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BENCHMARKS FOR TEACHER EDUCATION PROGRAMS IN THE PEDAGOGICAL USE OF ICT

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Introduction

The 22-page subject index of the report of the AERA Panel on Research and Teacher Education (Cochran-Smith and Zeichner, 2006) has no entries referring to information and communication technologies (ICTs) and only two referring to computers. Several chapters remark that teachers should develop ICT skills, but what this actually means is not discussed to any substantial degree. This does not mean that there are no publications on the subject or that research on ICT and teacher education and teacher learning is non-existent. Two worlds seem to be on different sides of a divide: the main stream teacher education research does not pay much attention to ICT while researchers studying ICT pay little attention to research conducted on teacher education. This chapter attempts to bring these two worlds closer to each other, presenting benchmarks for both pre- and in-service teacher education programs. Benchmarking is a process through which organizations evaluate different aspects of their processes in relation to best practice with the aim of improving performance. The benchmarks, in this case, could be seen as standards demanded of teacher certification education programs.

Teacher education programs should stimulate the pedagogical use of ICT to improve existing teaching practice and contribute to the development of new, innovative teaching practices. Pedagogical use of ICT refers to how teachers use ICT to facilitate student learning. In referring to pedagogical use of ICT in this chapter, we include all three major perspectives on learning: (a) behaviorist-empiricist, (b) cognitive-rationalist, and (c) situative-pragmatist-sociohistoric (Dede, 2008; Greeno et al.,1996).

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In the context of everyday classroom practice, the behaviorist-empiricist perspective relates to learning environments where information is efficiently *transmitted* to students, with many opportunities to practice and individualize feedback. Facilitating these processes with ICT includes the use of computer programs for acquiring and practicing routine skills. The cognitive-rationalist perspective relates to learning environments that *connect instruction* to students' learned or intuitive conceptual understanding and facilitates active knowledge construction or reorganization. ICT could facilitate these processes by presenting learners with interactive environments or simulations that stimulate them to apply and expand their knowledge. Learning environments in the situative-pragmatist-sociohistoric perspective let students *interact* with each other and with their material environment and learn to *participate* in the characteristic dialogue and discourse of the community within a specific domain. Facilitation of these processes with ICT can be found in CSCL (Computer Supported Collaborative Learning) settings.

To develop benchmarks for teacher education programs, we used the analyses of exemplary teacher education programs included in Kirschner and Davis (2003), together with a review of the research literature on teacher education for the pedagogical use of ICT. Kirschner and Davis analyzed 26 good practices in ICT-supported teacher education, which were collected from five regions around the world and aimed at the preparation of student teachers for working in an ICT-rich environment. Based on the assumption that in exemplary teacher education practices one can observe what teacher educators consider to be the competencies that good teachers need to have, Kirschner identified a number of core competencies. In addition, he distilled from these cases guidelines for the pedagogy of teacher education. The exemplary practices were analyzed with respect to the emphasis they placed on different aspects of ICT-use in teacher education, the depth and the breadth of the practices, and the pedagogy employed. Based on these analyses Kirschner and Selinger (2003) composed a baseline for teacher education programs on ICT-related pedagogic benchmarks. They recommended that these benchmarks are only useful when integrated within a program of teacher education that models good pedagogical practice. The present chapter extends this earlier work on the "what" benchmarks with the "how" benchmarks.

In the rest of this chapter we will elaborate on the pedagogical characteristics of exemplary teacher education programs and their effects on teacher education and then present the benchmarks and discuss their status.

The Pedagogy and Effects of Teacher Education

Perhaps the best overview of the principles for effective teacher education programs for ICT stems from Reeves' (1994) 14 pedagogical dimensions. A slightly adapted version of these principles were used by Kirschner and Selinger (2003) and Boshuizen and Wopereis (2003) to present pedagogical aspects of the exemplary practices they analyzed. The programs chosen as best practices conformed largely to the ideas of modern constructivist education, where learning is seen as an active process and where a balance is required between learner support and teacher guidance.

The exemplary programs generally provided contextualized learning activities to enhance the possibilities of transfer and to help student teachers develop insight into underlying principles and conditions for their application. These programs were quite flexible, so that modifications could be easily introduced, a necessity in the ICT-field that changes rapidly in many directions. Most programs also gave learners a lot of autonomy to determine their own learning, supported a broad range of learner activities, and were sensitive to individual differences in skills, personal interests, and needs. The majority of the programs had built-in facilities to support co-operative learning. Sharing of experiences and actively learning from each other not only broadens and deepens learning outcomes, it also leads to reflection and development of metacognitive skills. When conducted in a CSCL environment, the students also learnt how to use such technology platforms in their own teaching practice. Finally most programs were characterized as having integrated culturally sensitive strategies (Boshuizen and Wopereis, 2003).

This description paints an optimistic picture of the current state of affairs but this does not necessarily mean that the overall impact of teacher education programs on achieving good pedagogical use of ICT is high. Ashton (1996) reviewed many studies conducted between the mid 1980s and the mid 1990s and concluded that student teachers do not learn everything we want them to learn, such as working effectively with students, dealing with ethic diversity, impacting the lives of the students, and "coping with the demands of today's classrooms" (p. 21). Richardson (1996) found that teacher education at the pre-service level did not impact highly on the attitudes or beliefs of student teachers. Skills and theories taught on campus were often not used in student teachers' practices. Many student teachers even had negative attitudes towards the theories encountered during their teacher education experience, feeling that the theories contributed little to good teaching or even worse, which were counterproductive to good practice. There was poor transfer of theories taught and of skills trained on campus to classroom teaching practice. This was called the theory–practice gap. Unfortunately, this situation was not much different ten years later. Clift and Brady (2006), summarizing what was known about the effectiveness of methods-courses and field experiences in teacher education, stated that short-term interventions through such programs have limited impact. Clift and Brady along with Grossman (2006) reported some discouraging results on the effects of specific strategies used in teacher education (e.g., use of portfolios, practitioner research and supervision). Research findings show that student teachers resist implementing what they have learnt when they find it difficult to engage in the recommended practices, even when their field experiences reinforce and support those practices. Beginning teachers are often socialized into the practices of their first job rather than grounding their practices on theories and recommended practices encountered during teacher education programs. Clift and Brady concluded that methods-courses and field experiences can affect prospective teachers' thoughts about practice and in some instances even affect their actual teaching practices, but practicing one's beliefs is neither linear nor simple.

Despite the discouraging results mentioned, both Grossman (2006) and Clift and Brady (2006) gave some recommendations on what could work. They mentioned, for example, microteaching, working in small student–teacher groups, and the inclusion of

reflection activities in these groups. The powerful work by Joyce and Showers (2002) shows that a combination of elements such as theory, demonstration, practice, feedback, peer coaching, and a supervision approach has proven to be effective in many situations. Programs that stimulate close ties between teacher educators and actual practice in schools are also effective. Brouwer and Korthagen (2005) showed that although occupational socialization – defined as "socialization that initially influence persons to enter the field of [physical] education and that later are responsible for their perceptions and actions as teacher educators and teachers" (Lawson, 1986, p. 107) – in schools has a considerable influence on developing graduates' in-service competence, there was also evidence on the positive impact of specific strategies in the teacher education programs such as (a) alternating student teaching and college-based periods, (b) tripartite cooperation among student teachers, mentor teachers and university supervisors, and (c) gradual increase in the complexity of student teaching activities.

A reason for the low effectiveness of teacher education programs in general, and the scarcity of evidence for the effectiveness of separate elements of programs in particular, may be due to the thin theoretical basis of such programs (Grossman, 2006). Examples of approaches that start from a theoretical basis are *competence-based* teacher education and *concern-based realistic* teacher education. In Benchmark 8, we elaborate on one of these approaches.

The results on teacher education effectiveness suggest that what we want student teachers and in-service teachers to learn about ICT may have the same disappointing fate as many other earlier endeavours to educate them. With this caution in mind, we present ICT-related benchmarks for teacher education programs.

Benchmarks

We formulated nine benchmarks for teacher education programs on the pedagogical use of ICT. The first four benchmarks concern the "what" of teacher education programs; the last five concern the "how".

Benchmark 1 – Personal ICT-Competencies

A prerequisite for using ICT as a pedagogical tool is that the teachers themselves can use ICT as a work tool (e.g., posting course materials in an electronic learning environment), a communication tool (to liaise between school, parents, local community, and beyond) and an administration tool (Thomas and Knezek, 2008). Teacher education programs, pre- or in-service, should thus facilitate teachers to become competent personal users of ICT. Minimally, present-day teachers require basic competencies with:

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

Further, these programs should develop the learner's ability to use ICT effectively for:

– communicating between and within student groups;
– communicating with other teachers, and
– lifelong learning, including self-assessment of learning and learning needs.

Some countries have introduced an "ICT driving license" for these competencies (e.g., Turcsányi-Szabó, 2008, in this book).

Benchmark 2 – ICT as a Mind Tool

Mind tools are computer applications that, when used by learners represent what they know, necessarily engage them in critical thinking about the content they are studying. 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" (Jonassen et al., 1998, p. 30). Mind tools 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 organize students' understanding of content organization necessarily engages them in analytical reasoning since creating the rule base requires them to think about causal relationships between ideas. At this point we must make a distinction between learning *with* ICT (i.e., as a productivity tool) and learning *through using* ICT (i.e., as a mind tool). In the former, ICT is the enabler, such as in using a project-planning program to help students plan their projects properly and hand in their projects on time. In learning through using ICT, the expected outcome is for ICT to bring about a change in the way one thinks and works. Going back to the planner, this can happen in the long run when the project planning program has taught the student to organize her thoughts, take critical paths and products into account, and plan her work efficiently (long) after having completed the project.

Programs should train teachers and student teachers to be able to use ICT as mind tools (see for instance van den Berg et al., 2008) to represent what they know as they transform information into knowledge and to engage in, and facilitate, critical thinking and higher order learning. Minimally, teachers should develop basic competence to use mind tools for ordering their own thoughts (e.g., through concept mapping) and those from colleagues, and modelling their own environment for optimal teaching.

Benchmark 3 – Social Aspects of ICT-Use in Education

ICT is having a profound effect on society (Thomas and Knezek, 2008). As a sociocultural phenomenon, ICT changes leadership and roles in organizations (Szewczak and Snodgrass, 2002), as well as teachers' and students' roles in schools. It creates opportunities for collaborative knowledge production and problem solving, breaking earlier limits of time, distance, and possession of knowledge. At the same time, it also creates new social dysfunctions, such as problems of privacy, escapism or

anonymity, lack of commitment and false role images. Pre- and in-service teacher education must face these issues.

The introduction of ICT – including Internet, mobile phones, and SMS – is changing interpersonal relations. While 10 years ago telecommunication between teenagers was largely supervised by adults, in the sense that parents knew when someone was on the phone and often knew who it was, now many households have Internet access, allowing children and adolescents to communicate with friends (and even strangers) at any moment they like. The "disembodied nature" (Dreyfus, 2001) of ICT-use and the very fact that they enable unsupervised and unnoticed communication have a liberating and disinhibiting effect, which children and adolescents heartily welcome, but which also has some unpleasant side effects. Children can easily communicate with others about whatever topic they have a common interest in, but the disembodied nature of chatting makes it very easy to present oneself in a more favourable way, making it difficult for the other to discriminate between friend and foe.

Traditional normative concepts such as privacy, anonymity, and intimacy are changing. Norms and values have traditionally been passed from adults to children, but now children are also engaged at the cutting edge of societal change. With instant messaging they multi-task conversations in ways that adults are hard pressed to understand. It is important that teachers and teacher educators:

- engage as members 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, and
- realise and discuss the impact of ICT on society.

Benchmark 4 – Adopting ICT in Teaching

Pre- and in-service teacher education and professional development programs should prepare teachers to use ICT in different educational or pedagogical settings. In other words, not ad*a*pting their teaching to ICT, but ad*o*pting ICT in their teaching.

Selinger (2001) noted that it is often the case that the increase in the use of ICT is little more than "more of the same." 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. He argues that the overhead projector and video made very little impact on teaching styles, and so why should computers be any different?

Computers, however, are substantially different from previous technologies because they give students access to new ways of thinking through dynamic images, simulations and models, and a huge array of – worthwhile and worthless – information. Teachers must 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.

There is also a growing, or possibly a renewed, interest in resource-based learning (Hill and Hannafin, 2001) that aims at achieving both subject and information

literacy objectives through exposure to and practice with diverse resources. Students become active learners as they use a wide range of resources in different media formats to investigate subject matter prescribed within their classroom curriculum. Teachers become motivators and facilitators in learning processes and provide the initial impetus that drives students to seek information and become creative problem-solvers. The end result is that a "learning culture" is fostered as a climate of active and productive learning. Such an approach is flexible and emphasises complex skills important for the digital age, such as problem solving and critical thinking.

A note of caution needs to be made here. Teaching teachers to use ICT outside of meaningful educational contexts must be avoided. This means that aspiring teachers will not only come to know the theory behind why and how to use ICT, but will also develop competencies in:

– planning for relevant individual, group and whole-class activities;
– preparing and producing learning materials with the help of ICT;
– dealing with the possibilities and consequences of using ICT;
– teaching and learning specialist subjects with ICT, and
– team teaching in situ or at a distance.

Benchmark 5 – Cooperative Education: Combining Institutional Learning and Learning in the Workplace

While education-related theories are introduced to aspirant teachers during their formal pre-service education and professional development, most beginning teachers agree that they actually learnt the most during their practice teaching period. Optimising pre-service teacher education, thus, entails connecting and embedding learning such that the division between working and learning dissolves. In other words, teacher education institutions and schools need to make a transition towards becoming modern knowledge organisations, and thus place a premium on knowledge development and knowledge management. Learning is more than knowledge acquisition. It is an integral process of thinking, producing, communicating, cooperating and designing by learners, and of coaching, structuring, assisting, giving feedback, and teaching by teachers and support staff (van den Dool and Kirschner, 2003).

Hall et al. (2006), after analyzing professional development projects in the Preparing Tomorrow's Teachers for Technology (PT3) grant program, concluded that success depends on the quality of leadership, administrative support from departments and colleges, available resources and personnel, just in time learning, and faculty's understanding of the relevance of proposed changes. It is, thus, important for institutions to explicitly specify the competencies it wants its staff members to achieve or possess and to check whether they have been acquired or are present. Feedback (both peer and expert) must also be facilitated. Supervision, reflection, and co-operation within the school can positively influence teachers' beliefs and actions, but these activities are time consuming (Grossman, 2006). Thus, time must be explicitly allocated for reflection, monitoring, and evaluation of the teachers' personal and professional development in the use of ICT in their teaching.

Finally, Grossman (2006) stressed the importance of teacher educators having close ties to practice in schools. To this end co-teaching by teacher educators and student teachers would facilitate implementation of new educational strategies that are different from those in typical school settings.

Benchmark 6 – Communities of Practice

Communities of practice (Wenger, 1998) are places where a process of social learning occurs between people with a common interest in a subject or problem collaborate over longer periods of time to share and exchange ideas, find, solutions and build innovations. At the very heart of learning in a community of practice is discourse to build both personal and shared understanding. Such a discourse enables enquiry and encourages construction of personal meaning as well as shaping and confirming mutual understanding. When learners participate in such communities, they are allowed, and are even expected and encouraged, to make a different type of contribution than more knowledgeable and usually longer participating members, a concept known as legitimate peripheral participation (Lave and Wenger, 1991). Such a participation "provides a way to speak about the relations between newcomers and old-timers, and about activities, identities, artefacts, and communities of knowledge and practice. This social process includes, indeed it subsumes, the learning of knowledgeable skills" (p. 29). In the case of teacher learning for pedagogical use of ICT this would include getting the net-generation or student teachers to contribute as digital natives from their knowledge base on the use of ICT (and thus provide information to established teachers), while established teachers in the community can contribute their vast knowledge of teaching and learning praxis. Computer supported networked communities are, in the context of this chapter, an important example of such a community of learning or practice. De Laat's study of networked learning (2006) illustrated that engagement in collaborative learning processes does not automatically mean that participants strive for collective learning outcomes. His review of studies in networked learning found that individual interests and learning goals are the main drivers of learning and that feedback and guidance from peers and experts are appreciated for supporting learning. Students, especially in the earlier phases, welcome active pedagogical guidance by the teacher or expert, which can later evolve into a more facilitative approach. Because of the equal access of both teachers or experts and students to discussion and comments made by all the participants and the fact that there is no clear distinction between students and teachers or experts (i.e., in certain circumstances the learner can know more or have more experience than the "expert"), management of the learning process is a joint activity and responsibility.

Benchmark 7 – Embedding Learning About ICT in an Open, ICT-Rich and Flexible Environment

According to van den Dool and Kirschner (2003), a transparent, open, connected, well-resourced and flexible learning environment in teacher education is a precondition for learning about the pedagogical use of ICT. Student teachers and faculty use a

wide range of electronic and human connections, have personalized access to human and electronic networks, and use tools such as PCs, laptops, handheld devices, digital cameras, MP3-players, and iPODs. Specifically designed and developed educational tools, applications and software (e.g., digital content, electronic learning environments, digital portfolios, electronic assessment programs) as well as tools, applications and software not specifically made for teaching and learning, but that can play a role in both processes, are plentiful. These learning tools and teaching aids are readily available and can often be integrated with each other. Examples of such tools are visualization tools, animations, simulations, knowledge networks and communities, mind maps, discussion boards, search engines, know bots, virtual environments, chat rooms, electronic whiteboards, tracking and reporting systems, teachable agents, applets, and widgets (see the experiences in PT3 projects such as Hall et al., 2006; Mims et al., 2006).

According to Simons (2002), such an ICT-rich environment offers extra potential to reinforce and promote learning. Examples are plentiful. ICT can be used for:

- making and building relationships with sources of information and with other persons;
- simulations, authentic tasks, games, case databases that help student teachers to actively create knowledge;
- supporting and fostering dialogue and learning through dialogue;
- promoting transparency (e.g., by making teacher–learner dialogues and dialogue patterns in collaborative learning experiences explicit and analysable);
- stimulating learning to learn (electronic tools for stimulating reflection, metacognition, peer feedback and peer tutoring);
- competence assessment (digital portfolios);
- dynamic task selection and feedback (pedagogical agents, expert systems);
- enhancing flexibility (with respect to place, time and pace of study, learner needs, learning style or preference, and just-in-time learning).

In sum, an ICT-rich environment in teacher education allows for increased communication, collaborative and cooperative learning, and individualisation.

Benchmark 8 – Learning About ICT Through Structured Experiences

Based on an analysis of the origins of the gap between the theory or skills taught in teacher education and teachers' practices, Wubbels et al. (1997) proposed that experiences should be taken as the starting point for learning. Similarly, van den Dool and Kirschner (2003) posited that the start of learning lies in the experience of the student teacher both as a student and a staff member. Starting from practical experiences can be a viable and fruitful avenue in teacher education to stimulate integration of theoretical notions in teacher actions with each other *and* with "reality." But to achieve this, careful planning, structuring and supervision is needed. Clift and Brady (2006) confirmed this, concluding that engaging in tasks associated with full responsibility may discourage or inhibit continuous attention to individual students.

Korthagen and Kessels (1999) offered a useful framework for thinking about learning from experiences in their *realistic approach to teacher education*, which focuses on

the specific concerns, questions, and problems student teachers take with them to the teacher education institute today, on the basis of yesterday's experiences in the school. They considered this as a theory-based approach, integrating competency-based methods (Gage, 1978) and the reflection paradigm (Valli, 1992) in teacher education. Putting this approach into practice requires teacher educators to have special competences to guide the intended reflective learning process in student teachers. This process is described through the so-called 5-phase ALACT model of reflection: (1) action, (2) looking back on the action, (3) awareness of essential aspects, (4) creating alternative methods of action, and (5) trial, which is a new action and therefore the starting point for a new cycle.

Benchmark 9 – Embedding Learning about ICT in Other Content Domains of Teacher Education

Teacher education programs are usually structured around disciplines and courses such as educational psychology, foundations of education, teaching methods, linguistics and – unfortunately – multimedia and ICT. Such a structure promotes compartmentalisation of what is experienced and learned and, thus, inhibits student teachers from integrating insights from different disciplines for the solution of practical problems (Merriënboer and Kirschner, 2007). Taking student teachers' experiences as a starting point requires a holistic, integrated program structure rather than one that is broken down into distinct disciplines. Teachers who learn technology-skills in isolation from methods-courses may be competent in using technology but unable to use their technology skills to foster student learning (Mims et al., 2006).

A holistic approach can help teachers to deal with complexities that are often encountered in teaching without loosing sight of the separate disciplinary elements and the interconnections between them. It allows for the integration of knowledge, skills, and attitudes; the coordination of qualitatively different constituent skills and the transfer of what is learned in the taught courses to daily life and work settings.

Discussion

The above nine benchmarks are not exhaustive. Kirschner and Selinger (2003), for example, explained that additional benchmarks could be introduced to address issues related to ICT in learner assessment and ICT in educational and school policy. Learning to use ICT for assessment and understanding the policy dimension of ICT-use are not yet widely perceived as important components of good practice. In the opinion of the authors, this is shortsighted.

A benchmark on *educational policy* is needed because 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. In the United States, for example, most of the states and the US Council for the Accreditation of Teacher Education have adopted the ISTE standards for teachers (National Education Technology Standards for Teachers, NETS.T; see Thomas and Knezek, 2008) as mandatory.

A benchmark on ICT for *assessment* deserves full attention. 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 (Baartman et al., 2006; Gulikers et al., 2004; Reeves and Okey, 1996). The current trend towards competency-based education requires sympathetic testing and assessment that can both determine if the competencies have been achieved and stimulates – or at least not deter – that type of learning. It is noteworthy that most of the case studies of good practice reported by Kirschner and Davis (2003) used and modelled innovative approaches to assessment in line with their pedagogical approaches. We therefore conclude that this benchmark is emerging for teacher education initiatives that aspire to be good practices.

One of the six standards of the ISTE NETS.T (see Thomas and Knezek, 2008) is on assessment and evaluation. The remaining five standards closely resemble our first four benchmarks (on the "what" of teacher education). Our benchmarks differ from the US Standards in also including guidelines on the "how" of teacher education.

An unsolved issue is whether the attention on ICT in teacher education will be a continuing necessity or whether it is only a temporarily necessary topic. As we have seen and continue to see in educational research, attention for the use of written texts in education and their effects on learning is to be expected for a long time to come. Research on the use of ICT in education and learning through ICT will need to be carried out. For teaching on the use of ICT in teacher education, the necessary time period could be shorter, in particular, when ICT becomes a common tool such as books have been for a long time. When our benchmark 9 about embedding of learning about ICT in other content domains becomes common practice then teaching on the use of ICT will disappear (cf. Kirschner and Davis, 2003). Certainly ICT is not yet as common as books and it is not yet time to stop paying special attention to the topic.

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