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Preparing teachers for schooling in the digital age: A meta-perspective on existing strategies and future challenges

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Abstract Recent developments in educational innovation and new technologies have made tensions between old and new models of schooling more apparent, creating new demands upon teachers as agents of change. Looking back at the last 20 years, it is clear that important steps in development have tried **to** find a good balance between technology- and pedagogy-driven changes. In the first part of this article, we present some strategic models that summarize these developments. The second part of the article addresses new challenges on the horizon that point towards possible future developments. However, from the position of teachers in schools today, this might create an ambivalence between old and new models of teaching and learning that use new technologies. These models are discussed as ways of preparing teachers to innovate, adopt, and implement new ways of teaching and learning in the digital age.

Keywords Teachers · Educational technologies · 21st century skills · Educational innovations

1 Introduction

Teacher development strategies are at the core of educational innovations during the last two decades, especially in terms of new technologies (Davis et al. 2009). Important progress has been made in capacity building among teachers, both on a practical level within classrooms and on a systemic level with development. For example, in the US the International Society for Technology in Education (ISTE) has established certain

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standards for teachers in the digital age. Still, teachers today face important challenges that demand new models and strategies. These challenges arise from technological innovations and the explosion of digital tools (Cox 2008), and from new perspectives on and potential for teaching and learning with technology. School systems worldwide are likewise in a phase of development where tensions between old and new models of schooling are becoming more apparent, creating new demands upon teachers as agents of change. These demands include integrating technology into student-centred learning and enhancing subject-specific, as well as cross-curricular, competencies.

Technological innovations and school systems follow a co-evolutionary progression of constant change (Davis et al. 2013). This progression demands that school communities work strategically to implement and use new technologies on different levels in their respective communities. The pressure on teachers to handle this change and transfer it into practice has been a common theme in research in this field for the last 20 years. Previous studies often blame teachers for being reluctant towards change (Mumtaz 2000), especially when teachers lack confidence in their ability to use technology and a correspondingly lack commitment to use information and communication technologies (ICT) in teaching and learning (Ertmer et al. 2007).

The focus of this article will be on teachers as core agents of change, who are part of systemic change processes using technologies. Using a meta-perspective, we will summarize and discuss research regarding teachers, educational innovations, and new technologies in more general terms, rather than performing detailed analysis of one project or data set. Our aim is to reflect on the impact and challenges of the ways in which teachers are defined as agents of change, as part of different initiatives on international, national, regional and local levels. We also aim to identify key aspects of teacher professional development, in order to prepare teachers adequately for the digital age.

In the first part of this article we will present selected strategic models that summarize these developments, especially as expressed in holistic and systemic models of change. The second part of the article will address new challenges on the horizon that point towards possible future considerations of capacity building among teachers. From the position of teachers in schools today, these challenges, which imply new competence demands on schools for changing societies and labour markets, might create an ambivalence between old and new models of teaching and learning using new technologies. In order to gather a sound understanding of these areas of tension, this article elaborates on recent research and strategies on the development of new systems of preparing teachers for schooling in the digital age (Eickelmann and Erstad 2013).[1]

2 Steps towards capacity building – contemporary models and research issues

On a global scale, important steps have been made in the ways teachers use ICT within primary, lower, and upper secondary schools. Even though access to technologies is

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still an issue of considerable concern in some countries, several important strategic developments have been made concerning teachers as change agents who use new technologies within the system of schooling (OECD 2006; Voyiatzaki and Avouris 2014; Petko et al. 2015; Chandra and Mills 2015.) In this section, we will highlight three important developments and strategies linked to practice, policy, and research that reflect the status of capacity building among such teachers. These developments and strategies imply a multi-level approach, in the sense that school leaders and teachers need to combine different change mechanisms to redirect practices and organisational processes, such as the schools' assessment systems and teacher collaboration. There are of course other issues of importance concerning teachers and teacher education in the way technologies are implemented and used, but contemporary research in this area directs our attention especially to these three strategies.

a)   *Computer and Information Literacy*

Digital literacy and similar concepts have become central in defining how fluent teachers and students are in using new technologies, both inside and outside of schools, and are understood as cross-curricular competences. During the last decade, an increased emphasis on technological literacy and fluency has indicated that access and implementation are secondary to ways of using technologies, and their impact on learning. The most recent large scale international study using computer-based tests in this area is the International Computer and Information Literacy Study (ICILS) (Fraillon et al. 2014), conducted by the International Association of Educational Achievement (IEA). This international study targets both secondary level students' digital competencies and the use of technology in schools, especially by teachers. At the teacher level, questionnaire items were developed on an international level and translated into the respective educational systems' languages, in order to measure teachers' familiarity with ICT, their views about ICT, their teaching with and about ICT, and different tools they were using in their practices. Teachers from 21 countries participated.

In concluding their report on the teacher questionnaire, Fraillon et al. (2014) write that a majority of teachers in the participating countries were using ICT in their teaching on a regular basis, at least weekly. Only in a few countries, such as Germany, did the majority of teachers use ICT less frequently (Fraillon et al. 2014). Factors that were important in promoting teachers' ICT use were their levels of confidence about their own expertise, and whether teachers worked in school environments where there was collaboration about and planning for ICT use, and where there were fewer resource-based obstacles to using ICT. Teachers most frequently used were word-processing and presentation software in their classrooms, as well as computer-based information resources such as websites, wikis, and encyclopedias. The authors conclude, "In general, the teachers appear to have been using ICT most frequently for relatively simple tasks rather than for more complex tasks" (Fraillon et al. 2014, p. 227).

This finding is in line with other research studies documenting difficulty among most teachers with using the full potential of new technologies, both on a practical level and due to their attitudes about what such technologies represent concerning teaching and learning. Likewise, they integrate such technologies within familiar practices rather than exploring new methods of teaching, and often use simple technological

applications (Balanskat and Blamire 2007; Somekh 2008). Issues of literacy are important here, because they draw our attention to the skills needed to use computers, mobile applications and information technologies for educational purposes. They also make teachers understand that the basic skills of "reading" and "writing" change over time due to technological developments (Coiro et al. 2008).

b)   *Innovative Pedagogical Practices Using ICT*

The second strand of research on teachers and new technologies is about innovative changes in teaching practices and learning. The main question here is how and in what way ICT catalyses pedagogical innovations by making use of the potential of digital technologies. Based on 174 qualitative case studies from all over the world, the final report of the international SITES M2 project (Second Information Technology in Education Study, Module 2; Kozma 2003) showed important insights into different ways that new technologies could innovate traditional pedagogical practices in schools. Similarly, drawing on a cluster analysis of all 174 case studies and a detailed analysis of 47 case reports, Kozma and McGhee (2003) provided descriptive profiles of seven patterns of innovative pedagogical practices. The seven clusters developed were integrated into four models of innovative pedagogical practices that use technology.

First, in the *Student Collaboration Model* (Kozma and McGhee 2003, p. 72), teachers advise students, students collaborate with others in their class and search for information, and both teachers and students use email and productivity tools as part of their collaboration efforts. Similarly, in the *Student Research Model*, students use different tools to conduct research projects and solve problems (Kozma and McGhee 2003, p. 74). A third model, the *Product Model*, traces how teachers created learning environments with different technologies to stimulate students to create products and publish and present their results, and how teachers collaborated with their peers to design instructional materials (ibid.). The last model is called the *Outside Collaboration Model*; here, teachers and students collaborated with outside actors (ibid.). These models represent characteristics of innovative pedagogical practices using technologies. This study is interesting, even though it is now more than 10 years old, because it is unique in the number of case studies from many different countries. More importantly, it points towards developments that that are still on the agenda for research about teachers and new technologies today.

An increasing variety of technological developments since 2003 have made innovations in pedagogical practices even more applicable for teachers today, especially the collaborative and communicative aspects of social media. These innovations have to a considerable extent been more technology-driven than pedagogy-driven, as smaller and more affordable mobile computers mean Internet access need no longer be limited to desktops. Compared to studies of computer and information literacy, innovative pedagogical practices are typically studied qualitatively: often, small-scale and case-based studies are conducted to analyse the shifts in pedagogy induced by technology. It is obvious that some teachers act as early adopters of new technologies for educational purposes, and the field features diverse research covering different subject domains and different technological tools and applications, such as science education (Donnelly et al. 2014) or the teaching of history (Ni and Kinabalu 2012). The problem, however, is that innovative teachers are a minority in most schools, and most teachers are instead

using simple technological applications, as documented above. In most of the published research, teachers' beliefs and attitudes towards ICT and its perceived value for teaching and learning play a substantial role (Teo 2009; Petko 2012).

c)   *Systemic Approaches*

Another important strategic element is the development of systemic approaches towards educational change, and holistic models that help us understand teachers using new technologies as part of educational innovation. In her literature review on "Whole school change" (2007), Pat Thomson emphasises that "[t]he ways in which we think about the school also impact on what counts as change. There are two important aspects to thinking about change in schools: (1) understanding the school as an organisation, and (2) understanding that change will be multilayered" (2007: 15). Multilayered in this sense means there are different levels, including different organisational elements in schools. The challenge, according to Thomson, is to create a supportive framework for change on different levels.

Adding to this, a major challenge has been the complexity of digital media and school development, since simplistic understandings of school change often fail to create sustainable solutions (Eickelmann 2011; Virkunen and Newnham 2013). Taking the multilevel understanding of schools into account, common supportive factors of sustainability over time include factors at the school and teacher level (Eickelmann 2011). At the teacher level, both intra-school cooperation, e.g. coaching systems, and integrating the de-privatization of classroom practice into school concepts and the school culture have been documented to be supportive (ibid.).

There is a real need to address multi-level analysis in trying to understand the impact of digital media on school development and the role of the teacher (Erstad 2008; Hargreaves 2003). This is still a challenge for education research in general, especially when trying to understand the institutional mechanisms involved in the educational use of new technologies (Arnseth and Ludvigsen 2006). There are some examples of how such multi-level approaches have been scaled up into system-wide innovations. Below we present two such initiatives. They are similar in the sense that they are both systematic approaches involving many schools and teachers, and both initiatives illustrate different factors that have to be considered when implementing and using ICT among teachers and students. However, they are also different in important ways. The first example specifies a model that is implemented on the school level, while the second example is a more process-oriented approach to networking, in which schools themselves create ways of collaborating and building capacity among teachers as agents of change.

2.1 Case study 1: A holistic approach (The Netherlands)

The first case is the 'Four in Balance' model from The Netherlands, which is used both as a framework for a yearly research review and as a model for school development (Kennistnet 2011).

The model and strategy shown in Fig. 1 derives from a regional project in The Netherlands. Its aim was to implement ICT sustainably by overcoming traditional approaches and by re-thinking schooling in terms of holistic approaches. The model
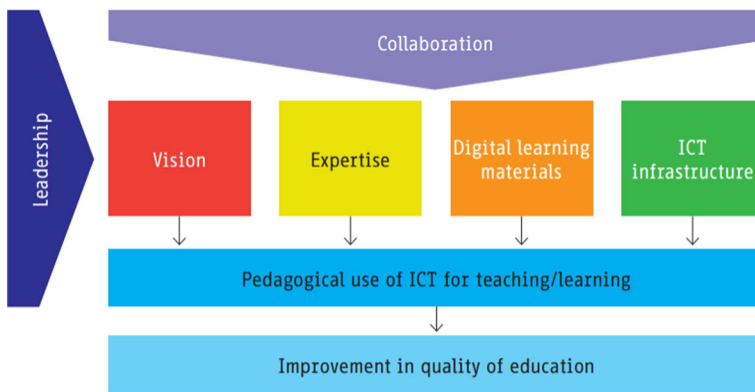
The basic elements of the Four in Balance model (Ten Brummelhuis, 2011)

Fig. 1 The 'Four in Balance' model

includes four pillars: Vision, Expertise, Digital Learning Materials, and ICT Infrastructure. These pillars point to key aspects in developing new and sustainable ways to take advantage of the possibilities provided by new technologies for changing teaching and learning practices. The main aspect of teacher preparation covers a holistic approach towards change.

Research on this model and its implementation shows that all four elements must be coordinated to balance effectively, but that implementation works best when the human factors (vision and expertise) come before the material factors (digital learning materials and infrastructure). In other words, education-driven coordination has a better chance of success than an approach in which technology is ahead of pedagogy (Kennistnet 2011). Professionalising teachers with explicit support from their respective school leaders has been an important factor for successfully implementing the model on the school level. In its integrated approach it also reminds us of the TPACK model, integrating technological, pedagogical, and content knowledge (Harris et al. 2009). On both the school level and the regional level among school boards (the Lucas Onderwijs and the Lucas Academy), teachers have been the main focus of change through collaborative capacity building, changing mind-sets, and identifying practices that are worth sharing, to facilitate dissemination. The relevant outcomes of the Dutch example described above are related to the holistic approach and the way teachers are engaged through networking and knowledge brokers, addressing challenges in teaching practices.

2.2 Example 2: Networking for capacity building (Norway)

An additional dimension expressed in some national and systemic approaches is the concept of networks between schools and teachers as a mechanism for capacity building and change. Some argue that through networks of schools and teachers using digital technologies and platforms, new ideas and new practices might be developed (Hakkarainen et al. 2004; Veugelers and O'Hair 2005). Research has also documented how organizing by networks is an alternative to a hierarchical and rational goal-oriented approach, where the main aim of such a network approach is to develop the collective capacity among teachers.

In Norway, from 2004 to 2009, a national program for school development and ICT was established called 'Networks for Learning,' with the aim of building networks beyond the individual school. It was organized with ten schools in each network, mixing primary and upper secondary levels, and with one teacher training college leading each network. About 600 different schools were involved in the program. A qualitative evaluation was done towards the end of the program, including interviews with different participants in a few selected networks. This study showed a broad diversity of experiences across different networks (Erstad 2009), related both to the way networks worked with different issues and to the different ways networks were organized.

The working method chosen in most networks was a combination of face-to-face meetings and online collaborative efforts. The physical meetings turned out to be very important for the networks, because teachers got time to discuss and reflect together, and to bring up tensions and problems in the developmental process at the schools, as part of expansive learning processes. The teachers and school leaders reported that these meetings had an important function: to make the networks evolve as communities of learning, and to push for changes in educational practices (Erstad 2009). This program documented how innovations towards new ways of organizing schools, and supporting teachers as change agents, is part of collaboration in larger networks. As to teacher preparation, the main outcome was to go beyond sharing experiences between individual teachers, and start supporting each other across larger networks of school communities and levels, developing new practices and new mind-sets.

The cases mentioned above represent important steps towards supporting teachers in their efforts to implement and use new technologies. However, at the same time they signal that developments during the last 20 years have not really prompted fundamental changes in our school system. In most of what is written about schools today, it is taken for granted that what has been will continue to be, making the existing system more efficient. Still, developments during the last 5 years indicate that more fundamental changes are in progress.

3 Teachers and 21st century challenges: Preparing teachers for the digital age

One of the most important recent emphases in new strategies for schooling has been on defining and implementing 21st-century competencies and skills. This goes back to the DeSeCo (Definition and Selection of Key Competences) reports initiated by OECD at the beginning of the 2000s. However, this impulse has become more apparent during the last 5 years, on both national and international levels. Two examples are the way the European Union has defined eight key competencies to be implemented in all European countries, and the global "Assessment and Teaching of 21st Century Skills" initiative (Griffin et al. 2012). In both of these examples digital competence, information literacy, or ICT literacy are defined as key competence areas for future schooling and education. In addition, these initiatives represent a new framing of the need for innovation and change. At the same time, technologies are getting more handy, user-friendly, mobile, and affordable, allowing for new ways of incorporating them into learning both within and outside of schools. Some studies point to teachers as key agents for change in

creating bottom-up strategies for better educational provision in the context of addressing 21st-century challenges (Eickelmann 2011; Erstad 2013). However, research into the implementation of new forms of schooling and the impact of 21st-century skills initiatives is rare.

In the public debate about 21st century skills in the US some argue that there is nothing new in these initiatives on 21st-century skills, and that the same ideas were presented and reiterated by pedagogues across the twentieth century (Kereluik et al. 2013). Others, however, argue that the specifics of how initiatives on 21st century skills are instantiated have changed (ibid; Keengwe et al. 2008). Also, reviews of frameworks and research on 21st-century competencies show that different frameworks around the world are quite consistent, in that certain competencies are defined as important for the future, even though there are some differences in priorities (Voogt and Roblin 2012; Binkley et al. 2012). Within these frameworks, technology is defined both as a competence area in itself, with digital literacy and computational thinking as key components, and as a driving force for development of other competence areas like problem solving, collaboration, and creativity.

Further, in several of their reports in recent years, the OECD has argued that 21st-century learning demands new approaches to education (OECD 2008; Dumont et al. 2010). This is based on a set of key findings that has emerged from learning sciences research (Bransford et al. 2000). For example, most schools were not teaching the deep knowledge that underlies knowledge work. Children retain material better, and are able to generalise it to a broader range of contexts, when they learn deep knowledge rather than surface knowledge, and when they learn how to use that knowledge in real-world social and practical settings. Thus, learning scientists began to argue that standard model schools were not aligned with the knowledge economy (Sawyer 2006). The OECD initiative called *Schooling for Tomorrow*, launched in the late 1990s, is an example of how the implications of such research suggest new approaches to the system of schooling, and to ways of integrating future thinking more fully in educational policy, practice, and research. See, for example, the "New Millennium Learners" project by OECD/CERI (Pedró 2006), or the MacArthur initiative "Connected Learning" in the US (Ito et al. 2013).

One meta-review of existing research on 21st-century competencies/skills focusing on teachers and future challenges was done by Kereluik et al. (2013), and was called "What knowledge is most of worth: Teacher knowledge for 21st century learning." They identified three key areas across different frameworks and research on 21st century learning in different countries: foundational knowledge, meta knowledge, and humanistic knowledge. Each area had different subcategories. Based on their meta-review, they elaborated on the technological impact on each of these knowledge areas, and how it creates changes for teaching and learning. In their words, "The effect of technology on foundational knowledge in the 21st century goes well beyond the obvious dimension of digital and information literacy. Content has also been altered with the rapid advancement of technology in the 21st century in terms of both access to information and how information is represented." (ibid., p. 132) The introduction of digital technologies has changed the methods and techniques of acquiring, representing, and manipulating knowledge in almost all disciplines, from mathematics to music, astronomy, and archeology. The argument is that the education of the next generation of citizens needs to change to keep up with these developments (Mishra et al. 2012).

Technology in the meta realm asserts itself as knowledge "to act" with foundational knowledge and technology. Humanistic knowledge, according to Kereluik et al. (2013) though seemingly the most distant from the effects of technology, has nonetheless been modified by technology in the 21st century, in that the ability to regulate one's efforts has become a multifaceted effort that necessitates successful organization of one's demands in different realms of life (e.g. personal, professional).

The reason why these initiatives and the research literature on these issues are seen as more fundamental is because they ask key questions concerning the school system we have today, which was developed for mass education and the industrial society. Further, they confirm that we need to develop new systems of schooling, partly due to changes in labor markets and workforces, and partly due to technological developments. As Kereluik et al. (2013) remind us, the impact of technologies goes well beyond digital, computer, and information literacy, to include more foundational issues of knowledge across different subject domains and systemic levels of schooling.

4 Implications – new models

Different notions of change are apparent in contemporary research and initiatives on technology and education. This became very clear in the EduSummIT discussion, which took into account the perspectives of researchers, policy-makers and practitioners from many different countries around the world. One popular notion which might be used within a more holistic approach is that of "disruptive innovation" (Christensen et al. 2008), which is often linked to the developments of MOOCs for higher education but also has implications for lower levels of schooling. Such research argues for dramatic and revolutionising change in just a few years. However, other literature in this field attests that educational institutions are complex organisations, and that change has to be addressed on different levels to create sustainable development as a more process-oriented approach (Fullan 2012; Eickelmann 2011; Erstad 2013).

We will group the implications of 21st-century challenges into three headings that frame conceptions of school and the role of teachers in different ways.

i)   *Opening up School-based Learning*

The term "powerful learning environments" (De Corte et al. 2003) points towards ways of empowering teachers and students in their knowledge work at schools. Teachers are still important as initiators and drivers of learning processes among students, but with more flexible solutions for connecting subject domains, and age levels of students in groups, and with more authentic experiences by collaboration between schools, museums, companies, and other organisations.

A methodological example is the so called flipped classroom, a way to re-think schooling and teaching in combination with other sites (Sams and Bergmann 2012). Instead of the teacher spending time introducing a theme or issue or instructing students about it, the teacher records short videos that students see before they come to school (like the Khan Academy), in order to focus on deep learning while at school. As to technology, an acceptance among teachers of BYOD (bring your own device), which is a policy of permitting students to bring personally owned mobile devices (laptops,

tablets, and smartphones) to school, opens up teaching practices with technology using different applications. Also, schools with extensive educational resources, computer games, and so forth, can likewise provide new scenarios for learning in schools, with new roles for teachers as "stage directors" for students' learning.

Another dimension is of course represented by virtual and online educational provision, like using *Second Life* to teach students from different sites, which creates new scenarios for where teaching and learning takes place, and represents significant challenges for regular teachers. In these learning environments, teachers play a key role in their willingness and capabilities to adopt or even develop schooling which is opening up school based learning, and to take advantage of the possibilities provided by different technological applications.

ii)   *Personalized and Deep Learning*

One model that has created increasing interest is "personalizing learning." It springs from an awareness that one-size-fits-all approaches to school knowledge and organisation are ill-adapted to individuals' needs, and to the knowledge society at large (Eickelmann and Erstad 2013; Jarvela 2006). The emerging idea is that systems capable of achieving universally high standards are those that can personalise the program of teaching and progression to the needs and motivations of each learner. Personalisation can mean adopting a more holistic, person-centered approach to learner development, as well as more demand-driven, market-friendly approaches to system change, where new technologies can play an important role (Eickelmann and Erstad 2013; Jarvela 2006). Similar perspectives are seen in the development of technologies on data mining, which have also provided teachers with new tools for learning analytics and ways of tracking developments among students.

The question here is to what extent technological solutions can take over some of the tasks of teachers in providing adapted challenges and tasks for individual students. This process is called adaptive learning, and uses online platforms like Knewton. Still, research documents that teachers remain very important because students need guidance and adjustments in learning environments, including resources in line with their different needs (Dede and Richards 2012). The importance of deep learning for enhancing the quality of learning, as part of 21st-century skills and key competencies, has been emphasised more strongly in recent years, and is now being implemented in national and regional curricula in countries like Norway, Finland, The Netherlands, and Singapore. This creates new demands on teachers, especially given the way new technologies provide possibilities for ways of working with students, access to information, and communication, as well as applications. For instance, technological platforms and games can trigger problem solving and deep understanding within and across subject domains (Bereiter and Scardamalia 2012).

iii)   *Across Formal and Informal Settings*

During the last decade, there has been growing interest in research exploring connections between the inside and outside of schools. The promising aspect of this research is that it combines systems analysis with personalized learning trajectories, and by trying to explore models and strategies for combining learning and teaching in

different learning contexts. In this model, schools are just one of several contexts where learning takes place and scaffolds knowledge building over time, as there are many online and offline ways of developing learning opportunities. Again, this raises fundamental challenges for teachers in schools, in that they have to handle increased complexity in the classroom with many resources available bridging students to the outside world (Ito et al. 2013; Erstad and Sefton-Green 2013).

J. Sefton-Green (2013) uses the term "learning at not-school" in his review of research of education in non-formal settings, in order to raise questions about how we conceptualize learning in contexts other than schools. The diversity of learning contexts outside of school makes it challenging to understand clearly what learning is for young people, and what role digital technologies play in their learning. Technologies might create new conditions for learning in various kinds of contexts outside of the regular school system (Kafai et al. 2009). The rationale behind many of the initiatives organising learning activities in settings outside of school do so strategically to avoid all the constraints of regular schools, e.g. traditional assessment systems, and to develop environments that might have broader potential to stimulate and support learners in new ways.

Sefton-Green (2013) shows how many of these efforts imply changes in how we think about learning and teaching itself, but also that there is a danger of turning all kinds of activities outside of school into educational experiences. Still, this research opens up new understandings of how museums, science centres, community centres, internet cafes, home settings, and diverse online communities represent opportunities for student learning—a trend that challenges the decontextualized nature of most school-based learning. As expressed by Kereluik et al. (2013, p. 133) the technological advances of the 21st century have brought us closer together and at the same time further apart. As a result of the increased opportunity for interaction across countries, teachers need to know how to foster cultural competence, emotional awareness, and leadership skills to facilitate not just interactions, but *meaningful* interactions and relationships.

5 Conclusion and future work

In this article an outline of models and strategies, based on some key themes from research on digital technologies in schools during the last two decades, served as a frame to analyse conceptions of teachers as part of change processes. Increasingly, policy, practice, and research have moved towards system-wide strategies and holistic approaches to school development and the impact of ICT, as illustrated by the two cases presented from The Netherlands and Norway. However, school systems and research are at a moment in time when new systems of schooling and teachers' roles as change agents have become more apparent, in order to address 21st-century challenges. These developments, combined with a deeper understanding of challenges facing schools and education systems in the 21st century, make it necessary to seek new, sustainable models and strategies to provide competencies and skills among teachers for future capacity building.

In concluding and outlining future work on these issues, we follow Kereluik et al. (2013) in their thoughts about teachers and change. They write that

Our analysis indicates that this seeming paradox of "nothing has changed" *and* "everything has changed" provides us a way forward. It suggests that, though the 21st century is different from previous times, it does not mean that our core roles (to know, to act, and to value) have changed. So, in that sense, there is no disjuncture between what we have been doing as educators in the past and what we do today (and in the future). That being said, it also indicates, even as we hold onto these core ideas, that we have to continually shift and come up with newer ways of instantiating them. […] The rapid changes we see in the world around us brought about by the forces of globalization and technological and cultural change often make it difficult to gauge what exactly it is that our students need to be learning in schools and how teachers are to be trained in order to prepare our students for the future (2013, p. 227).

This tension between old and new strategies, as experienced by teachers when they implement and use new technologies, is a challenge that has to be addressed now. The implications are that we need to make contemporary frameworks and research on 21st-century competencies more accessible for teachers in their practices. Teachers also have to become more involved in discussing the future of education and become change agents, using new technologies. Looking at the history of implementing digital technologies in schools, it seems to be easy to get discouraged about what these technologies' impact might have been already and what it will be in the future. Even though there are many examples of innovative practices in schools that use new technologies and frameworks to develop 21st-century skills (Voogt and Roblin 2012), it is still an open question to what extent technologies have created changes to the education system as such. The impression, on many national levels, is rather that these technologies are used to enhance and strengthen already established classroom practices.

One lesson that can be learned from theory and research is that even though the challenges of changing contemporary education systems in fundamental ways seem almost impossible, several developments in the co-evolution of society, pedagogy, and technology address new systems of schooling that are both visionary and possible. These developments point towards more flexibility and diversity in systems of schooling than what contemporary systems represent. Our argument has been that initiatives on 21st-century competencies and skills pose fundamental questions about changing the way schools need to qualify future citizens with the necessary competence and skills for future work and living. In this light, it seems even more crucial now than before to prepare teachers to address these challenges, and to support them in both their professional development and their pedagogical practice.

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