

Uptake and Use of Digital Technologies in Primary and Secondary Schools – a Thematic Review of Research

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PEER REVIEWED ARTICLE

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English abstract

This article is a review of international research on the uptake and use of digital technologies in primary and secondary schools. The aim was to provide a credible and clear picture of current research, together with some well-informed suggestions as to how future research could develop. Two strategies were used: (1) identify themes within current research that indicate important lessons to be learned in relation to the uptake and use of digital technologies in primary and secondary schools, and (2) based on these lessons, identify which knowledge-gaps need to be closed and in the light of this suggest directions for further research. It is concluded that a rather complex and fragmented picture of the uptake and use of digital technologies emerges from the literature review. Three specific suggestions for research on the uptake and use of digital technologies in primary and secondary school are provided: (1) the outcomes of technology use in relation to different levels in the educational system, e.g. arenas of implementation and realization, (2) digital practices that are longitudinal and information-rich and that go beyond existing knowledge, and (3) initiatives for a renewal of theoretical and methodological approaches when designing and analyzing studies within the field.

Keywords: Digital technology, literature review, primary school, secondary school, uptake and use, policy, school leadership, teacher professional development.

Introduction

Different education stakeholders have expressed the hope that digital technologies will substantially influence teaching and learning in primary and secondary schools. For instance, OECD (2009) put forth that digital technologies have the potential to change education and teaching in schools, while the European Commission (2008) claims that digital technologies can improve and change the core activities in educational settings. However, in education, the concept of change is both complex and multi-dimensional. Engeström (2008) informs us that “the multiplicity of change mechanisms is in itself a challenge to both practitioners and researchers” (p. 380) and Erstad (2011) stresses the importance of applying a holistic perspective in relation to the role of digital technologies in educational activities when trying to understand processes of change and development in schools. In their overview of US research on digital technologies, Warschauer and Matuchniak (2010) highlight the importance of embracing cultural conditions and, according to them, research into the uptake and use of digital technologies and change should preferably be related to socioeconomic status (SES), student diversity and cultural differences in school.

In this article, we argue that we need to unpack the discrepancy between the overall policy, the hope for change in school that is driven by digital technologies and the real state of technology use in teaching and learning. In general, reform studies have shown that simple recipes for change in school do not exist (Bryk, Bender Sebring, Allensworth, Luppescu & Easton, 2010; Elmore, 2004; Fullan, Hill & Crevola, 2006). Although a growing body of research on digital technology use in education seems to confirm this experience (Erstad & Hauge, 2011), we still need to learn more about how digital technologies affect the education system and educational practices at different levels. This article contributes to the understanding of this information gap by focusing on research on the uptake and use of digital technologies in primary and secondary schools. Apart from providing a systematic categorization, summary and overview of the research and its results, this kind of literature review can help to inform ongoing technology reforms and research into technology use and change in school.

The understanding of uptake and use

From a Nordic perspective, significant efforts have been made on the uptake and use of digital technologies in primary and secondary schools. However, there seems to be discussions about the effect of these efforts in each Nordic country. In the study, *E-learning Nordic 2006* (Ramböll, 2006), it is indicated that digital technologies do have a positive effect on the change and improvement of the school organization and also on students' learning. Even so, it is declared that higher learning outcomes from the use of digital technologies are expected, but that the potential advantage of digital technologies in schools has not yet been fulfilled. This could also be understood from another point of view, namely that digital technologies increase the complexity in schools. For instance, Sutherland, Armstrong, Barnes, Brawn, Breeze, Gall, Matthewman, Olivero, Taylor, Triggs, Wishart and John (2004) make the point that the use of digital technologies further contributes to the complexity in schools and creates challenges and creative tensions between an out-of-school use of digital technologies and institutionalized knowledge, tasks and teaching methods. While this creative tension could take teaching and learning to new heights, it could also challenge existing educational practices in positive and less positive ways, e.g. a reduction of legitimacy (cf. Lindberg & Olofsson, 2010). However, according to Säljö (2010), research results reported in relation to the uptake and use of digital technologies in schools are not always clear and seldom indicate success (e.g. Cuban, 2001; Krange & Ludvigsen, 2008, 2009). The outcomes are far from straightforward

when digital technologies are introduced either in general or in specific subjects or contexts of learning. McGarr (2009) argues that there is still a lack of research on the subject to show convincingly that the uptake and use of digital technologies in school practices actually changes the organization and the educational theories used to inform teaching and learning.

According to Tondeur, Devos, van Houtte, van Braak and Valcke (2009), the possibility of understanding the uptake and use of digital technologies in schools depends on the research design. They argue that both structural and cultural aspects must be recognized and that the research design requires several different levels, or, to put it a different way, they require a more holistic approach. Wong, Li, Choi and Lee (2008) claim that in research on the integration of digital technologies there is a need for more comparative case studies with an understanding of the processes of change in educational systems as their primary focus. Such research designs are especially appropriate when focusing on the interaction between contextual factors and the uniqueness of different situations in schools.

From the research reported on above, one might conclude that several issues need to be considered when researching the current empirical field or when trying to grasp what conclusions can be drawn from research. One such issue concerns the concepts used to guide and focus the research. “Uptake” and “use” are concepts that are often used in relation to digital technologies in primary and secondary schools and occur frequently in peer-review articles written in the empirical field. This often seems to be the case regardless of the scientific discipline of the researchers and is probably due to the fact that these two concepts capture a variety of practices, dimensions and levels related to digital technologies in schools. However, in many articles the meaning of “uptake” and “use” is rather vague in that they are not always defined and are often taken for granted. This is also evident in the articles related to the literature review reported here. In a sense, it may be possible to conceptualize “use” as “ongoing use”, whilst “uptake” could highlight the processes of implementation and integration of new aspects of digital technologies and how they are made use of. However, these distinctions may only be possible to uphold at a theoretical or analytical level. In the articles analyzed here it is not easy, or even possible, to separate these two aspects of digital technologies and how they are used in educational contexts. Consequently, we employ “uptake and use” as a phrase that simultaneously addresses both aspects of digital technologies: something “in use” and something about “to be used” in perhaps new and changing contexts.

Two strategies are used in this research review: (1) identify research themes that might reveal important lessons to be learned in relation to the uptake and use of digital technologies in primary and secondary schools, and (2) based on these lessons provide some suggestions for future research as to which knowledge-gaps still need to be closed.

Digital technologies embrace several terms, such as computers, information- and communication technology (ICT), learning management systems (LMS) and digital media like, for example, wikis, blogs, social media and podcasts (Davies & Merchant, 2009). Software is often connected to the use of digital technologies too (e.g. Brown, Klein & Lapadat, 2009). The review includes studies researching different digital technology tools and terms, such as filters for analyzing the problem of “uptake and use”.

Methodological considerations

We took a broad approach rather than relying on a small sample for the review, for instance from a few specialist international scientific peer-review journals decided beforehand. Although it might have been easier to control some aspects of validity and reliability if a narrower approach had been chosen, we agreed that a more thorough overview of the field was necessary. In an attempt to provide a transparent view of the process of searching for and evaluating the articles to be included, and thereby live up to some of the claims of reliability and validity, what follows is what we consider to be a correct and systematic account of how this work was carried out.

The logic behind the searches was to find articles about the uptake and use of digital technologies in primary and secondary schools. In the initial search for relevant literature we consulted the international search engine EBSCOhost. Two databases, Academic Search Elite and ERIC, were included. We decided that one way of upholding the scientific quality of the article was to include only scientific journals with peer-reviewed articles. In addition, it was also decided to limit the search to relevant articles published between the years of 2004 and 2010. In order to limit the search even further, specific search terms that were understood as characterizing the research field were chosen. Given that the idea was to make the searches of the field as inclusive as possible, the search terms used could be regarded as rather broad in scope. Notwithstanding, this was understood to be a productive way of identifying articles that were relevant for the literature review. The following terms and combinations were used: *digital technologies or ICT or computers, teaching or learning or K-12* and *implementation or uptake or use* and *school culture or school organization*. The searches gave 110 hits.

The first search raised some questions related to the search engines and the organization of the databases. It became apparent that finding appropriate keywords did not guarantee extended results or even results that were possible to repeat in a new search. The first round of the search was performed by one of the authors of this article. In order to double-check the search, another author performed what was imagined to be the same search. Even though exactly the same search terms and combinations were used, the results were slightly different. This may have been due to the location from which each individual logged into the database, e.g. from which university the search was performed. Different universities subscribe to different databases and sources, which means that if two universities subscribe to different journals this *may* also result in different outcomes when searching reference databases like ERIC and Academic Search Elite. In view of this a second search round was conducted, this time from a different university. The search engine CSA was used, and the search included the databases ERIC and PsychInfo. In an attempt to extend the search even further, it was decided to use the following terms and combinations: *digital technologies or ICT or computers* and *teaching or learning or K-12* and *implementation or uptake or use*. The terms *school culture* and *school organization* were excluded this time, given that the uptake and use of digital technologies could be studied without relation to cultural or organizational issues. Again the search was limited to articles published between the years 2004 and 2010. The second search gave 276 hits. Together with the 110 hits from the first round, this gave a total of 386 hits.

The procedure was then to read through the titles and abstracts of the 386 articles found, with a focus on articles that specifically embraced aspects of and were concerned with the uptake and use of digital technologies in primary and secondary schools. This facilitated the removal of articles that did not really match the purpose of this article. In all, 53 articles from the first search and 118 articles from the second (a total of 171 articles) were identified as fitting the criteria. During our reading

of the articles themes and procedures were identified by means of an inductive approach. The principle for organizing the articles in themes reflected the different “levels” of the educational system, i.e. (a) policy level, (b) organizational level and its leadership, (c) the teacher level, including issues relating to their competence and professional development, and (d) the student level. These themes should be seen as analytical categories, as some articles address more than one theme. Since the aim of this literature review was to provide a credible and clear picture of the current international research on the uptake and use of digital technologies in schools, we decided to describe the themes by using characteristic publications that exemplified the focus of each theme. Here only content characteristics were deemed to be important, and no other considerations, such as nationality, discipline, journal or the sex of the authors, were taken into account. Out of all the 171 articles, 35 different articles have been used as characterizing examples.

Review

The four different themes that we identified on the uptake and use of digital technologies in primary and secondary schools were: (1) Uptake and use of digital technologies in schools in relation to *policy*, (2) Uptake and use of digital technologies in schools in relation to *school organization and school leadership*, (3) Uptake and use of digital technologies in schools in relation to *teachers and teachers’ professional development*, and (4) Uptake and use of digital technologies in schools in relation to *students*. This thematic categorization is an analytical outcome of the inductive approach used. In some cases it is possible to address only one of the specific themes, whereas in other cases certain lines or argumentation make it possible to address two or more of the themes. Thus, it was the logic behind a particular research study that led to it being placed in one theme or another. Examples of characteristic studies based on empirical data are given, as well as studies using a more conceptual or argumentative approach.

Uptake and use of digital technologies in schools in relation to policy

The first identified theme concerns different aspects of the uptake and use of digital technologies in schools as related to policy. In this context, one emergent focus is the discrepancies between the conceptions and ideas of what it is possible to achieve with digital technology in schools. For example, there seems to be a discrepancy between the arenas for formulation and the arenas of realization. Tondeur, van Braak and Valcke’s (2007) empirical study of primary teachers in Flanders, Belgium, is an example of a study with this kind of focus. Through a survey of 570 teachers from 53 different primary schools, they examine the actual uses of digital technologies in line with the competencies outlined by the Flemish Government. Tondeur et al. show that teachers are mostly concerned with the development of their own technical skills, but that the digital technology curriculum emphasizes the integrated use of digital technology in the learning and teaching process. According to Tondeur et al., this indicates a gap between the proposed and the implemented curriculum for digital technologies. The potential value of a school-based curriculum for digital technologies is suggested – a curriculum that converts the national curriculum related to digital technologies into an agenda for digital technologies as part of the overall school policy.

Based on documentary and qualitative data, Schibeci, MacCallum, Cumming-Potvin, Durrant, Kissane and Miller (2008) propose a solution to close such a gap. They emphasize that the integration of digital technologies in schools should not only include exciting practices and regulating policies, but also the processes that teachers are part of when learning to master the digital technologies for

teaching purposes. According to Schibeci et al., such processes should be combined with the cultural, social and historical aspects of learning.

Other researchers show that the uptake and use of digital technologies is possible without the “push” from policy levels. For instance, in his literature review on digital technologies in Irish post primary/secondary schools, McGarr (2009) focuses on how the education system received different initiatives related to digital technologies and policy changes. McGarr concludes that national and political initiatives and steering had little impact on involvement and uptake in the schools. According to McGarr, there is still a lack of research that clearly shows that the uptake and use of digital technologies in school practices also changes the school structure and the theories used to enhance or facilitate teaching and learning.

Another focus concerning policy is the question of how different stakeholders position themselves in their technology preferences. For stakeholders such as industry, there is an interest in creating and upholding the picture of potential benefits with digital technologies in schools, even though such benefits may not always exist. For instance, Convery (2009) shows through a document analysis that unwarranted claims of benefits from the use of “handheld computers” were put forth in a Government-sponsored report using a specific rhetoric and layout. By using photographs of learning situations with smiling teachers, large-scale strategic quotes and subtitles like “Benefits for classroom teachers” and “Enhancing Learning”, the impression was given that the handheld computers were more suitable than the underlying research actually showed. While there were results showing benefits in management and information, the help for teachers in their teaching or the benefit for students regarding their learning were less clear. From this position, Convery argues that “unrealistic expectations inhibit teachers’ pragmatic attempts to integrate technology in classroom contexts, and the teachers subsequently become blamed for the failure of technology to fulfill its promise” (Convery, 2009, p.25).

A final and different focus can be exemplified with the research of Sutherland, Armstrong, Barnes, Brawn, Breeze, Gall, Matthewman, Olivero, Taylor, Triggs, Wishart and John (2004), who describe how teams of teachers and researchers have developed ways of embedding information and communications technology (ICT) into everyday classroom practices in order to enhance learning. Based on video and interview data, Sutherland et al. depart from a more technology-driven argument when suggesting that it is important for teachers and policy-makers not to treat new digital technologies as unproblematic innovations that will somehow lead to enhanced learning and “replace” older and existing technologies.

Uptake and use of digital technologies in relation to school organization and school leadership

The next theme identified in this review concerns research on the uptake and use of digital technologies in relation to school organization and school leadership. The research displays a variety of foci, challenges, struggles and solutions. An emergent problem is the challenge of dealing with the complexity of the educational context: in research and when to implement digital technologies. When implementing digital technologies in teaching and learning there seems to be a need for schools and school leaders to identify which improvements they actually want to achieve and which tools and methods should be used.

A study by Tondeur, Devos, van Houtte, van Braak and Valcke (2009) highlights the complexity of the uptake of digital technologies in primary schools. Using quantitative data, Tondeur et al. show how the uptake of digital technologies is positively related to a school profile reflecting higher levels of both structural and cultural school characteristics. An important conclusion drawn is that structural and cultural school characteristics are relevant for promoting educational change in general and the uptake of digital technologies in particular. Similarly, when framing the uptake of digital technologies in a context of managing change in schools, and building on data collected from a large-scale questionnaire, Wong and Li (2008) report that perceived changes in student learning towards a constructivist paradigm were mediated through pedagogical and organizational interventions. In addition, Wong and Li make a point with regard to the implications of improving school effectiveness and argue that in order to unleash the power of the uptake and use of digital technologies in school practitioners should first make clear what kind of improvements they are looking for. They ask the following rhetorical questions: Is it improvements in traditional processes and knowledge that might emerge from the use of digital technologies, or are practitioners looking for new reasoning and new knowledge? If a collegial exchange of experiences using digital technologies in educational contexts is found to foster pedagogical innovations and improve school effectiveness, then policy-makers and school administrators should pay more attention to both the institutional culture and the social context.

Another example of the variety in this theme is the survey study reported by Tondeur, Valcke and van Braak (2008). They claim that their focus on the multi-dimensional interaction of both teacher and school characteristics was helpful in developing a richer understanding of the complex process of the uptake of digital technologies. According to the researchers, actions taken at school level are crucial. They argue that such actions are related to school characteristics that in turn affect processes, for example school-based in-service training, the development of vision and mission statements, and questions about the possibility of accessing computers in the classroom. Supported by the responses to their questionnaires, Vanderlinde and van Braak (2010) call this the e-capacity of a school, understood as a school's ability to create and optimize sustainable conditions at school and teacher levels in order to bring about effective change through digital technologies. With results from her case study, Tearle (2004) stresses that change provides positive learning opportunities, and although this takes time, it makes demands on people. She concludes that a culture of collaboration and collective efforts, with frequent reassessments of ways of working, will help the school as an organization to remain open and receptive to opportunities for change in relation to the uptake and use of digital technologies. van Merrienboer and Brand-Gruwel (2005) argue in a similar way when claiming that the added pedagogical value of digital technologies lies in new ways of organizing and changing learning tasks and learning contents.

Another analytical focus is related to the work of school leaders and school leadership. In his explorative and discussion-oriented article, Williams (2008) emphasizes the role of school leaders at a time of rapid growth of digital technologies. He argues that the high use of digital technologies creates a gap between a digitally supported youth culture and the more institutional culture of schools. Williams makes the point that such a transformation will be one of the greatest challenges facing today's school leaders. Another point is that the use of digital technologies in different informal contexts creates an even larger divide between the digital culture of the youth and the institutional culture that often exists in school. Williams emphasizes that school leaders play an important role in closing this gap.

Hayes (2006) takes on a slightly different approach in her longitudinal case study of the uptake of digital technologies in government schools in Australia. A particular focus is on the school leaders

and their problems when leading such uptake processes. Two main conclusions are drawn, the first being that school leaders need to develop the skills of a so-called new knowledge worker. The second conclusion is that research repeatedly reports disappointing results when it comes to how schools adapt and integrate new digital technologies. The author argues that in their methodological design empirical studies are not sensitive to the unique background factors of each school. In addition, they emphasize that the uniqueness of each school gives a certain set of context-bound challenges that require locally developed practical solutions.

The final focus in this theme concerns the challenging issue for school leaders to live up to, or deal with, expectations from the surrounding society in relation to the use of digital technologies in school. For example, building on data collected from semi-structured and focus group interviews, McGarr and Kearney (2009) examine the effect of digital technology on the leadership role of a group of school leaders. They report frustration among the school leaders, many of whom felt unable to achieve the level of digital technology use they expected in their schools. According to the researchers, the main reasons for this frustration were a lack of up-to-date resources, poor levels of technical support and insufficient time for the provision of significant technology resources.

Uptake and use of digital technologies in relation to teachers and teachers' professional development

The third identified theme concerns research on teachers, teachers' professional development and teacher education in relation to the uptake and use of digital technologies in schools. Teachers are seen as key players for the uptake and use of digital technology, and aspects like teachers' motives, beliefs, confidence and competence are highlighted. Teachers' professional development is also in focus and is often related to the use of digital technologies in specific school subjects, as well as in relation to the initial teacher education for developing the pedagogical skills, ideas, visions and attitudes that favour the uptake and use of digital technologies in schools.

Most of the research identified in this theme seems to be coherent. An agreement seems to exist that teachers are playing a crucial role in the process of uptake and use of digital technologies and in the development of new practices pervaded by digital technologies. For example, in his research review, Ferdig (2006) concludes that from a teacher perspective the most valuable aspect is that the uptake and use of digital technologies can motivate increased quality in teaching, rather than that the digital technology in itself embodies certain qualities that guarantee good teaching and learning outcomes. Sipilä (2010), on the other hand, claims that the uptake of digital technologies in school is a process that is mediated by teacher characteristics, technological framework and the conditions within the school. According to Sipilä's findings, based on quantitative data collected by the use of an online questionnaire, providing teachers with laptops can be a way of enhancing the teachers' use of digital technologies both at work and in their spare time. He argues that when the use of modern digital technology is not tied to a specific time or place, teachers will have more time to evaluate the possibilities provided by the technology, which in turn will probably increase the use of digital technologies in the classroom. In relation to their empirical study, Ward & Parr (2010) discuss the possibility of reframing the question of digital technology. They argue that teachers who understand the use of digital technologies and the subsequent benefits to teaching and learning are probably more willing to learn, try new things and move away from more traditional classroom practices (see also Herrington, Herrington, Hoban, and Reid, 2009; Haydn & Barton, 2008).

Schibeci, MacCallum, Cumming-Potvin, Durrant, Kissane and Miller (2008) conclude in a qualitative study that teachers' learning experiences with digital technologies are facilitated and

empowered through long-term collaboration with colleagues and students over time. They also argue that becoming familiar with digital technologies cannot be perceived as a linear process. These researchers emphasize the importance of teachers being assisted in their uptake and use of digital technologies.

Another focus in the research connected to this theme concerns teacher beliefs. For example, in their questionnaire study, Hermans, Tondeur, van Braak and Valcke (2008) give empirical evidence for claiming that teacher beliefs about the practice of teaching are important in explaining why teachers adopt digital technologies in the classroom. Their results indicate that teacher beliefs are a strong predictor of classroom use, and that beliefs are of importance in relation to the resistance and receptiveness of school teachers to the use of digital technologies in their classroom practices (see also Tondeur, Hermans, van Braak & Valcke, 2008).

The relation between digital technologies and how they are used in different school subjects is another prominent focus of research on this theme. This kind of research is often framed in studies of teachers' professional development. One example is Bennison and Goos' (2010) study of the professional development experiences of Australian mathematics teachers in Queensland secondary schools. In their large-scale survey they show that a significant number of the cohort had not undertaken any activities in relation to the use of digital technology in teaching mathematics. Lack of time and access to technology appeared to be significant constraints that prevented teachers from participating in both formal and informal professional development (see also Loveless, 2006). Another example is Haydn and Barton (2008), who report on a descriptive study of teacher professional development related to the use of digital technologies in subject teaching. They identify factors that obstruct the use of digital technologies in subject teaching, such as lack of time, difficulty in accessing enough computers for the students and the availability of data projectors in ordinary classrooms. Based on interviews with teachers from six different subject areas, John (2005) shows how other factors, such as the brief, evolving and incomplete nature of the relationship between a subject's sub-cultures and digital technologies, create problems in teaching. In her argumentative article, Lin (2008) focuses on digital technologies as a subject in itself. She poses questions such as how are students supposed to acquire digital technology knowledge and skills and who is supposed to teach such knowledge and skills to the students? Lin argues that one might not expect students to learn automatically just by taking part in activities with digital technologies. She concludes by saying that it is unreasonable to expect that teachers who use digital technologies in their own subject areas should also be held responsible for teaching digital technologies generally.

The research represented in this theme is also slightly more normative with regard to proposals of models or frameworks for how to enhance the use of digital technology in schools. For example, based on a case study of a particular school, Loveless (2007) argues that a framework of teacher professional knowledge that highlights the relations between subject domain knowledge, the didactic relation with digital technologies and various teaching situations can support teaching with digital technologies. O'Bannon and Judge (2004) argue from a multi-method study that even if schools invest in new digital technologies, their use in the classroom is rather limited. They present a model claimed to be effective for improving teachers' digital technology skills and their ability to integrate and use digital technology in practice. In their model, emphasis is placed on access, professional development, support, incentives and assessment.

Yet another focus of this theme is the relation between teacher education and the uptake and use of digital technologies. Sang, Valcke, van Braak and Tondeur (2010) argue that successful use of digital

technology is related to the thinking processes of classroom teachers, such as teachers' beliefs in, teachers' efficacies and teachers' attitudes towards digital technology. It is therefore important to begin such thinking processes at the teacher education stage. Their data was collected by means of a survey study focusing on the relation between teacher trainees' thinking processes and the potential level of uptake of digital technologies in Chinese schools.

A final focus in this theme can be addressed through the work of Hammond, Crosson, Fragkouli, Ingram, Johnston-Wilder, Johnston-Wilder, Kingston, Pope and Wray (2009). They depart from the question: "Why do some student teachers make very good use of ICT?" They understand "very good use" in relation to frequency, variety of use and the meeting of objectives as interpreted by tutors and mentors. Using results from an exploratory case study, including observation and interview data, they argue that student teachers who make very good use of ICT also reflect on the contribution that digital technologies make. Hammond et al. point to the responsibility of the student teacher him- or herself when it comes to understanding and using digital technologies in teaching.

Uptake and use of digital technologies in schools in relation to students

The fourth and final identified theme comprises research that is particularly aimed at students' uptake and use of digital technologies in school. These studies do not overlap with the other themes as much as the others sometimes do. In particular, this research takes the students' academic performance or learning outcomes into consideration and connects them to learning conditions and/or students' socioeconomic status (SES). In the following, some of the most characteristic research of this theme is presented, with the most prominent focus being on the impact of the societal surroundings outside school.

One example concerning students' academic achievements and students' SES is the research reported on by Ferrer, Belvis and Pamies (2010) based on a mixed method approach. They state that current research is rather limited when it comes to the impact of digital technologies in education and the effect these technologies have on students' academic performances. They also discuss the differences in academic performance according to SES. Social variables such as gender, place of birth and parents' level of education and occupation are included. In their study of a project, conducted over a period of two years in public schools in Aragón, Spain, in which all students were provided with an individual tablet PC, the most eye-catching result is that students born in foreign countries feel more empowered in the learning process using tablet PCs than students born in Spain. In addition, students with a poor academic record improved more, and finally, students from families located in disadvantaged socioeconomic and cultural environments are said to have gained more in terms of academic results. Another example is the theoretical and statistical study carried out by Hohlfeld, Ritzhaupt, Barron and Kemker (2008), which focused on the digital divide in an American context (Florida). Hohlfeld et al. argue that the digital divide is usually described in three stages: (1) that students must have access to digital technologies in order to develop the necessary computer skills that enable them to acquire knowledge to create products and make decisions, (2) that students are able to use computers independently, and (3) that students improve aspects such as their intellectual, economic and cultural conditions. However, Hohlfeld et al. claim that a fourth stage in the digital divide is necessary – one that concerns the support that is available for the uptake of digital technology in schools. In their studies, it is concluded that low SES elementary and middle schools provide a good deal of support. The researchers maintain that this could be a sign that by starting to focus on the implementation of support structures, low SES schools in Florida position themselves

as schools that improve the uptake of digital technologies. One interesting finding from the study is that students in low SES schools seem to make use of content delivery software more often than students in high SES schools, and that this seems to be reversed when it comes to the use of production software (also cf. Warschauer and Matuchniak, 2010).

Using an ethnographic case study approach in research into the digital literacy of young people in Australia, Bulfin and North (2007) report that young people's practices develop around their use of digital technologies that flows across and between school, home and other spaces, thus making simple distinctions and binaries about use in each domain problematic. In their theoretical framing, young people's engagement with language, learning and technology might be characterized as a dialogic negotiation of a complex range of texts and practices. Related to this finding is the work of Ilomäki and Rantanen (2007), who report from a longitudinal case study, containing both quantitative and qualitative data, on the development of students' digital technology expertise in a technology intensive context. Like Bulfin and North (2007), Ilomäki and Rantanen included students' use of digital technologies at school and at home. According to the results of the study it seems as though a process-oriented learning environment and an intensive use of digital technologies supported the development of student expertise. The flow across and between school, home and other spaces reported on by Bulfin and North (2007) also seems to be present in Ilomäki and Rantanen's study. For example, the students used digital technologies for solving tasks outside school and developed plans related to digital technologies in their further education and future profession. In addition, the intensive use of digital technologies seems to have created both confidence with and a positive attitude towards digital technologies.

In terms of uptake and use, the final focus in this theme concerns how digital technologies differ in different age groups and school-stages. For example, Dwyer (2007) reports from a multi-case study using interview and observation data that aspects such as digital technology resources and the time available for their use, combined with type of use, work against the valuing of digital technologies in the early years of primary school. Dwyer argues that compared with students in the later primary years, students in the early primary school years experience a reduced potential to benefit from learning with digital technologies in school.

Discussion and conclusions

This article has focused on the uptake and use of digital technologies in primary and secondary schools. It has attempted to provide a credible and clear picture of the current international research on this topic. It should be noted that difficulties were encountered in terms of the vague and seldom well-defined understanding of "uptake" and "use" in most of the articles reviewed. As stated in the introduction to our article, these two concepts seemed to be taken for granted. In view of this we decided to employ "uptake and use" as "a phrase to simultaneously address both aspects of digital technologies, something in use and something about to be used in perhaps new and changing contexts". Such a way of understanding uptake and use might have the potential to guide future literature reviews and empirical studies on this topic.

Before a few, we hope, well-informed suggestions are given for moving beyond the current situation, each of the four themes that have been identified and presented above will be discussed and understood as lessons learned from the literature review.

The first theme, “Uptake and use of digital technologies in relation to *policy*”, seems to represent a struggle or discrepancy between the focus and ambition expressed at policy level and actual practices in schools. In the research, a discrepancy is sometimes implied between policy-makers, school and ambitions when it comes to digital technologies. This can be understood in relation to the different arenas they constitute, i.e. one arena for formulation and one arena for realization. This seems to complicate the matter of the uptake and use of digital technologies in different ways, especially when the arenas are confused. In such cases, researchers often pursue a use that is intentional and describe a practice that is not ready or good enough. One crucial issue is whether consensus can be reached on the uptake and use of digital technologies to such an extent that “good enough use” can be specifically defined. Policy-makers and other stakeholders often push their ideas of what is good enough forward in opposition to what teachers experience as a certain minimum competence for using digital technologies. This seems to be a dilemma. There also seems to be a need for the research community to inform stakeholders at policy level about such a dilemma. In terms of communicating research results, the current review can be regarded as one way of addressing the discussion.

The second theme, “Uptake and use of digital technologies in relation to *school organization and school leadership*”, seems to be problematic in relation to the readiness of primary and secondary schools to implement and take advantage of the technologies in everyday practice. There seems to be a need to re-address the role of digital technologies within the school as an organization. Before starting any development work, teachers and leaders should ask themselves what kind of improvements they really want or need and how digital technologies might support them. A critical question might also be asked, namely why should digital technologies be an obvious part of the school organization and the learning activities? In addition, school leaders need to consider how to steer or support the uptake of digital technologies and to acknowledge that the social context and institutional culture in their school are vital to successful implementation. Bearing in mind that technology uptake also seems to be a highly expected activity on the part of the surrounding society, including at policy level, school leaders may experience the work of technology implementation as challenging and difficult. The fact that their work is embedded in a complex and multi-dimensional educational context that is characterized by conflicting interests and dilemmas, goals and policies (Achinstein, 2006; Frelin, 2010) makes it difficult to lead the school in a rationalistic way. In the light of this, we can only conclude that the institutional aspects of digital technologies in organizing and leading schools need to be re-addressed as a research field (cf. Arnseth & Ludvigsen, 2006; Erstad & Hauge, 2011).

The third theme, “Uptake and use of digital technologies in relation to *teachers and teachers’ professional development*”, is just as complex as the two previous themes. The review includes teachers’ use of and beliefs about digital technology in relation to the subjects they teach and to their own professional development. Some of the research studies reported can be characterized as complex, while others adopt a more critical approach and some take a more normative stance when presenting models for the successful uptake and use of digital technologies. A broad and to some extent heterogeneous picture has emerged. However, in the research studies reviewed, the crucial role of teachers is commonly agreed on. Inspired by Säljö’s (2010) reasoning, in this third theme we conclude that the use of digital technologies in schools needs to be researched further in order to provide a deeper understanding of the learning and teaching they can enhance. Less focus may be needed on digital technologies in emerging learning and teaching practices, and more focus might be preferable on digital technologies as driving forces for this development. Further, there appears to be a need for continuing research into teacher beliefs regarding the uptake and use of digital

technologies in classrooms and on teachers' related professional development (cf. Kirkwood and Price, in press).

Regarding the fourth and last theme identified in the literature review, "Uptake and use of digital technologies in relation to *students*", it is interesting to note that SES is a theme that warrants further investigation. The larger societal surrounding seems to have an impact on the uptake and use of digital technologies and indeed also frames the possibilities and patterns of their use in primary and secondary schools. In addition, some of the research studies in this theme report on how to come to terms with inequalities concerning students' use of digital technologies, in a short-term, long-term and life-long perspective. We conclude this fourth and final theme by pointing out that the use and flow of digital technologies across and between school, home and other spaces seems to need further research. For example, questions that need to be asked include: Are there differences in SES with regard to what kind of Personal Learning Environments (PLEs) the students create and use? Are there differences in how these PLEs inform students' learning in the classroom? To what extent do the PLEs support the students for living in today's society or the society of tomorrow? This could be understood as a challenging but important task for researchers and practitioners in a primary and secondary school context.

To conclude, we will address the second strategy outlined in this article. Through the lessons learned we would like to provide some additional suggestions for future research, especially with regard to the knowledge-gaps that still need to be closed. Here it should be said that a rather complex and fragmented picture of the research has evolved through the literature review. Different aspects and issues concerning the uptake and use of digital technologies in primary and secondary schools are focused on, also at policy level. In general, the research concerns schools and schools as organizations and seems to be concerned with all aspects, including a research focus on individual students, their beliefs, attitudes and academic achievements. In addition, the articles inform us that on the one hand the research design can, or should, include large-scale surveys, and on the other hand include small information-rich cases. In addition, future studies should have a more precise focus on the uptake and use of digital technologies, and/or adopt a holistic approach that encompasses structural as well as cultural aspects.

Against the background of this understanding, we would like to make some suggestions for the future. Firstly, despite the rather extended body of research, there seems to be a need for research on each of the four identified themes that is also related to the results generated in the other themes. Future research studies should also to be better informed about previous research than appears to be the case at present. In addition, such studies ought to explore research areas that have not yet been thoroughly investigated. Here, research that is sensitive to the rapid development of digital technologies would be valuable. Secondly, there seems to be a need for more longitudinal and information-rich research studies. Although such studies may not generate results that apply to all schools in all countries or in a greater context, such as the European Union, this research could provide results that pave the way for developmental discussions about the uptake and use of digital technologies in primary and secondary schools. If this is not prioritized, the risk is that future research will continue to report a picture that is already known. Thirdly, we suggest that future research should stretch beyond the current situation by experimenting with new theoretical and methodological ways of designing and analyzing the studies in this field. One example of such a methodological approach would be to adopt a multilevel focus that takes into account the various stakeholders in primary and secondary schools. The use of a multilevel methodology may produce research results that allow each set of school stakeholders to feel that their stake is being addressed.

A multilevel methodology approach could also produce new insights into the uptake and use of digital technologies in schools and in education, how technologies are constructed and how knowledge develops in the use. Such an approach could help to address the complexities of the interactions between policy, strategic leadership, teachers and students, and probe more deeply into how the use of digital technologies can be understood in terms of the learning and teaching they enhance in primary and secondary schools.

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