Concept-guided development of classroom use of ICT

Concept-specific types of ICT use and their integration into teachers' practices

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Publication date
2017
Document Version
Other version
License
Other

The field of educational technology research continues to struggle with the shifting landscape of technology integration in teaching and learning. […] Yet, the interplay and complexity of technology integration continues to be elusive.

Howard & Thomson, 2015, p. 3

Technology can amplify great teaching but great technology cannot replace poor teaching.

OECD 2015

Chapter 1 General introduction

This thesis presents four studies exploring whether concept-guided development of ICT use in education is a promising approach to integrate technology into teachers' practices in a meaningful way. This technology use can entail anything from practicing skills or web searching with the use of (desktop, laptop or handheld) computers to watching videos on an interactive whiteboard or learning in a virtual reality setting, playing simulation games et cetera. While the possibilities for using technology to support and enhance learning and teaching are increasing fast and great investments are made by governments and schools to take full advantage of these possibilities, the adoption and integration of technologies lag behind the aspirations. This has been the subject of many studies over the past three decades, leading to different types of suggestions for a solution. One approach that has been proposed is the concept-guided development of technology use by schools, an approach in which the school's educational concept functions as the main starting point for the development of the school's technology use. In this thesis four studies are presented in which we explored how this approach was carried out in a project in which five primary schools in the Netherlands with different educational concepts participated and the resulting technology use in the participating schools.

Conceptual framework

Digital technology in the classroom

Educational technology has been a major focus of interest of educators, school leaders and researchers over the past thirty years. It is also referred to as classroom technology, information and communication technology (ICT) in education or ICT for education

(ICT4E). Technology can be roughly divided into technology used in schools to support teaching and learning or to support the school's administrative processes. This dissertation focuses solely on the former.

Since the introduction of the first personal computers in the classroom in the 1980's – e.g. the ACOT project (Dwyer, Ringstaff, & Sandholtz, 1991) or the 100-schools project in the Netherlands (Voogt & Ten Brummelhuis, 2014) – schools today can choose from an abundance of tools with applications for myriad educational purposes. These tools include both hardware, like desktop, laptop and handheld computers, digital cameras and interactive whiteboards, and software, like educational and off-the-shelf software programs, virtual reality, information from the internet, and communication and collaboration tools (Web 2.0).

Rationales for ICT-supported teaching and learning

In the literature a number of reasons can be found for using or promoting the use of educational technologies. One rationale behind the promotion and adoption of technology in classroom practices is the omnipresence of digital information and communication technologies in our everyday lives today. According to a recent study from Pew Research Center nearly 75 per cent of teens aged 13 to 17 in the United States have or have access to a smartphone. 91 per cent of teens go online from mobile devices at least occasionally and of these teens 94 per cent go online daily or more often (Lenhart, 2015). Research in the Netherlands shows even higher rates. Here 99 per cent of teens aged 13 to 18 has a mobile phone, 98 per cent of these are smartphones. Laptops and tablets are used daily by about 35 per cent and a couple of times a week by about 30 per cent (Kennisnet, 2015). The fact that technology has become such a self-evident part of young people's lives leads some to argue that it would be an anachronism not to include a similar level of 'technofication' in the school place (Hammond, 2014).

Closely linked to this is the argument that to be able to function in such a computerised, digitalised information or knowledge society, one needs digital and information skills and schools should take an active role in helping students develop these skills. Both at

work and in our private lives we need to be able to handle digital devices and to handle and process the continuous streams of information that reach us constantly and from all directions (Anderson, 2008; Voogt & Roblin, 2010). Despite the fact that children today grow up with digital technology as a self-evident part of life, it has already become clear that these 'digital natives' do not automatically develop digital skills automatically (Bennett, Maton, & Kervin, 2008). In addition to these technology-related skills also the development of other '21st century skills' such as collaboration and self-regulated learning are believed to be supported and promoted by the use of learning technologies (Aesaert, Vanderlinde, Tondeur, & van Braak, 2013; Dede, 2010; Lemke, Coughlin, & Reifschneider, 2009; Voogt & Pelgrum, 2005; Voogt & Roblin, 2012).

A third rationale behind the promotion of educational technology derives from its – not undisputed – potential to improve learning processes, by making teaching and learning either more efficient, more motivating and/or better fit for the ways in which today's students tend to learn. Technology can help teachers to deal with diversity among students (e.g. Heemskerk, Volman, ten Dam & Admiraal, 2011) and to make lessons more interactive (Smith, Higgins, Wall, & Miller, 2005; Kennewell, Tanner, Jones, & Beauchamp, 2008). The use of technology in the classroom has been found to lead to more engaging learning activities (Bransford, Brown, & Cocking, 2003; Deany, Ruthven, & Hennessy, 2005; Balanskat, Blamire, & Kefala, 2006) and to more effective education with better learning results (cf. Archer, Savage, Sanghera-Sidhu, Wood, Gottardo, & Chen, 2014; Cheung & Slavin, 2012; Cheung & Slavin, 2013; Kulik 2003; Lemke, Coughlin, & Reifschneider, 2009; Li & Ma 2010; Webb & Cox, 2004). There are also studies, however, that have shown no such effects or even the contrary. An OECD study recently suggested that moderate use of computers at school may lead to 'somewhat better learning outcomes' than rare use of computers, while very frequent use is associated with much lower learning outcomes (OECD, 2015). Despite this ambiguity in the literature the (alleged) power of technology to enhance learning processes and outcomes continues to be a persuasive rationale behind the promotion of its use in the classroom.

Challenges to the integration of technology use in the classroom

From each of these perspectives – the omnipresence of ICT, the need for digital and other 21st century skills, and the improvement of learning processes – the promise of classroom technology is high and for decades now both policy makers, school leaders and teachers have made efforts to fulfil this promise. Considerable investments have been made to promote and facilitate technology use, but nevertheless the actual integration of technology use in most schools still does not live up to the expectations (Lemke et al., 2009; OECD, 2015). In general the integration of classroom technology use means that the technology use becomes an integral part of how the classroom functions, i.e. that it becomes as accessible as all other classroom tools (ISTE, 2002), or, in other words, that it becomes a natural element in classroom practice (Vanderlinde & van Braak, 2010). Integration can be described at the level of the individual teacher (i.e. integration into teachers' practices), at the level of the school (i.e. integration into the school organisation and curriculum) or at the national level (i.e. integration into the national curriculum). Several factors have been identified that either promote or hinder the actual implementation and integration of technology use into teachers' practices. One of the factors at the level of the teacher are teachers' ICT-related competencies. These include knowledge, training, teachers' readiness for ICT integration, and their beliefs, ICT attitude, and ICT skills (Ertmer, 2005; Hew & Brush, 2007; Inan & Lowther, 2010; Pelgrum, 2001; Tondeur, Hermans, van Braak, & Valcke, 2008; Van Braak, Tondeur & Valcke, 2004; Ward & Parr, 2010). Factors at the school level include issues of ICT infrastructure, time, and provision of training and support (Hew & Brush, 2007; Inan & Lowther, 2010; Pelgrum, 2001; van Braak et al., 2004; Ward & Parr, 2010), ICT coordination and school-wide ICT integration planning (Hew & Brush, 2007; Vanderlinde, van Braak, & Hermans, 2009). The integration into the teacher's practice and into the school organisation and curriculum have been shown to be interdependent. While a digital school infrastructure is obviously necessary for teachers to integrate ICT into their classroom practices, it is not sufficient; even when the necessary tools are available in the classroom teachers do not necessarily use them (Inan & Lowther, 2010). A condition that concerns both the teacher level and the school level

is the educational concept of the school. The term 'concept' in this context refers to the educational views (values, beliefs, perspectives) on which a school's classroom practices are based. Research suggests that a good fit between the educational concept of the school and the ICT use that is aimed at is another important condition for the successful integration of ICT into educational practices. Zhao, Pugh, Sheldon and Byers (2002) describe this in terms of the distance between the ICT innovation (i.e. the intended ICT use of the school) on the one hand, and the school's educational culture and practice on the other hand. A short distance between the innovation and the school's culture and practice promotes successful ICT integration. Similarly, Tolmie (2001) finds that how and with what learning effects ICT resources are used, depends on how well they fit in with the established patterns of activity. According to Niederhauser and Stoddart (2001) teachers are inclined to apply technology in a manner that is consistent with their personal perspectives about curriculum and instructional practice. Such findings have led to a shift in the literature from a focus on the technology and its opportunities for teaching and learning to a focus on pedagogical aspirations and the ways in which certain technologies can support these (Ertmer & Ottenbreit-Leftwich, 2013; Kampylis et al., 2013; Kirkwood & Price, 2005; Lewin & McNichol, 2015; Mor & Mogilevsky, 2013; Ten Brummelhuis & Kuiper, 2008).

Sustainable integration of technology use

In order for innovations in education to lead to the intended effects they need to be sustained over a longer period of time (Jerald, 2005). In other words, newly developed technology use needs to be integrated and this integration also needs to be sustainable. One aspect of sustainability of an innovation that has received attention in the literature on educational innovations is longevity, i.e. the extent to which an innovation lasts over time (Datnow, 2005). According to Jerald (2005) an innovation, in order to be sustainable, also needs to be extended to 'next generation improvements' and, over time, to be adapted to the school's changing needs and possibilities.

Based on the literature on integration and sustainable integration of technology use we propose that the sustained integration of technology use (in general and/or of one

specific use of technology) that supports learning is the ultimate goal of development of technology use.

Concept-guided development of technology use

Consistent with the arguments for promoting a favorable fit between the educational concept of a school and its technology use, this study proposes a concept-guided approach to developing technology use. The term educational concept in this respect encompasses both the school's pedagogical practices and the beliefs and perspectives that motivate these practices. Central to the concept-guided approach is that the school's educational concept functions as the main starting point for developing its technology use. Classroom technology is often used explicitly as a lever to transform teaching and learning into constructivist classroom practices (Ertmer, 2005; Vanderlinde & van Braak, 2010), yet studies have shown that teachers tend to use technology in ways that fit their pedagogical approach (Niederhauser & Stoddart, 2001; Tolmie, 2001; Zhao et al., 2002). The concept-guided approach aims to use this mechanism in order to develop technology use that can support classroom practices without necessarily transforming them.

This is especially relevant in countries with a decentralised educational system like in the Netherlands, with only a general national curriculum and a considerable amount of freedom for schools to decide how to realise this curriculum. A concept-guided approach can contribute to developing technology use that fits the variety of educational concepts in such a system. By focusing first on what is pedagogically desirable (i.e. what type of teaching and learning is aimed at) in a particular school, before investigating what technology might promote this, the developed technology can be expected to reflect the school's educational concept and to be more successfully integrated. There have not been any studies so far that have investigated to what types of technology use this approach can lead in schools with different educational concepts and to what extent such a concept-guided approach to technology development would lead to lasting, i.e. sustainably integrated technology use.

Context of this study

The four studies presented in this thesis were performed in the context of a project[1] in which five primary schools in the Netherlands developed technology-enhanced learning arrangements in a concept-guided way. The learning arrangements were realised in the course of two school years. The literature shows that ICT can support a variety of educational concepts (Niederhauser & Stoddart, 2001; Inan et al., 2010; Higgins & Spitulnik, 2008). Both individual and collaborative and both learner-directed or teacher-directed learning can be supported by ICT (Ten Brummelhuis & Kuiper 2008) and ICT can facilitate the individualisation of learning processes as well as support learning within a learning community (Volman, 2005). In order to explore the impact of a concept-guided approach to the development of ICT use in a variety of school types the schools participating in this project were selected based on their educational concept. Two schools had an educational concept that was labeled as 'traditional', which refers to a fixed curriculum and a strongly teacher-directed approach. Three schools were labeled as 'innovative', indicating a more open curriculum and a student-centred approach. All schools were already using ICT to support teaching and learning, yet were aiming at more intensive and/or more effective ICT use. The schools are described in more detail in the following chapters. Table 1.1 shows an overview of the participating schools and the grades that were involved in the learning arrangements. The first two schools are the schools that were labelled as 'traditional', the other three schools as 'innovative'.

Table 1.1. Overview of participating schools and classes

School name	*Grades involved in learning arrangements 1 to 4*			
	1	*2*	*3*	*4*
Princess Amalia	5/6	3	6	3
Alma Mater	1/2	2	6	K (age 4-5 yrs)

[1] This was called the Cumulus project, initiated by educational consultancy company APS and financed by the Dutch public organisation for education & ICT Kennisnet and APS. VU University Amsterdam and HAN University of Applied Sciences supplied the research staff.

The Beehive	2/3/4	5/6	3/4 + 5/6	2
Queen Beatrix	4/5/6 (2 classes)	4/5/6	4/5/6 (2 classes)	-
Beech Grove	2/3/4 (4 classes)	2/3/4 (2 classes)	-	-

Note: all the learning arrangements were studied in one class (with one teacher and one or more grades), unless stated otherwise.

In the course of two school years a team of teachers at each school was involved in the project. The teams included two to eight teachers at a time and the teachers participated on a voluntary basis. Each team was supported in designing and implementing up to four technology-supported learning arrangements of their own choosing. A learning arrangement would consist of a lesson plan, including learning goals, tools and activities, and could concern any school subject. The technology use in a learning arrangement could entail anything from the use of 'drill-and-practice' software to the use of a wide range of technological tools to support a variety of learning activities in an enquiry-based project. The teachers were coached by educational consultants from the educational consultancy organisation that participated in the project (see note 1). At the start of the project consultants with expertise concerning processes of educational innovation helped the teachers reflect on their school's educational concept and their school's ambitions for intensifying its use of technology in line with this concept. Based on this reflection the learning arrangements were designed as the teachers saw best fit. They were supported in choosing technology for these arrangements by advisors with expertise in the field of educational technology. The teacher-as-designer approach was expected to favourably affect the implementation and integration of the designed learning arrangements by installing a sense of ownership in the teachers (Handelzalts, 2009; Ketelaar, Beijaard, den Brok, & Boshuizen, 2013; Maher, 1987). No specific limitations were set with regard to the ICT tools that were to be used, the duration of the learning arrangement or the type or frequency of ICT-supported activities. The schools were supplied with the necessary ICT tools. At three moments during the project all participants – i.e. teachers, school leaders, consultants and researchers – gathered to

discuss the proceeding of the project. Plans and experiences were exchanged and preliminary research findings were presented and discussed.

General research problem and questions

The four studies presented in this thesis all have an explorative character as the proposed concept-guided approach to technology integration was new and no previous studies of this type of technology development and integration had been performed so far. The overarching purpose of these studies was to investigate whether concept-guided development of ICT use in education is indeed a promising approach, by exploring how this approach was carried out in the project with five primary schools and the integration of the resulting technology use in the participating schools. All studies focused on the level of the participating teachers and their classrooms. The overarching research question was:

To what extent does a concept-guided approach in schools with either a 'traditional' or an 'innovative' educational concept contribute to the development of ICT use that becomes integrated into the teachers' classroom practices?

In order to answer this question we focused on four sub questions. The first two questions concern the technology use that resulted from the concept-guided approach in the participating schools, both comprehensively (question 1) and more specifically, focusing on the use of the interactive whiteboard (IWB) (question 2). The next two questions focus on the integration of the developed technology use in the teachers' classroom practices (question 3) and its sustainability after the project ended (question 4). The questions were formulated as follows:

1. *To what extent does concept-guided development of ICT-enhanced learning arrangements in primary schools lead to distinguishable types of ICT use?*
2. *What types of classroom interactivity does the interactive whiteboard support in 'traditional' and 'innovative' schools that develop their ICT use in a concept-guided way?*

3. *How can the achieved integration of technology in 'traditional' and 'innovative' schools that develop their use of technology in a concept-guided way be characterised in quantitative and qualitative terms?*
4. *a. Which technology use that was developed during the project was sustained, i.e. was still visible in the school one year after the project had ended?*
   b. Was the technology use developed further during the year after the project, and if so: how?

Methodology

Studies 1 and 2: exploring the types of ICT use

The first two studies focused on describing the technology use that resulted from the concept-guided approach in the participating schools. A total amount of 17 learning arrangements were realised across the five schools over the course of the project. In order to answer the research questions of studies 1 and 2 we analysed extensive data about these learning arrangements, that were gathered in the context of a practice-based research in which teachers and researchers cooperated . For each learning arrangement the teachers formulated their aims and expectations with regard to the learning arrangement, in the form of 'working hypotheses', e.g. 'Interactive spelling lessons with the interactive whiteboard make the lessons more motivating and increase learning results'. Based on these working hypotheses two or more research questions were formulated by the researchers for each learning arrangement, in cooperation with the involved teachers. In addition to these research questions that mostly focused on learning motivation and results, for each learning arrangement a research question was formulated that focused on how the technology was used in the learning arrangements. The main sources of data in most learning arrangements consisted of lesson observations and teacher interviews. The other research instruments that were used included pupil interviews, learner reports, teacher diaries, pupil diaries, and other documents, like teachers' planning documents or software manuals, depending on the nature of the working hypotheses and subsequent research questions. Based on these

data a report was written by the researchers and member checking with the teams of teachers involved was used to verify – and if necessary correct – the initial analyses (Lincoln & Guba, 1985).

The first study presented here focused on the types of ICT use that were developed at the participating schools. In this study each school represented one case while the learning arrangements were studied as embedded sub cases (Yin, 2009). The main data for this study were the reports and some of the raw data of the practice-based research described above. The reports were subjected to content analysis (Huberman & Miles 1994) and finally a cross-case analysis per school type enabled us to find patterns in the ICT use related to the school types, in terms of the ICT tools that were available and used in each learning arrangement, the goals with which these tools were used and the activities that were performed with these tools.

In the second study, which focused on classroom interactivity with the IWB, video observations that were part of the data collection of the practice-based research were used. Observations of six lessons in six different classes at four of the participating schools were analysed. The interaction with the board was described in terms of teacher or student-led control of the operation of the board and of the content on the board. The dialogue that occurred while using the board was described in terms of the teaching and learning model apparent in the dialogue, i.e. either focusing on knowledge transmission or knowledge construction. In a cross-case analysis these descriptions were compared in order to find possible patterns of interactivity per school type (Miles & Huberman, 1994).

Studies 3 and 4: integration of developed ICT use

In our next two studies our focus shifted to the integration and sustainability of the developed technology use. For these studies the main source of data were semi-structured focus group interviews that were held at regular intervals with teachers at all five schools during the project and at two schools one year after the project had ended. The interviews followed the same interview protocol at each school. The interview protocol was not directly connected to the working hypotheses concerning the learning

arrangements, instead focusing on more general topics. These topics concerned the teachers' participation in the project (e.g. 'what are your experiences with the project so far?'), the technology that was used, and the role it played in the school's classroom practice, (e.g. 'to what extent are teaching and learning supported by technology in your school?'). The focus groups at each school consisted of two to eight teachers who participated in the development and/or the realisation of one or more learning arrangements. At all schools at least two to four interviews were held, at the beginning and end of the first year of the project, at the end of the project (end of year 2) and at two schools a fourth interview was held a year after the project had ended. For the third study, which focused on the achieved integration of the developed technology in quantitative and qualitative terms, the quantitative character of the achieved technology integration was captured through summarizing the number or different tools that were used in the learning arrangements and how many computers were available per class. This was based on the reports of all 17 learning arrangements described earlier. The qualitative character of the achieved technology integration was captured by analysing the focus group interviews with regard to how the teachers themselves perceived and valued the developed technology use in their schools. For the fourth study the third and fourth focus group interviews were analysed from the two schools that were visited one last time a year after the project had ended. The teachers' accounts in the focus group interviews were checked against the descriptions of the learning arrangements at these two schools in the reports. The focus group interviews were transcribed and subjected to content analysis (Huberman & Miles, 1994). A comparison was made between the schools with regard to the found sustainability and grounded theory (Glaser & Strauss, 1999) was used to explore possible explanations of the differences that were found.

Together these four multiple case studies give us a comprehensive and informative overview of different aspects of the technology use that was developed in a concept-guided way by the participating schools. An overview which adds to the existing literature on educational technology and which also has practical implications, both for teachers aiming at improving teaching and learning with technology and policy makers

who need to create the necessary conditions. These implications are discussed at the end of each of the following chapters and in the final chapter.

Dissertation outline

The four studies that are reported in this thesis are clustered into two parts. The studies in Part I focus on the technology use that was found in the learning arrangements that the schools developed, answering the questions: does it lead to distinguishable types of technology use? (first study, chapter 2) and does the IWB support different types of interactivity in schools with different educational concepts? (second study, chapter 3). The studies in Part II focus on the integration of this technology use into the schools' classroom practices, answering the questions: how can the integration achieved by the end of the project be characterised? (third study, chapter 4) and what technology use is sustained after the project and is it developed further? (fourth study, chapter 5). In chapter 6, Conclusion and Discussion, the findings from these four studies are summarised and discussed in order to answer the overarching question. Both practical and theoretical implications of these findings are discussed and suggestions for further research are given.