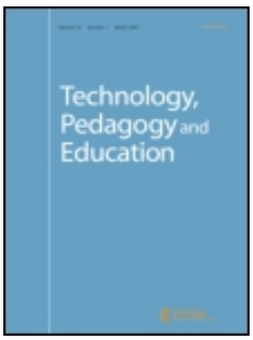

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Pedagogic Benchmarks for Information and Communications Technology in Teacher Education

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ABSTRACT This special issue has described a number of excellent initiatives for the implementation of information and communications technology (ICT) into teacher training which achieve more than functional digital literacy. This article is a synthesis of these 26 cases of good practice and reveals that there are many examples of good practice which can be used as models for calibration and/or modelling of ICT teacher training across the world. The results show that top priorities for both pre-service and in-service programmes for teacher training are that teachers become sufficiently competent to make personal use of ICT, competent to make use of ICT as a mindtool, become masters of a range of educational paradigms that make use of ICT, and sufficiently competent to make use of ICT as a tool for teaching. These characteristics are found in almost all of the programmes that the experts in this research project chose as good practice. Aspects which were considered to be important, but which are not always present in the programmes evaluated, are that teachers master a range of assessment paradigms which make use of ICT and understand the policy dimension of the use of ICT for teaching and learning. All of this needs to take place in an environment that not only talks of modern constructivist thinking and pedagogy, but adopts and models those practices. The days of teaching *about* the use of ICT are over and directed teaching of ICT skills is not recommended. The article provides evidence that it is possible to catalyse and model appropriate practice for teacher education with ICT in ways that promote educational renewal for the twenty-first century.

Introduction

The number of students in high school that are digitally skilled has increased greatly in the past few years. This is especially true for Internet skills (including email). Ownership and use of computers at

> home is far more important for developing digital skills than availability of computers in the school.
>
> Of the more than one thousand students questioned in May 2001, 97% had a computer at home, 84% had Internet access at home, 80% had their own email address and 22% said that they had their own web site. (De Haan et al, 2002, p. 169)
>
> In high schools, more than 25% of the teachers has [sic] either no basic ICT skills or has minimal skills (6 and 21% respectively) and almost 60% has either no skills or minimal skills with respect to the pedagogic uses of ICT (25 and 31% respectively). (Dutch Inspectorate of Education, 2002, p. 6)

Many countries and agencies are developing and guiding professional development so that the majority of teachers can be prepared to use information and communications technology (ICT) in education. UNESCO has been working to produce guidance for less-favoured countries at the request of their governments (UNESCO, in press). A World Bank report also identifies ICT in teacher education as a key issue, especially in the preparation of aspiring teachers (Hepp, 1999). Many developed countries are also promoting initiatives for ICT in teacher education and Niki Davis, in her final editorial for this journal in 2001, noted that ICT in teacher education is at its first zenith and that 'the heat is on' for those who prepare educators to use information and communication technologies effectively.

Davis & Tearle (1998) reviewed frameworks for ICT in teacher education in 1998 to inform a European Commission research objective of a 'Core Curriculum' for ICT in teacher education (then known as Telematics for Teacher Training, or T3). They noted that many countries around the world were taking action to ensure that their educational systems were updated to permit equality of access and to ensure that key ICT skills were developed in schools and other educational institutions. They also noted that it was becoming abundantly clear that the training of teachers in ICT skills and appropriate pedagogical approaches was essential. Davis & Tearle led the creation of a holistic framework to guide good practice (the T3 Core Curriculum can be accessed at http://telematics.ex.ac.uk/T3). It was expanded and updated by the UNESCO Task Force on ICT teacher education during 2001-02 and is discussed in this issue in a separate article by Niki Davis.

The Methodology of this Study

The study that lies behind the articles of this special issue of *TPEd* can be characterised as a quick-scan of initiatives in the field of teacher training across the globe. Five experts in the field of ICT and teacher education from around the world conducted the research as an asynchronous distributed

research group, which made use of a web-based project environment (*Projectplace*®) for determining the reference framework, sharing relevant documents, cases and web sites, discussing practices and collecting data.

After contracting the experts the group as a whole, making use of the document archive and threaded discussion forum, developed a 'reference framework' based upon Collis & Moonen's (2001) categories for ICT in teacher training (Figure 1). The apparent simplicity of the framework and its editing into two data collection forms belie the complexity of the processes that result in good practice in ICT in teacher education. The discussions and archive of related papers accumulated in the *Projectplace*® environment reflect the difficulty of arriving at an agreed framework through which to collect and analyse data. For the purposes of this article, it should be noted that the framework was hotly debated by the experts and project team and should be seen as one of a number of possible frameworks. Although its relatively simple form did expedite the process, a more extensive version may be valuable in the future, particularly in relation to the holistic nature of ICT in teacher education. This framework was used to gather a description of cases characterised as 'good practice' as discussed in the next section.

Based upon this reference/study framework, three actions ensued. First, the distributed experts made use of their knowledge of the field and their own professional networks to locate examples of good/best practice. Second, the project team developed two instruments for documenting the practices, namely a checklist and an evaluation form. Finally, the experts filled in the forms and supplied additional documentation so that the team in Heerlen, the Netherlands could begin on the meta-analysis.

Meta-analysis is a systematic technique for comparing the results of different research efforts, and is often used for resolving apparent contradictions in research findings. Meta-analysts translate results from different studies to a common metric and statistically explore relations between study characteristics and findings. Although the term 'meta-analysis' is a little 'heavy' to describe what was done in this research, it did, however, concur with the three major methodological stages of this technique – namely, meta-analysis typically follows the same steps as primary research. Meta-analysis first requires the purpose of the review to be defined in terms of organising frameworks (practical or theoretical questions of varying scope – see previous paragraph), which are clear enough to guide study selection and data collection. Second, the material to be analysed is selected by applying the criteria for inclusion that is specified in the framework, and expanded with specific criteria for the analysis. Finally, data are collected from studies such that their outcomes are transformed to a common metric for comparison. In this study, this resulted in benchmarks that provide a point of reference by which something can be measured and that includes a set of performance criteria which a product is expected to meet.

Reference Framework

In this study we see ICT as a core technology for the setting of learning during programmes of teacher education (Collis & Moonen, 2001). A core technology refers to the principal way of organising the learning experience; the component around which all other components are planned. In contrast, complementary technologies are optional, serving a valuable function but able to be compensated for via the core technology if so needed, or dropped altogether if not functioning or feasible.

Collis & Moonen also speak of the goals as learning how to use ICT and learning with ICT. When learning *how to use* ICT, the focus of teacher training is how to use such products in the classroom or off-campus. Teachers face new roles with respect to using ICT and learn how to fulfil those roles. In learning *with* ICT, the presentation and distribution of instruction is primarily through 'web environments or systems offering an integrated range of tools to support learning and communication' (Collis & Moonen, 2001). The synthesis of these two axes can be seen in Figure 1.

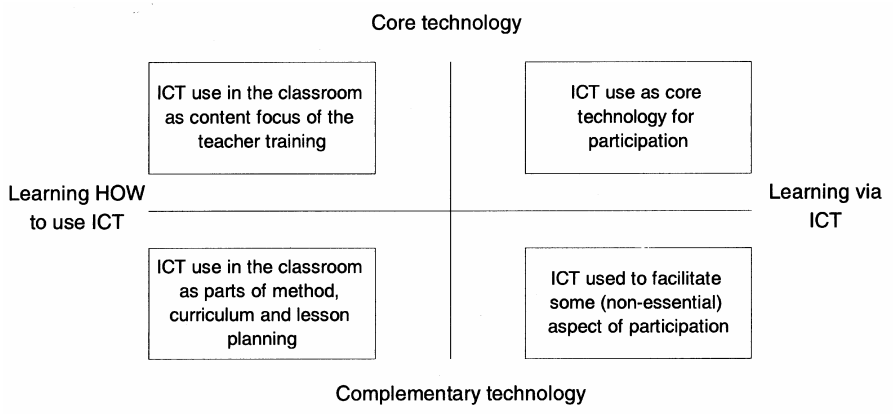

Figure 1. Synthesis of axes.

We have chosen in this study to concentrate on ICT as a core technology, and thus on the upper two quadrants as basis for the study/reference framework. The upper-left quadrant 'ICT use in the classroom as content focus of the teacher training' refers to helping teachers gain competence with ICT, for example, with specific software packages or the Internet. The upper-right relates to ICT (predominately web environments) as the tool used to support flexible learning for teachers and particularly for specialist or postgraduate school-based or home-based study for teachers, just-in-time professional development including networking with other teachers, mentoring new teachers, and interregional or international collaboration. The on-line learning networks for teachers provided in many parts of the world are examples of teacher learning via ICT as a core technology.

Results

General Results

Twenty-six examples of good practice were collected from five regions of the world (see Table I), aimed at preparing (student) teachers to work in an ICT-rich environment. A detailed list is provided in the Appendix to this issue. The practices were analysed with respect to the emphasis that they placed on different aspects of ICT in teacher training, the depth and the breadth of the practice(s), and the pedagogy employed. In this section we will first describe some striking similarities and differences between the practices. Then we will go into specific aspects of the practices based upon the reference framework and pedagogical aspects.

	n	%
Australasia	3	11.5
Canada	1	3.85
Scandinavia	6	23.1
Europe	4	15.4
Israel	1	3.85
United Kingdom	6	23.1
USA	5	19.2
Total	26	100.0

Table I. Case studies of good practice by geographical region.

The first aspect that emphasises the heterogeneity of the examples is the target group of the practices. The selected practices are directed at teachers (in-service education: 27%), aspirant teachers (pre-service: 46%) or both (27%). Although all phases of education were represented, the major emphasis was on primary and secondary levels (24/26 and 14/26). In addition, two cases of preparation for two groups of leaders were also included, namely head teachers/principals (1); and aspiring teacher educators (1).

	n	%
Pre-service teachers	12	46.2
In-service teachers	7	26.9
Both in-service & pre-service teachers	7	26.9
Total	26	100.0

Table II. Cases of good practice by target group.

	n	%
Primary	12	46.2
Secondary	2	7.7
Primary & secondary (including 1 for school leaders)	9	34.6
Primary & secondary & tertiary (inc. 1 for teacher education)	3	11.5
Total	26	100.0

Table III. Cases of good practice by the educational level students will teach at.

The cases were also described in relation to full-time or part-time programmes. Eight cases are incorporated into curricula designed for full-time study. Eleven are aimed at part-time study. Seven cases were open to both full-time and part-time study.

	n	%
Full-time	8	30.8
Part-time	11	42.3
Full-time & part-time	7	26.9
Total	26	100.0

Table IV. Cases according to the mode of study.

Another important aspect is the intensity of the practices. By intensity we mean the length of the study (in time) and the study load. The length of the study ranges from hours to a minimum of 4 years. Some courses are, for example, self-study web practicals, while others are part of complete curricula where ICT is fully integrated into a degree programme, often leading to a national or regional licensure component. The study load was not always given, but practices reported ranged from 2 to 40 hours a week (mean = 17.7 hours, standard deviation = 15.9 hours).

There is an almost equal spread across distance and contiguous education (11 contiguous, 9 distance and 3 mixed format), and there is a strong bias towards a mixed media format (3 paper based, 7 electronic, 13 mixed). (In both sets of data, three cases are missing.) Although this is not surprising given the length of most of these courses provided through full-time study, it does indicate that it is rare for teachers to be trained to use ICT through electronic media.

The next section presents the benchmarks and pedagogical underpinnings of the cases. The benchmarks are discussed on the basis of the seven major aspects of the reference/study framework (see Table V). Within each of these aspects, a number of sub-aspects are also discussed.

Benchmark	Presence
Become a competent personal user of ICT	100%
Competently make use of ICT as a tool for teaching	95%
Competently make use of ICT as a mindtool	100%
Master a range of educational paradigms which make use of ICT	100%
Master a range of assessment paradigms which make use of ICT	81%
Understand the policy dimension of the use of ICT for teaching/learning	71%
Other (often social) aspects of ICT use in education	91%

Table V. Overarching benchmarks for ICT and teacher education across the 26 cases.

The pedagogical underpinnings of the cases are based upon the pedagogical dimensions of computer-based education as defined by Reeves (1994), which was used in the evaluation form filled in by the reporters. Reeves's dimensions are based on different aspects of learning theory and can be seen as criteria for evaluating different forms of computer-based education (see Figure 2).

Specific Results

This section presents the specific results from the practices. Before presenting each of the aspects separately, the reader should note that Table V shows the presence of the aspects delivered across the practices. However, not all cases included the range of ICT subcategories listed in Table V, which were generated by the expert discussion prior to the survey of good practice.

Become a competent personal user of ICT. All cases included 'Become a competent user of ICT'. The three subcategories that were most notable for their disparity were:

1. Learning to use ICT as a work tool (in project environments, computer-supported cooperative learning) – not included in 7/26 cases.
2. Learning to use ICT as a communication tool between the school, parents, local community and society in general – not included in 6/26 cases.
3. Learning to use ICT as a tool for the administration of education (e.g. maintaining records, registration of progress and results, timetabling, reporting) – not included in 7/26 cases.

The initial ICT skills are being taught or their acquisition supported in all of the cases, but the breadth and depth of application is dependent on the individual scope of the programme or course.

In some programmes it is explicitly stated that learning basic skills, like working with office programs, is integrated into a certain aspect of learning how to teach. For example, in the 'New Style Teaching Programme' at the Ichthus University, students learn the possibilities of office applications in an

assignment where they have to design a multimedia resource about the teaching profession. Here, the student learns while carrying out a meaningful task. On the other hand, there are other programmes like the 'Cambridge Consortium ICT Training for Teachers' CD-ROM, where although specific attention is not given to those 'button' skills in the program, this CD-ROM contains a skills section to support the development of generic ICT skills, as and when teachers feel the need to upgrade their skills in order to use ICT in their teaching more effectively. In other programmes such as the BA(QTS) degree at the Institute of Education at the University of Warwick, students with differing levels of ICT competency are identified via an on-line audit of their ICT skills. Students with deficiencies in basic ICT skills attend special ICT sessions. Skilled students are selected and given an introductory session to the Institute's multimedia network. They are then asked to work with a small group of students, as peer mentors, to support the development of these skills with other students.

The gap found with respect to using ICT as a work tool, in project environments or for collaborative learning, is a little unsettling. Computer-supported collaborative or cooperative learning can be seen as one of the carriers of the new constructivist philosophy of learning and education. If teacher educators want to prepare their students for working in environments where learning materials will often be designed and developed in teams, then it would be wise for them not only to 'talk the talk' of educational innovation, but also to 'walk the walk'. Michelle Selinger (2001) states:

> Schools can evolve into community centres to further promote student connections to the community around them and work with groups on real-world projects. The on-line delivery of education will provide a means to centralise course development and links to academic tutors on a global scale. Email and computer discussion forums are ideal for disseminating good practice between teachers. Although teachers are enthusiastic about these forums, they report that they are unable to make full use of them as the time available to do so is limited. (p. 15)

Preparation and experience with these tools as part of ICT teacher education could prepare teachers and reduce the time they would need to spend on gaining skills to use ICT effectively once they are practising teachers.

This gap is also present in learning to use ICT for communicating with parents, guardians and the 'learning community' in general. These skills will become increasingly important (at least in the developed countries) as parents develop this mode of communication in their everyday lives, and with more and more children coming from one-and-a-half to double income households where parents can no longer keep up face-to-face contact with their children's teachers.

Competently make use of ICT as a tool for teaching. All but one of the cases selected identified the objective that students to 'learn to competently use ICT as a tool for teaching' (at the general level). The exception to the rule was 'La Main à la pâte' (France), a prize-winning programme which 'helps towards renewing the teaching of science in primary schools by inviting teachers to place children in a position whereby they can experiment, observe, query and reason, opening them up to the beauty of the world round about them and its intelligibility'. A web site is available where teachers can find information on class activities, scientific documents and educational documents such as learning objectives and materials/techniques to achieve them. Teachers may also participate in various training and scientific networks. In other words, although the programme is seen as an example of good practice for learning to teach, it was developed as a tool for teachers of primary science to improve their teaching and lesson preparation (design, development). These teachers are likely to remain unaware of some of the newer technologies for learning, such as the ease in which voice and video conferencing can now be used as schools move towards broadband connectivity.

Inspection of specific results shows that within this aspect, certain goals are (almost) always prevalent while others are not. The first three goals, for example, are an integral part of almost all the programmes. These are: adapting technologies to better teaching, planning, and learning material preparation and production, which are seen as important elements in good practice. The following seven subcategories were not included for all students in more than six of the 26 cases and are given in order of increasing exception:

1. Team teaching in situ or at a distance – not included in 7 programmes.
2. Manage learning – not included in 8 programmes.
3. Implications of different machines and platforms – not included in 9 programmes.
4. Managing teaching – not included in 11 programmes.
5. Teaching at a distance – not included in 12 programmes.
6. Instructional design of course materials – not included in 14 programmes.
7. IP telephony, video conferencing – not included in 17 programmes.

It is interesting to note that in some of the cases, the learning competencies are embedded in a web-based environment. For example, the programme 'eScience' (University of Helsinki) has a learning web portal and web-learning environment for pupils, a teaching material resource for teacher training students and a content area package targeted at primary school teachers, including student teachers.

Competently make use of ICT as a mindtool. Mindtools are computer applications that, when used by learners to represent what they know,

engage them in critical thinking about the content they are studying (Jonassen, 1996). Mindtools scaffold different forms of reasoning about content; they require students to think about what they know in different, meaningful ways. For instance, using databases to organise students' understanding of content organisation engages them in analytical reasoning, where creating an expert system rule base requires them to think about the causal relationships between ideas. At this point we must make a distinction between learning with ICT (as a mindtool) and learning from ICT (as a mindtool). In learning with ICT, we speak of short-term goals where the ICT is the enabler. Using project-planning software in project-centred learning will, in the short term, help students plan their project properly and hand in their projects on time. In learning from ICT, we speak of long-term goals where ICT causes a change in the way one thinks and works. Using the same example, in the long run if the project-planning software has taught the student to organise her thoughts, to take critical paths and products into account, and to plan her work efficiently (long) after having completed the project, then we speak of learning from ICT (and possibly ICT as a mindtool). Jonassen et al (1998) describe this in terms of partnership between the learner and the computer and it is used in the sense of 'intellectual tools' that has been promoted by Vygotsky (1978) along with his notion of extending the Zone of Proximal Development. Davis et al (1997) discuss that sense of ICT as a tool, and also place it within the social systems of the classroom, school and college:

> Learning with computers refers to the learner entering an intellectual partnership with the computer. Learning with Mindtools depends 'on the mindful engagement of learners in the tasks afforded by these tools and that there is the possibility of qualitatively upgrading the performance of the joint system of learner plus technology.' In other words, when students work with computer technologies, instead of being controlled by them, they enhance the capabilities of the computer, and the computer enhances their thinking and learning. The result of an intellectual partnership with the computer is that the whole of learning becomes greater than the sum of its parts. (Jonassen et al, 1998, p. 14)

In this study we explicitly asked if ICT as a mindtool was an aspect of the teacher training programme. All 24 of the programmes attempt to train (student) teachers to be competent users of ICT as a mindtool. Many computer applications have been developed explicitly to engage learners in critical thinking while others can be repurposed to do this. Examples of mindtools include semantic organisation tools, dynamic modelling tools, information interpretation tools, knowledge construction tools, and conversation and collaboration tools. This last type of mindtool, the conversation tool, is used increasingly. Probably the most important reason for this increase is the adoption in education of theories of learning where both the social and the constructivist nature of learning are emphasised.

Software that promotes reflective discourse can also be used as a way of bringing the theoretical aspect of teacher training, taught in university or colleges, together with the practice experience and articulated in schools in which beginning teachers undertake teaching practice (Pearson & Selinger, 1999). Several aspects of collaboration (with other teachers, experts and designers) and cooperation (between teachers, teacher educators and student teachers) were highlighted in the study. The focus on collaboration with other teachers, experts and designers is part of 20 programmes and cooperation between teachers, teacher educators and student teachers forms a component of 21 programmes. A good example of how this is being developed can be found in the eScience project and 'eL3', where 'walking the walk' appears to be the way the course material is set up. Both examples in the cases involving educational leaders ('ISU Graduate Education' and 'Strategic Leadership of ICT') include this and it is an essential component of the latter.

Master a range of educational paradigms which make use of ICT. All the cases are aimed at helping students to gain command of a range of educational/pedagogical paradigms which make use of ICT. In their programmes of study, learners consider contemporary insights concerning learning and teaching and the role ICT plays within these processes. A good example is the unit 'Technology in Education' at the Faculty of Education at Curtin University of Technology (Perth, Western Australia), where students in two countries (Canada and Australia) take part in on-line discussions on the pedagogical issues of using ICT. In this way, both programmes practise what they preach with respect to social constructivist insights into ICT and pedagogy.

New pedagogic and ICT knowledge and skills can also be learned as part of in-service training in schools. In the Finish 'Virtual School for Science Education' at the Department of Teacher Education at the University of Helsinki, this topic is applied in a school context in connection with real and virtual meetings.

Michelle Selinger (Selinger & Yapp, 2001) notes that it is often the case that increase in the use of ICT moves beyond 'more of the same' to education. The CEO Forum (2001), to inform the development of ICT in schools and teacher education, describes the progression of schools, colleges and universities as they transform education (see http://www.ceoforum.org). However, when learners are not given more autonomy, technology is not used to give students new ways of learning and there is very little change in pedagogical practice. According to Cuban (1993), teachers tend to appropriate new technologies and incorporate them into their traditionally held views of teaching and learning. Cuban argues that the overhead projector and video made very little impact on teaching styles, so why should computers be any different? But computers are substantially different from previous technologies because multimedia and hypertext give students

access to new ways of thinking through dynamic images, simulations and models. The Internet provides access to a huge array of previously untapped information. Teachers must adapt and transform their practice in order to find ways of harnessing the power of the new technology. Their jobs will change but their role should become no less important in the same way that public libraries and books did not make teachers redundant.

Chris Yapp (2001) put it the following way:

> It is a great fallacy that New teacher = Old teacher + ICT. Instead, training teachers in the use of ICT in their own curriculum areas should be the start of a process of educational transformation, not its completion. (p. 20)

Educational and pedagogical paradigms using ICT are also important at a strategic level. For this reason, the case study of good practice that is provided for head teachers (principals) is particularly important. The programme 'Strategic Leadership of ICT' led by the National College for School Leadership/Head Teachers (principals) needs to keep abreast of the possibilities of ICT in education and the implications of the implementation of ICT for their schools. The main features of this case are (a) school-based evaluation and analysis; (b) observational visits to effective practice schools; (c) application awareness raising; (d) on-line discussion forums and (e) school action planning for improvement in ICT. This case study of good practice includes all the aspects/sub-standards because they are seen as 'a strong leadership issue'. There is also engagement with collaboration/cooperation, teacher roles, school culture, and the effect of ICT on students with respect to autonomy, authentic activity, learning styles, situated learning, motivation and equity issues including disenfranchisement.

Master a range of assessment paradigms which make use of ICT. New paradigms about learning and teaching must include new views and visions of assessment. Technological developments create new possibilities for what is often called 'alternative assessment' (Reeves, 2000). Teachers and aspiring teachers should be aware of the range of assessment paradigms, including the complex 'alternative' forms of assessment needed for assessing the attainment of higher-order educational goals that involve deep understanding and active use of knowledge in complex, realistic contexts that may make use of ICT. Most of the cases (20/26) take note of this standard. Both the limitations and affordances of ICT tools in assessment are present in 19 cases and new ways of assessing learning are seen as important. Several cases incorporate new modes of assessment for students in their programmes of study:

1. In the Technology in Education course at the Faculty of Education at Curtin University of Technology, 'students produce a range of alternative

assessments, including an electronic portfolio and self-assessment rubrics, assess in peer groups and are exposed to a range of non-traditional methods helping them see how they might use ICT in their own classes'.
2. The ASU West case study includes significant service learning in collaboration with teachers in the schools and this authentic learning feeds into the assessment system using artefacts developed in the process.
3. In the New Style Teaching Programme at the Ichthus University, students work for a semester on 'Management of Diversity with the Help of ICT', where they conduct research into student tracking systems so as to learn the possibilities of ICT-supported student tracking.
4. As part of the Postgraduate Certificate in Education (Primary level) at the University of Brighton, learners have to work on planning, developing and evaluating ways in which ICT can be used to assess competencies and not simply skills. They also develop a portfolio of evidence for assessment. One of the most frequently mentioned 'new ways' to assess learning is the electronic portfolio. With regard to this instrument, one can distinguish between (a) the use of this instrument during the study (and then the student implicitly learns about the pros and cons) and (b) learning how to use this instrument in practice (the [aspiring] teacher learns to develop and/or assess an e-portfolio). Two cases of the use of an e-portfolio are the eScience programme and the ASU West 'Early Childhood Teacher Preparation Programme' (see below).
5. The ASU West Early Childhood Teacher Preparation Programme has students write a digital net-portfolio across the entire training. This includes the planning, implementation of the case and collaboration and reflection between the group members and self-assessment of one's learning process during the training. For the eScience case the entire assessment and thus the successful completion of the programme is based on the portfolio of the teacher student; whereas the e-portfolio is one aspect of the ASU assessment system. Several other cases have optional development of an e-portfolio by students.

Understand the policy dimension of the use of ICT for teaching/learning. Research and practice provide evidence that ICT implementation at the classroom (micro) level requires policy at the school (meso) and district/national (macro) level. In the United Kingdom in 2001, this aspect was a mandatory part of the Teacher Training Agency Standards required of newly qualified teachers. For example, secondary (ages 11-18 years) teachers have to 'have, for their specialist subject(s), where applicable, a detailed knowledge and understanding of the National Curriculum programmes of study, level descriptions or end of key stage descriptions where applicable'. Most states in the USA have also mandated standards for ICT in teacher education, many simply adopting the standards laid down by the International Society for Technology in Education (ISTE, 2001). Although

18 cases included this 'policy standard', it is not always clear how this element is implemented in these cases. The programme of the Faculty of Education at Curtin University of Technology reports that 'technology planning in schools has been a large part of Western Australian policy implementation of computers into schools through the "TECHNOLOGY 2000" programme. Students have to assess their current practice school situation and discuss methods they might use to help staff use ICT in schools with peers.' In Northern Ireland, the 'Classroom 2000' project of the Postgraduate Certificate of Education programme reports that 'significant parts of the course material are held on a password-protected web site which students use to access recent research and policy documents both when they are at the university and in school. Students make use of this material in their studies.'

Nine of the programmes do not appear to pay attention to translating government policy to the classroom and an alarming number (almost half) report that they pay no attention to the critical step in policy implementation, namely *assessing the situation in policy terms*. However, care should be taken in interpreting the data because policy and its implementation in education are sensitive to cultural differences and may change with speed.

There are a number of positive examples such as in the Curtin programme, where students have to assess their current practice school situation and discuss methods they might use to help staff use ICT in schools with peers. Also, the Sipoo project in Finland is a fine example of the integration of learning about policy and its implementation, because students actually inform the making of policy! This may provide an example to mirror and improve practice in the future.

Other (often social) aspects of ICT use in education. Almost all of the cases report education in this broad area. With respect to ICT and citizenship, the Post Graduate Certificate of Education at the University of Ulster in Northern Ireland reports that the development to 'model practice in use of ICT in teacher preparation through the use of electronic communications, citizenship, location of PCs and integration into subject teaching, web-based course resources and on-line portfolios' is an important goal of the programme. This 'dissolving boundaries' case also links teacher education and schools on both sides of the geographical and cultural divides in Ireland, modelling innovative democratic learning supported by ICT. The Bachelor of Education – Primary at the University of Western Sydney in Australia attempts an integral approach to this problem. This programme leads to career opportunities in primary education and in training and development for different groups including primary schoolteachers in government and non-government sectors, as well as education field officers in sport, welfare, community education, and in training and development facilities in industry (hospitality, banking and government departments). In

this programme, practice teaching and other professional experiences are undertaken in a variety of educational settings, including small and large schools, and urban, multicultural and special needs workplaces.

Twenty cases pay attention to the teaching and learning of specialist subject(s) with ICT. The University of Virginia case includes highly focused courses that work in the specialist subjects, using service learning in collaboration with teachers in secondary schools and often accompanied by leading-edge research. The University of Texas at Austin 'Uteach' case adopts a similar approach for shortage subjects of maths and science, where initial and in-service teachers work together in a collaborative programme. A third good case is the German programme 'eLernen und eLehren in der integrierten Lehrer-Aus- und –Weiterbildung' (eL3: eLearning and eTeaching in Initial and Further Teacher Education), where teachers collaboratively learn to work on ICT applications for their specific school subject. In this programme courses can be classified at three levels. At the third level courses are very specialised.

There are two good examples of an integral programme. 'Learning and Teaching' on the Internet (Iceland) is a graduate/in-service course in a programme offered on the use of ICT in schools at the Iceland University of Education. The programme can either be 15 or 30 units. Courses have both site-based and distance-learning components. Courses offer a wide range of (technical) options through which students are exposed to pedagogical theory. For example, in one course web-logging software (*Blogger*) is used as a means to apply theories of metacognition to monitor one's own learning. Another course used databases connected to web sites in an innovative way to allow pre-service and in-service teachers to participate in research work. The final alternative integrated approach is ISU 'Elementary Education'. The elementary programme includes a foundation course to introduce ICT with early transferable ICT activities and workshops to build knowledge and skills. In addition, a course for graduate students has resulted in over 10 years of mentoring and coaching most of the programme's teacher educators so they can model good practice with ICT in the teaching of their discipline. For example, the reading teacher educator has developed a web site to develop reading across the curriculum and quick time virtual reality tours of primary classrooms' use of resources for reading (including ICT).

Pedagogical aspects. Results can be seen in Figure 2. The box approximating the average score has been checked. Where the average score lies approximately midway two values (e.g. 3.5), the two boxes have been checked.

Examination of Figure 2 shows that several of the 26 cases of good practice analysed adopted the underlying epistemology, philosophy and psychology. However, it was noted earlier that a range of pedagogies was used and therefore most cases, if not all, incorporated some behaviouristic

approaches. The goal orientation and contextual orientation, which are biased towards sharper focus and contextualisation, also fit with authentic learning about ICT in teacher education that will ease the transition to good practice in the workplace. Indeed, many of the cases already discuss merging in-service learning and work towards improved education and support of teachers and teacher educators. For example, all five US cases include this aspect and that is a major aspect of how they stood above many other cases in the USA.

								M	SD
Epistemology	Objectivist	☐	☐	☐	☒	☐	Constructivist	4.13	1.01
Pedagogical philosophy	Instructivist	☐	☐	☐	☒	☐	Constructivist	4.17	.98
Underlying psychology	Behavioural	☐	☐	☐	☒	☐	Cognitive	4.13	.63
Goal orientation	Sharply focused	☐	☒	☒	☐	☐	Unfocused	2.43	1.16
Experiential validity	Abstract	☐	☐	☐	☒	☐	Concrete	4.26	.69
Contextual validity	Contextualised	☐	☒	☐	☐	☐	Decontextualised	1.96	.82
Flexibility	Teacher-proof	☐	☐	☐	☒	☐	Easily modifiable	3.96	.77
Individual differences	Non-existent	☐	☐	☐	☒	☒	Multifaceted	4.48	.51
Learner control	Non-existent	☐	☐	☒	☒	☐	Unrestricted	3.48	.85
User activity	Mathemagenic	☐	☐	☐	☒	☐	Generative	4.19	.60
Cooperative learning	Unsupported	☐	☐	☐	☒	☒	Integral	4.35	.65
Cultural sensitivity	Non-existent	☐	☐	☐	☒	☐	Integral	3.87	.81

* Contextualised = use ‘immediately’. Decontextualised = learn now, use later

Figure 2. Pedagogical aspects of good practice in ICT and teacher education.

The programmes chosen as best practice conform largely to the ideas behind modern constructivist learning. The term constructivism has come to serve as an umbrella term for a wide diversity of views. Although it is well beyond our purposes to detail these similarities and differences across the many theories claiming some kinship to constructivism, most theories seem to be committed to the view that 1. learning is an active process of constructing rather than acquiring knowledge, and 2. instruction is a process of

supporting that construction rather than simply communicating knowledge (Duffy & Cunningham, 1996).

In addition, social constructivism holds that in order to learn effectively, learning is best situated by engaging with challenging real-life contexts where the environment is rich in information and where there is no one right answer. The recommended tasks are authentic and learning is best approached through 'cognitive apprenticeship'. Learners negotiate through interactions with others and in this way they can learn to develop the necessary multiple perspectives on reality that are especially important (when learning takes place in ill-structured domains). Reflexivity is essential and must be nurtured. Education is one such complex domain. Kirschner (2000) provides a discussion of learning in this way using integrated electronic learning environments.

The Benchmarks

Based upon the results of this quick-scan study, the following 'baseline' for programmes in ICT for teacher training was composed. In other words, pedagogic benchmarks for teacher education in ICT are now presented. We recommend these five benchmarks only where they may be integrated within a programme of teacher education that models good pedagogic practice.

Benchmark 1 – Personal ICT Competencies

Programmes for teacher training should facilitate aspiring and practising teachers to be competent personal users of ICT. Minimally, teachers should have or develop basic competencies involving the use of:

- office applications such as word processing, spreadsheets, databases, drawing packages and a simple web-page editor;
- resource tools such as CD-ROMs, the Internet, web portals, different types of search engines;
- communication tools such as email, listserv and synchronous chat.

Beyond this, a programme for teacher training should develop the learner's ability to use ICT effectively for:

- communication between and within student groups;
- communication between and with other teachers;
- continuing their own education once they have completed their studies, including self-assessment of own learning and learning needs.

Benchmark 2 – ICT as a Mindtool

Programmes for teacher training should train aspiring teachers to be able to make use of ICT as mindtools. As previously discussed, mindtools are computer programs and applications (for example, those in Benchmark 1) that facilitate meaningful professional thinking and working. Mindtools help users represent what they know as they transform information into knowledge; they are used to engage in and facilitate critical thinking and higher-order learning. As a minimum, teachers should develop basic competencies to use mindtools for:

- cooperation (between teachers, teacher educators and student teachers);
- collaboration on pedagogical projects (with other teachers, experts and designers, etc.).

Benchmark 3 – Educational/Pedagogical Use of ICT

Programmes for teacher training should train aspiring teachers to be able to make use of ICT within many different educational/pedagogical settings. In other words, not in *adApting* their education to ICT, but rather *adOpting* ICT in their education. As a minimum, teachers should develop basic competencies to use ICT effectively for:

- collaboration/cooperation in both asynchronous (email, discussion lists, web-based forums, listservs) and synchronous (video, audio, chat, whiteboard, file sharing) environments;
- resource-based learning (informing, asking questions, evaluating, comparing).

Related to this is the need for teacher training organisations to deal with the pedagogical uses of ICT at a meso level, for example for comparing and selecting resources such as:

- learning environments;
- project environments;
- collaborative environments;
- learning management systems;
- software.

Finally, it is of paramount importance that programmes for teacher training familiarise and prepare aspiring teachers and teacher educators themselves with the effects of ICT on:

- their own role as teacher;

- their students to increase autonomy, authentic activity, learning styles, situated learning and motivation, enfranchising those who are out of the mainstream.

Benchmark 4 – ICT as a Tool for Teaching

The major pitfall that must be avoided when training teachers to use ICT is using the tool for the tool's sake. None of the cases of best practice included this and many modelled innovative practices where ICT enhanced and extended the curriculum and served to develop education. ICT must be used to meet educational objectives in a way that is integrated into the school programme. This means that aspiring teachers not only come to know the theory behind why and how to use ICT, but will also develop competencies in:

- adapting technologies to good/better teaching such that the teaching/learning can change for the better;
- planning for relevant individual, group and whole-class activities;
- preparing and producing learning materials with the help of ICT;
- dealing with the possibilities/consequences of using ICT;
- teaching and learning specialist subject(s) with ICT;
- team teaching in situ or at a distance.

Benchmark 5 – Social Aspects of ICT Use in Education

ICT is having, and will continue to have, a profound effect on society. Traditional, normative concepts such as privacy, anonymity and intimacy are changing. Norms and values have traditionally been passed from adults to children, but now the children are also engaged at the cutting edge of societal change. With instant messengers they multitask conversations in ways that adults are hard-pressed to understand. For example, breaking news of a terrorist attack can now often be known more quickly on the other side of the world than on the other side of the city. It is important that teachers and teacher educators:

- engage as member of a (wired) school community;
- provide a role model of good ICT practice;
- learn to share and build knowledge;
- understand the implications of the Information Age on schools and schooling;
- realise and discuss the impact of ICT on society.

Future Benchmarks: ICT in assessment and policy

Learning to use ICT for assessment and understanding the policy dimension of ICT use are not widely perceived as good practice at this time. In the opinion of the authors this is short-sighted, especially the use of ICT for assessment. Assessment via ICT, and in particular new forms of assessment involving the learner as a collaborator in assessment (e-portfolios, learning diaries), peer assessment, and authentic assessment are of growing importance (Reeves & Okey, 1996; van der Vleuten, 1996; Dochy et al, 1999). ICT can enhance the efficiency and use of multiple sources of information, particularly those linked to progression and the reputation of the learner and teacher. There is no more powerful impulse to student learning than tests and examinations. In other words, the interaction or reciprocal relationship between assessment and the way the learner perceives learning can be a powerful force. The way the learner knows or expects that he or she will be tested causes the learner to adapt his or her learning to satisfy that expectation. This is much more influential than the way the instruction is designed and presented. Where there is a mismatch between the (perceived) goals of education and the (perceived) goals of assessment, it is inevitable that assessment will win. An educational innovation where the assessment remains unchanged, or is perceived to have not changed, is doomed to failure. This so-called 'backwash effect' states that the way learning is assessed determines the way the learner will study and learn (Prodromou, 1995). The current shift from objectivist, didactic teaching to more constructivist, competency-based learning and education requires sympathetic testing and assessment that, on the one hand, can determine if the competencies have been achieved and on the other hand, stimulate – or at least don't deter – that type of learning. Teachers need to be prepared for this and it is notable that most of the case studies of good practice used and modelled innovated approaches to assessment in line with their pedagogical approaches. We therefore conclude that this benchmark is emerging for initiatives aspiring to good practice.

The need for a benchmark on policy is less clear. However, it is possible that this item was misinterpreted in some cases. It would be strange for learners to remain ignorant of local standards regarding ICT in their educational system, especially where ICT was mandatory or integrated into mandatory standards for the subjects the individual is preparing to teach. For example, most of the US states and the US National Council for Accreditation of Teacher Education have adopted the ISTE standards (2001) for teachers as their mandatory requirement. An alternative interpretation of this question is related to the development of ICT policy for education, but this is not a recommended benchmark for aspiring teachers' education in ICT.

Conclusion

Twenty-six cases of good practice in ICT in teacher education were identified across Europe, North America and Australia. The 26 cases are described in more detail in their regional context in other articles in this special issue. It should be noted that, although good practice is often recognised as patchy and there are many more cases that could have been added to this sample had time and resources been forthcoming, there is no reason to believe that the synthesis provided by this article would change. Those who collaboratively designed the survey and collected the cases were acknowledged experts and included leading practioners in this field on all three continents. However, great caution is recommended when applying this to less-developed countries and regions because they will need to develop the capacity to support change across their educational systems and to develop an appropriate infrastructure (UNESCO, in press).

The six benchmarks of good practice identified for both pre-service and in-service programmes for teacher education were that teachers become:

1. competent personal users of ICT;
2. competent to make use of ICT as a mindtool;
3. master a range of educational paradigms that make use of ICT;
4. competent to make use of ICT as a tool for teaching;
5. master a range of assessment paradigms which make use of ICT;
6. understand the policy dimension of the use of ICT for teaching and learning.

The first four benchmarks are characteristics found in almost all of the programmes that the experts in this research project chose as good practice. The final two aspects were also considered to be important, but were not always present in the cases evaluated. The experts also agreed that, in cases of best practice, the benchmarks would be seen in an environment that not only talks of modern constructivist thinking and pedagogy, but one that also adopts and models those practices. The days of teaching *about* the use of ICT are over and directed teaching of ICT skills is not recommended.

If we want teachers, students, administrators, politicians, instructional designers, et cetera to consider the computer (and other information appliances) and the Internet as 'normal', then it's time to stop treating the computer as something special. We do not speak of, do research on or specifically teach our future teachers about book-assisted instruction (BAI) although our present-day educational system is almost totally based upon BAI. Teachers are able to plan their lessons, choose what to 'teach', what to expand upon, and what to leave to individual self-study thanks to the school book and the fact that the system is based on BAI. Departments can coordinate curricula, students know what to study, and parents know what to quiz all thanks to BAI. Testing, certification institutes, and accreditation

agencies know what to test, certify, and accredit thanks to school books ... But no one in her/his right mind in education talks about BAI or for that matter about BBAI (blackboard-assisted instruction), TAI (teacher-assisted instruction), and so forth. These are all seen as normal parts of education – both teaching and learning – and are treated as such. Why then do we continue to speak of CAI (computer-assisted instruction), why do we still have special courses on computers and pedagogy, why ... ? As long as we continue to think of the computer and computer networks as being something special in education, then they will never become 'NORMAL'.

This article has identified benchmarks for ICT in teacher education and provided evidence of their importance. These benchmarks fit well with the literature reviewed including the holistic planning framework developed by the UNESCO Task Force for ICT teacher education that worked in parallel with this study (UNESCO, in press). This study therefore reinforces the vision of ICT in teacher education as a force to catalyse the renewal of education for the twenty-first century.

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