of alienating teachers from the reform unless they are intimately involved in the process. One of the reasons for the early success of Escuela Nueva was that it was a grass roots movement, in that it was teachers themselves who trialed innovations and then disseminated good practice. When the project went to scale, however, the package of inputs was ‘frozen’ and there was less scope for teacher involvement in the innovation. This may have reduced their ownership of the program.

It is important, therefore, to involve as wide a spectrum of educators as possible in the process of reform. Teachers need to be given opportunities to feed into whatever policy formulations are selected as the focus of the innovation. Where possible, school-based solutions to problems should be encouraged, and a mechanism should be developed for sharing examples of good practice between teachers.

Practical application of multigrade techniques

One possible pedagogical underpinning for multigrade classroom organization lies in the multiage literature. This perspective argues that grouping children across grade and age boundaries is beneficial for children both socially and cognitively. A good summary of this position is provided by Pratt (1986). He uses findings from anthropology to show that the ‘natural’ way in which infants are socialized in many cultures is in mixed age groups. He also points out that age segregation is a relatively recent phenomenon. The biggest advantage for children in a mixed age setting, it is

argued, lies in the development of wider friendship groups and a reduction in competition and aggression. A review of qualitative research from the USA by Miller (1989) suggests that, if multigrade school contexts are not overly disadvantaged by virtue of their location, these types of advantages can and do accrue to children.

In developing countries, the evidence that exists of conditions in multigrade schools suggests that they may be extremely disadvantaged by virtue of their location. Studies by UNESCO/APEID lists several home background disadvantages, such as lack of parental interest in education, poor nutrition, and a mismatch between home and school culture. Other difficulties commonly lie in the supply of materials and infrastructure, and appropriately trained and qualified teachers. However, there is also some evidence that multigrade schools can be very positive places for children when these constraints do not apply.

In Togo and Burkina Faso, Jarousse and Mingat (1991)suggest three possible explanations for the differences they found in achievement between students in multigrade and monograde classes. Firstly, they argue that teachers in multigrade classes employ more effective pedagogy. There is more emphasis placed on individual work, peer work, and a wider variety of presentation techniques are used. Secondly, the pupils remain with the same teacher for a two year period. Thirdly, weaker students in the upper grade are able to catch up because some teaching is geared towards the younger children in the class. Lungwangwa (1989) also found that the introduction of multigrade techniques in Zambia resulted in a decrease in drop out rates from school, and an increase in enrollment.

In Belize, the more effective multigrade schools in the Nielsen et al (1993) study tended to be nearer to main towns, to have two classrooms or more and fewer than three classes per teachers, and to have access to above the national average in textbooks. Their teachers were more mature (above 30), more educated, more likely to be trained, and to live close to the school. Teachers in the high performing schools made more use of peer tutoring and cross age tutoring. They also involved the community in the life of the school. High performing schools had frequent supervisory visits, and a principal who was supportive of her teachers and stayed at the school.

In the Turks and Caicos Islands, Berry (2001) found that multigrade teachers were more likely to employ group work than monograde teachers. This is because they had to deal with more than one grade level in the same class. He speculates that as a result of this, multigrade students are more likely to have opportunities to interact together in mixed ability groups. This leads to a more cooperative classroom and advantages for low achievers in particular. In monograde classes, on the other hand, teacher directed lessons with high levels of competition are much less advantageous to under-performing students.

There are, therefore, examples of good practice from both the Caribbean and Africa. In both regions, there is also evidence that the good practice in multigrade classes is in some respects superior to that found in monograde classrooms.

Critical Educational Issues in Multigrade Teaching

Having seen what multigrade education is, I will now focus attention on the use of computers in Multigrade teaching. However, although my emphasis is on computers, I would also use the broader term of Information and Communication Technologies (ICTs) to refer to ways and means of increasing efficiency in multigrade teaching. I chose deliberately so that we can see how using ICTs in multigrade teaching situations creates more challenges than in monograde teaching.

No single change or reform can possibly address all educational challenges, but information and communication technology can address a broad range of changes and improvements. Some areas in which the appropriate use of computers in education might make an important difference are: .

Learner-centered education:
Teachers must take on new roles as facilitators who empower students to question, experiment, collaborate, inquire, and construct knowledge and understanding. .

Higher-order cognitive skills:
New curricula, teaching practices, and pedagogies are needed that enable students to develop and refine critical thinking skills. .

Enabling reflective learning and creative expression:
Educators need to create learning environments that enable students to acquire and use information that helps them understand their world and experiences and, eventually, generate new information and knowledge. .

Lifelong learning:
Learning has to take place before, during, and after formal education, beyond the classroom, and through a variety of means. .

Active inquiry, research, and analysis:
Students must learn to formulate critical questions, identify, acquire, and organize information from different sources, and analyze and make judgments about collected information. .

Collaborative, project-based learning:
Students must be able to work cooperatively in groups, on projects that cross disciplines, constructing knowledge using a variety of both electronic and print research and reference materials, just as problems are solved in real-world and work situations.

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Technological literacy:
Digital technologies have penetrated most work environments, so the lack of technical literacy and skills is a serious handicap in modern economies. .

Educational/real world relevance:
Education must provide information, skills, and experiences that are relevant to the world in which students will live and work. .

Individualized instruction:

Differences in individual knowledge, learning abilities, and styles are not usually accommodated in traditional classrooms. As a result, students often demonstrate lower retention rates, poor performance, a dependence on rote learning, and a lack of enthusiasm. Current learning models show that individualized, project-based instruction can reverse these negative effects and contribute to greater student and teacher satisfaction.

It is clear therefore that the use of computers in multigrade teaching situations require cross-cutting strategies that use the commonalities of the basic core concepts of the program to cater for learners of different abilities learning under the same circumstances. The idea is to use concepts that appeal to both older and younger students without holding down any specific group of learners behind.

ICT-Mediated Instruction

The first question to be considered about the effectiveness of ICT in education is what, if any, impact ICT-mediated instruction has on student performance. ICT-mediated instruction refers to instruction delivered via a technological channel such as television, radio, or a computer and network. It is interesting that most focus on the use of ICTs in education in Nigeria almost always refer to computers, at the exclusion of other potentially powerful communication technologies – such as radio, CDs, cassettes – that could also be used to facilitated learning. In this context, it should be borne in mind that the use of ICTs in education referred to here is for the conventional use which assumes availablity of the technology in all its forms.

ICT-mediated instruction can be synchronous, with both the instructor and the student participating simultaneously. For example, instruction may be delivered via desktop videoconferencing by a teacher located at a university to employees at widely separated companies. ICT-mediated instruction may also be delivered asynchronously, with the instructor and student participating at different times. Instruction based on teaching materials placed on a website does not requiring simultaneous participation. Or synchronicity may not matter, as when self-contained instructional materials are packaged on a CD-ROM. In this case, the instructional designer may have developed the materials months or even years before the student uses them and communication between the two is impossible.

Studies focusing on the use of computer-mediated instruction conducted in the 1980s found more positive results. In a meta-analysis of over 500 individual studies, James Kulik (1994) found:

1. Students usually learn more in classes in which they receive computer-based instruction.
2. Students learn their lessons in less time with computer-based instruction.
3. Students also like their classes more when they receive computer help in them.
4. Students develop more positive attitudes toward computers when they receive help from them in school.
5. Computers do not, however, have positive effects in every area in which they were studied. The average effect of computer-based instruction in 34 studies of attitude toward subject matter was near zero (as cited in Glennan & Melmed, chap. 2, 1995).

Kulik's meta-analyses were conducted on studies of computer use prior to the 1990s. Such use was often limited to drill and practice and tutorial software programs. In the 1990s, use of ICT in schools is moving toward engaging students in "authentic" learning tasks in which students use computers, software, and network access to simulate events, communicate, collaborate, analyze data and access information resources. For these applications of ICT in schools, the research data are less extensive. However, some individual studies have been conducted that demonstrate positive learning and affective outcomes (cf., Means and Olson, 1995; Software Publishers Association, 1995; and Special Issue on Educational Technologies: Current Trends and Future Directions, 1994).

However, one concern often expressed about ICT is that its use will isolate students from each other and from their teachers. In a 10-year longitudinal study undertaken by Apple Computer, "Dispelling widespread myths, the researchers found that instead of isolating students, access to technology actually encouraged them to collaborate more than in traditional classrooms. And instead of becoming boring with use, technology was even more interesting to students as they began using it for creating and communicating" (Apple Computer, Inc., 1995). It appears, therefore, that ICT, properly used, may enhance and increase communications between people.

In conclusion, evidence has consistently shown ICT-mediated instruction using conventional teaching methods is as good as traditional face-to-face instruction and, in the case of computer-based instruction, may in select instances improve student learning and attitudes towards learning. However, the picture is less clear – but promising – for more sophisticated uses of ICT in the classroom, especially for the host of applications and methods that support "constructivist" learning, in which students are encouraged to work in rich environments of information and experience to build their own understandings about them. Worldwide, research into the effectiveness of ICT-mediated instruction is continuing and should provide a clearer picture of the effectiveness of ICT in supporting constructivist pedagogy. For example, as part of the *Helsinki 2000* project, Finnish investigators are conducting a five-year, multi-disciplinary investigation focused on analyzing innovative pedagogical practices through intensive case studies on computer-supported collaborative learning (Hakkarainen, Halinen, Lipponen, Momaki, & Lehtinen, 1999).

ICT-Enabled Education

A second way to assess the merit of ICT use in education is to consider what, if anything, such use enables students and teachers to do that they would not otherwise be able to do. To explore this question, we consider three aspects of the educational use of ICT that are of direct relevance to our learning situatios – *supporting new pedagogical methods*, *enabling collaboration*, and *developing skills for the workplace*.

Supporting New Pedagogical Methods

Modern constructivist educational theory emphasizes critical thinking, problem solving, "authentic" learning experiences, social negotiation of knowledge, and collaboration – pedagogical methods that change the role of the teacher from disseminator of information to learning facilitator, helping students as they actively engage with information and materials to construct their own understandings. That is, students learn *how* to learn, not just *what* to learn (cf. Forman & Pufall, 1988;

Newman, Griffin, and Cole, 1989; Piaget, 1973; Resnick, 1989; Strauss, 1994).

ICT has the potential to be used in support of these new educational methods, as tools enabling students' learning by doing. ICT can make it possible for teachers to engage students in self-paced, self-directed problem-based or constructivist learning experiences; and also test student learning in new, interactive, and engaging ways that may better assess deep understanding of content and processes (cf. Strommen & Lincoln, 1992; U.S. Department of Education, 1993).

Improved assessment tools can also be developed using ICT. Such assessments can engage students in tasks that require data manipulation, simulation or other interactive acts of knowledge construction. VizQuiz is a multimedia program that allows students to take a chemistry quiz at a computer, but with the added advantage that color graphics, animations, and video clips can be included in the questions. In addition to multimedia capability, such programs can provide hints, remedial feedback, worked out solutions or explanations, and instantaneous grading.

However, although ICT offers the opportunity to construct powerful learning experiences, it is pedagogically neutral. That is, instead of being used in the ways described above, ICT can be used in support of traditional teaching methodologies like the large group lecture, student note taking, and examinations (cf. Hunt, 1998).

Teachers can use a computer and projector to show slides to illustrate a lecture, students can use laptop computers to take notes during the lecture, and multiple choice quizzes about the content of the lecture can be put on a website. How these new ICT tools and resources will be used is a human decision, not inherent in the technologies themselves.

Enabling Collaboration

Not all resources are inanimate. ICT enables educational collaborations between individuals and groups of people. Such collaborations may take place locally or between people in widely separated geographical locations. They may be temporary or long-term. Students may collaborate with peers in other schools, teachers may collaborate with university professors, members of the local business community may serve as mentors to students, scientists in government agencies may work with school children, and so forth. Only educational usefulness and access to ICT limit the possibilities.

Developing Skills for the Workplace

After leaving school to embark on a career, young people can expect the day-to-day practice of every discipline to be affected by the use of ICT. In the future, economic competitiveness, employment, and personal fulfillment may no longer be based on the production of physical goods. Personal and national wealth creation may be linked to the production and dissemination of knowledge and depend on research, education and training, and on the capacity to innovate. Having advanced ICT skills and knowing how to use discipline-specific applications may help students secure suitable employment and enhance their productivity once employed. Furthermore, as has been noted above, the ability to engage in life-long learning opportunities offered by educational institutions around the world is increasingly dependent upon access to, and use of, ICT.

In light of changing perceptions about what constitutes appropriate skills for the modern era, some organizations are promulgating educational standards, attempting to codify what all students should learn about ICT.

However, although it can be anticipated that the increasing use of ICT in education and society will change the nature of the knowledge and skills students must acquire in order to compete and contribute in an increasingly ICT-dominated global economy, what skills will be necessary is not clear:

> What do students need to know and do with technology? Unlike the more stable content and goals we have for other areas of school study, technology continues to change and evolve; with these changes come ever-new goals for how technology should serve learning, and what students should know about technology. A review of the "prevailing wisdom" about appropriate technology use since the early 1980s takes one down an ever-turning road that includes programming in BASIC, then with LOGO; and on to drill and practice applications on integrated systems; word-processing and curriculum-specific tools like history databases, simulations, and microcomputer-based labs; then multimedia; the Internet; and now Web page design. While there may be some logic to this progression, the reality is that, just as educators get their arms around one approach, with the attendant investments in software, training and possible curricular readjustments, the messages about appropriate technology use change. (Fulton,1998).

There does seem to be a growing consensus that all students must achieve "Information literacy": As sated in Finland, for instance, "it is the task of general education to provide every girl and boy with the versatile basic skills in acquiring, managing and communicating information which are necessary in the information society and essential for successful further study" (Ministry of Education, Finland, 1995).

Teacher Education and Training

To create ICT-enabled teaching and learning environments, it is also necessary to provide ICT training for teachers. In some countries, for example Great Britain, it is now required to have training in ICT-use to earn a teaching credential. Beyond preparative training, as educational applications of ICT continue to evolve, refresher training for experienced teachers will be necessary.

In one possible framework for organizing ICT training for teachers, McDougall and Squires (1997) identify five foci: (1) skills with particular applications, (2) integration into existing curricula, (3) IT related changes in curricula, (4) changes in teacher role, and (5) underpinning theories of education. The authors note that most ICT teacher training mistakenly focuses entirely on the first issue.

Furthermore, it may not be sufficient to simply provide training for teachers. For instance, Murphy and Gunter and others (cf. Sharp, 1998) advocate that ICT training be extended to educational administrators:

> Lack of teacher technology training has been the failure of most schools trying to grasp technology and harness the power that technology can bring to the classroom. However, successful technology training can be accomplished only through effective administrative leadership … These leaders must be knowledgeable in the use of technology and must show support by providing access to the equipment and materials necessary for successful

integration. (Murphy and Gunter, 1997, p. 136; 138)

But, even more vital than ICT training for teachers and administrators, there is a continuing need to educate qualified teachers to staff schools. ICT is being used in a wide variety of ways to support teacher education as well and teacher training in ICT use. Email, websites, desktop videoconferencing, and other technologies and applications are all playing a role in such efforts.

Teacher Education

Preservice teacher education refers to the formal preparation of individuals to enter the classroom as qualified teachers. In-service teacher education refers to on-going professional development programs offered to teachers once they have entered the profession. Perraton and Potashnik (1997), in a review of ICT use in teacher education, note that while most teachers working in schools worldwide have received some preparation, not all have received adequate preparation. In fact, many have received none at all. In India in 1996, for example, there were about 240,000 teachers who were not fully qualified. There also are severe teacher shortages in many countries, the problem being especially severe in South Asia and Africa (p. 4). Even in developed countries where there are sufficient numbers of teachers, as in the U.S.A., many are unqualified or under qualified to teach specialized subjects like mathematics and science (cf. National Science Foundation, 1998).

ICT is being used in a wide variety of ways to support both pre-service and in-service teacher education. In Africa, UNESCO is developing a large distance education project to help eight countries train teachers and principals un-reached by traditional training. The project, to be launched in 1999, is expected to train half of the teaching staff in five selected countries (UNESCO Education News, 1998). Also in Africa, education ministers from six Southern African Commonwealth countries have signed an accord to co-develop distance education programs with a priority given to the in-service training or teachers in science, mathematics, and technology (Commonwealth of Learning, 1998).

In Australia, the Faculty of Education at the University of Wollongong is linking teachers and postgraduate students directly to lecturers through email networks and provides online support to teachers in schools (Hedberg & Harper, 1996). *TeacherNet UK* (http://www.teachernetuk.org.uk), an independent organization, offers teachers the opportunity to develop an online profile of their interests, needs, and prior achievements, and then matches the individual participants accredited professional development programs. *TeacherNet UK* also enables peer support and mentoring through email and web-based discussion groups. In Iceland, the University College of Education offers a Bachelor of Education (BEd) degree via the Icelandic Education Network (http://www.ismennt.is). In Denmark, teacher education is being conducted using ICT including computer-mediated conferencing (CMC) supplemented by satellite-based teleconferencing, multimedia and standard computer-based training (Ingesman, 1997). And, in a final example of how ICT is being used to support teacher education, the *TRENDS* (Training Educators through Networks and Distributed Systems) Project (http://www.lrf.gr/english/trends/trendshome.html), a collaborative effort of the seven European Union countries, is developing an in-service, school-based teachers training system based on multimedia and network technologies.

Teacher Training

As noted in a Finnish government report of a technology assessment project, "how computers are used in education depends on the pedagogical competence and technical skills of the teaching staff who must know how to exploit these modern technologies in pedagogically meaningful ways" (Finnish National Fund for Research and Development, 1998). Regional, national, and local plans for ICT in education typically include provisions for teacher training (cf. World Bank, 1998).

ICT training for teachers has at least two aspects – technical training and preparation to integrate ICT use into the curricula. First, teachers need technical training to learn how to use and maintain ICT equipment and software. Such technical training is being offered to teachers in a wide variety of ways. Preservice university-based courses, in-service workshops, commercial training programs, and other opportunities abound, many of which make use of ICT to deliver instruction (cf. McKenzie, 1998). Second, as "integration of technologies into curricula requires changes of huge magnitude" (Foa, Schwab, and Johnson, 1998, p. 1), training in how to integrate ICT-use into the curriculum is necessary. Such instruction should including effective teaching methods with ICT and the use of discipline specific applications.

Training methodologies vary, but "training of trainers" models are common and, in most instances, may be more cost-effective than on-site, small group or individual ICT training. In such programs, "teacher-leaders" are selected by a variety of criteria, usually including prior experience with ICT in education, staff development expertise, and commitment to the program by school and district administration. These individuals receive intensive training courses to master technical details and approaches to integrating ICT into the curricula. Once trained, they return to their educational institutions and provide ICT training and support for their peers. Such programs may also include on-going, long-term support for the trainers including site visits, computer-based conferences, and email mentoring. In large geographical areas, the responsibility for such training and on-going support may be delegated to regional ICT consortia, coordinated by a central administrative body.

In the United Kingdom, the ICT Training Initiative of the Teacher Training Agency (TTA) (http://www.teach-tta.gov.uk) offers a combination of technical and discipline-specific applications training. The TTA, working with other educational organizations and a commercial company, will produce a package – including CD-ROM, video and paper-based materials – to help teachers identify their specific training and development needs in the use of ICT in teaching their subjects. Starting in April 1999, training – some of it Internet-based – will be offered to enable existing teachers to acquire the ICT knowledge, understanding, and skills which will be expected of all newly qualified teachers entering the profession from 1999.

In Australia, the *Connecting Teachers to the Future* project is providing teachers with training and a laptop computer, modem, and an Internet account "to empower teachers with personal skills in the use of information and communications technologies and to help them enhance the curriculum they develop for their students" (Gray & Buchanan, 1998).

Thus ICT integration in teacher training is an effective way to prepare teachers for teaching multigrade schools. This is indeed articulated in a series of challenges facing this integrated, which is the outcome of a specific research on South Africa. These challenges included:

- ICT integration into teacher education is complicated by the variety of levels at which ICT capabilities can be taught (pre-service versus in-service, primary versus secondary, simple versus advanced skills) and by the variety of types of capabilities (pedagogically linked or decontextualised ICT skills, subject-specific ICT skills). These layers of complexity make it very difficult to plan broad-scale and effective strategic interventions in this field.
- Although there is evidence of a number of teacher training initiatives in Africa at both the pre-service and in-service levels, these are mostly small scale, regional and fragmented with little sharing of experience between nations. There is currently no comprehensive pan-African framework that covers the development of local technological models and local teacher training content for building African teachers' ICT capabilities.
- There is also a lack of coherent individual government policies with respect to developing teachers' ICT capabilities in Africa. Several African countries have developed national ICT policies, and several more are in the process of finalizing their ICT policies. However national ICT policies with respect to teacher training remain fragmented, under-funded and inadequate.
- Many African education ministries are desperately short of funds to allocate to existing education requirements. Therefore, although most view ICT as an important new field for education development, ICT programs for teachers are low in terms of spending priorities.
- Many of the courses and projects on ICT for teacher education identified in this research have been created with donor funding. Most are funded for specific periods of time, and it is unclear whether they will be able to sustain themselves once their external funding stops.
- Accreditation is one way to create tangible benefits for teachers from ICT training. However, the challenge is how to ensure that accreditation is consistent across a wide variety of very different courses and there is not a proliferation of poor quality courses offering the same accreditation as much better courses.
- There are serious concerns in Africa regarding the shortage of locally developed, contextually relevant course content for both teachers and learners. It is vital that considerably more emphasis be placed on developing contextually relevant African digitized content so that African teachers can realize the full potential of ICT to transform their teaching practice.
- There is currently a broad range of course materials of various levels of quality available to African teachers. There is a challenge to ensure that good quality courses get the high-level support that they require to become widely adopted, while poor quality courses are either improved or abandoned in favor of the better courses.
- The majority of African teacher training institutions are too under-resourced even to meet existing expectations. The addition of an ICT curriculum requires extra infrastructure, the development of teacher trainer ICT capabilities and the development of ICT training materials (content).

- There is no point in spending any time and effort equipping teachers with the necessary skills to integrate ICT into their teaching if schools do not have the computer laboratories and other ICT resources necessary to put their skills into practice with their learners.
- Teachers require sufficient time for training and access to information about suitable courses.
- Finally, the prohibitively high cost of training African teachers in ICT is a constant issue and underlies all of the challenges already mentioned. Everything from the development of course materials, to the implementation of training programs (whether pre-service or in-service), to ICT access for teachers, to monitoring of course quality and consistency is limited by insufficient funds. The shortage of public funds in Africa is the fundamental challenge to be overcome before ICT capacity-building can become a reality in African education.

Finally, let us see how all these ideas will fit into a typical multigrade class by analyzing the Aide Memoir for Monitoring ICT use in multigrade schools. I will illustrate with specific software programs during the laboratory session of the workshop.

Aide Memoir for Monitoring ICT in Multigrade Schools

Teacher _____ Class _____Date_____

Context of the lesson _____

1. Effective ICT planning includes:

- planning links to scheme of work as provided by the ministering agency
- clear objectives linked to statutory links or opportunities identified in the National Policy on Information Technology
- lesson objectives building on previous teaching, learning and assessment of earlier learning
- objectives that allow for differentiation
- planning for those pupils with higher level ICT skills
- ICT resources that are prepared before the lesson
- ICT planning that identifies the effective use of other adults
- planned and effective pupil groupings

2. In the introduction, the teacher:

- gives a clear start to the lesson:
  - makes clear what children will do in the activity
  - separates what they are going to learn from they are going to do
- actively teaches new ICT skills and knowledge in a way that makes sense to pupils
- makes sure all children involved can see the demonstration
- makes sure any support staff give discreet help to certain children
- maintains a good pace throughout the introduction, without sacrificing learning
- gives pupils clear targets of what is expected of them during the lesson
- provides opportunities for discussion as appropriate
- discusses and compares ways in which non ICT methods may be used

3. In questioning, the teacher:

- asks quality questions (open and closed) to review learning e.g. Why does? What if…? How would you…? Could you explain….?
- has question time with pupils' hands down, to give all the opportunity to think before answering
- allows opportunities and encourages pupils to formulate questions
- asks specific pupils to answer on occasions
- asks other pupils to comment on answers or summarize questions
- encourages pupils to consult with a partner/group in order to formulate an answer
- uses wrong answers to develop understanding

4. During the lesson the teacher

- draws children back to a small group demonstration if appropriate
- maintains pace and gives children a deadline for completing their work
- encourages children to demonstrate or offer their methods and solutions for discussion
- uses appropriate resources including wall displays where appropriate
- circulates when not working with a specific group to assess, give feedback, correct, extend or refocus learning
- uses timely intervention to move learning forward
- uses time effectively to provide maximum access to ICT resources

5. Working with groups, the teacher:

- sets clear time scales and expectations for the tasks
- has the ability to engage with a number of pupils, rather than becoming stuck with one or two
- recognizes when it is appropriate to draw together a group or whole class for input
- works intensively with an ICT group on occasions in the classroom (if not in the ICT room)
- makes appropriate use of any support staff or adult helpers
- avoids interruption by making sure that those working independently know:

    - where to find resources (e.g. help guides and prompts)
    - what to do before asking for help
    - what to do if they finish early

6. During the Plenary the teacher:

- reviews learning objectives and questions pupils' understanding of that learning
- gives various pupils an opportunity to share their learning
- asks questions to assess learning

7. Does the teacher have good ICT subject knowledge, understanding and competency? The teacher:

- shows a thorough knowledge of the subject content covered in the lesson
- uses and displays ICT vocabulary and encourages pupils to use correct terminology
- draws on pupils' prior ICT skills and knowledge when presenting new materials
- plans ICT activities that are stimulating, motivating and engage pupils' interest
- challenges pupils with good ICT skills gained from access to ICT outside school

- has high expectations of all pupils
- expects the same level of literacy in ICT as, for example, in a literacy lesson
- is technically competent to manage the lesson

8. Feedback and Assessment. The teacher:

- makes learning objectives and success criterion explicit to pupils, using language children understand
- talks to pupils to assess their progress during the lesson
- provides opportunities for whole class review of work e.g. plenary
- provides opportunities for pupils to reflect on what they have learned
- focuses the plenary on learning objectives
- ensures that marking focuses on learning objectives
- makes evaluative comments on work which indicate how it should be improved
- ensures that assessment informs planning

9. Manages

- pupils including behavior, left handers, care of equipment, movement in room etc.
- time
- resources – ensuring appropriate software, bookmarks and help sheets are ready for use
- ICT resources ensuring they function reliably
- support staff - briefed with thorough knowledge and understanding of ICT resources in use
- homework - appropriate homework is set – and followed up
- pupils with no access to ICT at home and provision is made for them

10. Learning and Response – Pupils:

- gain new ICT skills or knowledge during the lesson
- make sufficient progress, during the lesson, towards the learning objectives
- can make judgments on when and how to use skills gained
- are encouraged to use online help or reference books when solving ICT problems
- are productive and work at a good pace taking pride in their work
- sustain concentration and remain fully engaged throughout the lesson when using ICT
- are confident to explore software applications and solve simple ICT problems when they arise
- think and learn for themselves, learn from mistakes and move towards independence
- work effectively together in pairs or groups, exchanging and sharing information
- review, modify and evaluate work as it progresses
- understand what they are doing

- know how well they are doing it
- know how they can improve their work using ICT and are given opportunity to do so

11. Displays

- represent the use of ICT
- represent the range of ICT
- show pupils' understanding of audience and purpose

12. Standards

- Very good (1), Good (2), Satisfactory (3), Less Satisfactory (4)
- Comment on strands seen
- Work set is at appropriate level for the children
- Differentiated tasks are suitable for range within class
- Level is appropriate i.e. pitched at the national expectations of a particular age group

13. Evidence used

- Pupil records
- Pupil working at computer
- Annotated portfolio
- Lesson observation
- Baseline information sheet
- OCC Record of Attainment or skills list

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