

Digital technologies in preschool education

Dedication to my husband and children Yasmin & Ayla

Örebro Studies in Education 62



MARYAM BOURBOUR

Digital technologies in preschool education
The interplay between interactive whiteboards and teachers'
teaching practices

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Abstract

This thesis is aimed at exploring the ways in which a digital technology, the interactive whiteboard (IWB), interplays with preschool teachers' teaching practices. In the literature and ongoing debates there are different claims about if and how digital technologies can contribute to children's development and solving preschool educational challenges. The ways children learn from and by digital technologies have been widely studied, however, there is relatively little research on how digital technologies interplay with teachers' teaching. Correspondingly, the approach taken here to the ways in which digital technologies contribute to early childhood education is based on preschool teachers' practices and reasonings. In particular the focus is placed on the following research questions. How do preschool teachers reason about the embedding of IWB into their teaching practices? How do preschool teachers use IWB to structure their teaching practices? How do preschool teachers scaffold children's learning processes in a context where IWB is used? How do IWBs mediate teaching actions? and What is privileged in the IWB-mediated teaching actions?

To address these research questions, three sets of empirical data have been collected. These datasets, including interviews with preschool teachers and video observations of their teaching using IWB, were collected in 2012-2013 within the frame of the licentiate thesis and in late 2017 and early 2018 within the framework of the PhD thesis. Analytically, the study is built on a sociocultural perspective that assumes that learning is a constant social process.

The findings of this study provide empirical knowledge regarding how preschool teachers reason about their use of IWB in teaching. The findings of the study, further, show that preschool teachers use diverse strategies to structure their teaching practice using the opportunities that IWB offers. The teachers' use of IWBs exemplifies the ways they take into account the available technological features to support children's learning within their ZPD.

In its identification of scaffolding actions, this study provides rich details about how preschool teachers use a particular digital technology, IWB, in their teaching to support children's learning and development. Scaffolding is seen as a collaborative process where preschool teachers' active participation and emotional support plays an important role in fulfilling the given practices, and leads children's learning to a higher level. By exploring how teachers' teaching actions are mediated by the mediational aspects of IWB and what is privileged in the IWB-mediated teaching actions, the current study, moreover, contributes to mapping the desirable or undesirable consequences of using digital technologies in early childhood education. It also exemplifies how the use of IWB interplays with preschool teachers' teaching practices.

The new dimensions to scaffolding theory constructed in this thesis, further, contribute to expanding of Wood et al. (1976) theory. This can have significance for other studies using digital technologies in educational settings and can contribute to early childhood education, since early interventions, such as the ways preschool teachers support children, are particularly crucial for a child's learning and their development later on in life.

Keywords: Preschool Teachers, Digital Technologies, IWB, Teaching, Children, Preschools, Scaffolding, Mediational Means and Mediated Actions

Maryam Bourbour, School of Humanities, Education and Social Sciences
Örebro University, SE-701 82 Örebro, Sweden, mabo@du.se

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This compilation thesis is based on the following four articles:

Article I

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Article II

Bourbour, M., Vigmo, S., & Pramling Samuelsson, I. (2014). Integration of interactive whiteboard in Swedish preschool practices. *Early Child Development and Care*, 185(1), 100-120.
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Article III

Bourbour, M., Högberg, S., & Lindqvist, G. (2019). Putting scaffolding into actions: Preschool teachers' actions using Interactive Whiteboard. *Early Childhood Education Journal*, 47(5), 1-14
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Article IV

Bourbour, M. (Submitted manuscript). Using digital technology in early childhood education teaching: Learning from teachers' teaching practice with Interactive Whiteboard.

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Gävle, February 2020
Maryam Bourbour

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1. INTRODUCTION

The starting point for this thesis is an interest in the challenges and issues that preschool teachers face when digital technologies are introduced into the preschool environment. By focusing on preschool teachers and their teaching, this thesis aims to explore the interplay between a digital technology, the interactive whiteboard (IWB), and preschool teachers' teaching practices.

Early childhood education should create a rich educational environment to ensure that all children receive equal opportunities to develop their skills in the first stage of the educational system (Sheridan & Williams, 2018). Preschool teachers' teaching is an important part of preschool education. There is an ongoing discussion about teaching in preschool and the ways that teaching can be translated into preschool educational practices. Some voices express caution about the schoolification of early childhood education and preschool educational practices that increasingly focus on preparing children for school (UNESCO, 2010). Other voices see teaching in preschool as an integrated part of early childhood education. This discussion has been recalibrated with the recent change in the Swedish curriculum for preschool (The Swedish National Agency for Education, 2018) in which teaching in preschool is described as a goal-oriented process which should "take place under the leadership of preschool teachers and promote the children's development and learning through the acquisition and development of knowledge and values" (p. 20). According to the curriculum, care, development and learning should form a whole where care, development and learning are integrated in preschool education. The curriculum requires that preschool teachers' teaching practices should be based on children's needs, experiences, and interests.

Educational settings in the modern world have been affected by a number of developments and changes (Selwyn, 2012, 2017). The process of globalization, the need for a skilled workforce, changing modes of knowledge production, the expanding area of children's rights, greater sensitivities to equality and gender issues, and emerging digital technologies in the age of artificial intelligence, have all placed considerable pressure on the composition of modern education. The rapid diffusion and uptake of digital technologies as a central agent of change has fueled the growth of the information age and a knowledge-based society that is, in turn, triggering the transformation of social structures and institutions. Such transformation is fundamentally changing how we live, work and communicate (Castells &

Cardoso, 2006; Lambropoulos & Romero, 2010; Selwyn, 2013; 2017). These technologies have also changed the way our children play, communicate and learn (Cuban, 2018; Morgan, 2010; Nikolopoulou, 2014; Plowman & Stephen, 2003; Roumbanis Viberg, Forslund Frykedal & Sofkova Hashemi, 2019; Siraj-Blatchford & Siraj-Blatchford, 2006; Yelland & Kilderry, 2010). Reflecting advances in digital technologies, educational settings across the globe have adopted these technologies as a promising solution to a number of their educational challenges (Collins & Halversson, 2018; Cuban, 2018; Selwyn, 2010, 2012, 2017).

As a result, preschools and schools have experienced an exceptional increase in the availability and use of digital technologies. It is assumed that integrating these technologies into educational settings can better prepare children for the ever-changing information and knowledge-based society (Plowman & Stephen, 2003; Selwyn, 2012, 2017; Siraj-Blatchford & Siraj-Blatchford, 2006). The findings of a number of studies report educational benefits of using digital technologies in preschools' and schools' teaching and learning process (Fridberg, Thulin & Redfors, 2017; Jahnke & Kumar, 2014; Lindahl & Folkesson, 2012). One thing that is highlighted is that using these technologies to their full potential can contribute to educational practices (Collins & Halversson, 2018). It is also claimed that integrating digital technologies can ensure no child is "left behind in the rush for technological expertise" (Cuban, 2001, p. 12). However, there have been counter claims that this positive view of technology is advocated by research known to be aligned with the commercial interests of for-profit entities (Cuban, 1986; Lantz-Andersson & Säljö, 2014). The research behind opposing views has been more critical of digital technology in the classroom, showing that the technology also brings in new challenges and undesirable consequences (Selwyn, 2012). Taken together, these rival opinions reflect ongoing debates about the impact of digital technologies on early childhood education (see Dunkels, 2019; Hedwall, 2019; Lernfelt, 2019).

Initiatives encouraging the introduction of digital technologies into preschool settings are driven by the Council of Europe, which in 2004 described digital competence as one of the key competencies for lifelong learning (European Parliament and the Council, 2006). In turn, the Swedish National Agency for Education has underlined the importance of digital technology in preschool educational practices, and states in the curriculum (2018) that "Education should also give children the opportunity to develop adequate digital skills by enabling them to develop an understanding of the

digitalisation they encounter in everyday life” (p. 10). The curriculum further encourages preschool teachers to structure the preschool learning environment so that digital technologies are used in a way that supports and motivates children’s development and learning. In accordance with these curriculum guidelines, Swedish preschools and schools have invested significantly in interactive whiteboards, tablets, and other digital technologies to be integrated into preschool educational practices (Hvit Lindstrand, 2015; Marklund, 2015; Nilsen, 2018; Walldén Hillström, 2014). The increasing availability and growing use of digital technologies in preschool, such as IWB, places new demands on preschool teachers to support children’s development appropriately (Otterborn, Schönborn & Hultén, 2018).

The integration of digital technologies into preschool educational practices has, as mentioned earlier, been challenged. There are many examples of initiatives looking to introduce digital technologies into educational settings which have failed to become the panacea some assumed they would be (Cuban, 2001; Selwyn, 2012). Many of the claims made about effects of digital technologies on preschool education are not grounded in robust and rigorous methodologies (Kjällander, 2011, 2019; Marklund, 2015) and there is a lack of evidence to show that digital technologies are effectively integrated into educational practices (Blackwell, Lauricella, Conway & Wartella, 2014; Keengwe, Onchwari & Wachira, 2008). Furthermore, when a digital technology is introduced, there is often a “great deal of initial interest and much enthusiasm about the effects it is likely to have on instructional practices. However, enthusiasm and interest eventually fade, and an examination reveals that the medium has had a minimal impact on such practices” (Reiser, 2001, p. 62).

Digital technologies can then appear oversold and underused (Cuban, 2001; Selwyn, 2012). In many educational settings the underlying pedagogies and teaching procedures seem hardly changed. The introduction of these technologies may even bring in new forms of inequality and bullying, which can challenge educational achievements (Mascheroni & Ólafsson, 2016; Selwyn, 2012, 2017). A growing body of literature (see Domingues-Montanari, 2017; Levin, 2011; Lissak, 2018), suggests that the introduction of digital technologies into early childhood education can challenge children’s emotional and sensory motor development which can have neurological, physical, psychological, and socially adverse consequences for children. In a similar fashion Levin (2011) argues that “children are being remote controlled by the scripts of others (television, videos, electronic toys), instead of coming up with their own unique stories and problems to solve” (p. 61).

A range of concerns associated with introducing digital technologies into preschool have accordingly been voiced in the published literature. Therefore, challenges about the actual usefulness of digital technologies and the ways these technologies may affect educational practices can be seen as key questions for teachers, stakeholders and policymakers. Earlier studies have indicated that a large number of preschool teachers do not use the opportunities that digital technologies offer in early childhood education (Blackwell, Lauricella, Conway & Wartella, 2014; Keengwe, Onchwari & Wachira, 2008). It is often indicated that using digital technologies in a meaningful way depends on how teachers adopt these technologies (Camilleri, 2018; Sinclair, 2009). In other words, digital technologies are just tools to be used and will not necessarily transform the preschool educational practices per se (Camilleri, 2018; McGarr, 2009; Plowman & Stephen, 2007, 2013).

Within the field of early childhood education research, the preschool teachers' role in designing and developing educational opportunities using digital technologies is particularly underlined (Ljung-Djärf, 2002, 2004; Nikolopoulou, 2014; Nir-Gal & Klein, 2004; O'Hara, 2004; Plowman & Stephen, 2007, 2013). This literature has highlighted a gap between the availability of digital technologies and preschool teachers' use of the technologies in preschool (see Ljung-Djärf, 2004; Masoumi, 2015; Palaiologou, 2016). The literature shows that many preschool teachers feel they are ill-prepared to implement digital technologies in their teaching practices. It also shows that teachers see digital technologies, at least in part, as a threat, a disruption of children's free play and a rejection of educare-based pedagogy (see Lindahl & Folkesson, 2012; Ljung-Djärf, 2008; Nilsen, 2018). On the other hand, teaching practices in early childhood education are often inspired by "embodied hands-on experience-based teaching and learning, often using aesthetic means of expression as a way [for children] to learn differently" (Taguchi, 2010, p. 23). As a result, the integration of digital technologies into preschool educational practices is slow and limited; as Palaiologou (2016) puts it, "there are still concerns as to whether digital devices have a place" (p. 306) in early childhood education.

On the other hand, there is a demand for and a pressure to integrate digital technologies into preschool goal-oriented practices (The Swedish National Agency for Education, 2018). In an increasingly digitalized society, it is becoming more and more important for preschool teachers to have the ability to create technologically-rich educational practices (Haelermans, 2017; Kjällander, 2019; Masoumi, 2015). However, little is known about

how digital technologies integrate into preschool educational practices. By addressing these challenges and taking into account current Swedish preschool curriculum reforms, this study wishes to examine how one particular digital technology, IWB, interplays with preschool teachers' teaching practices.

IWBs are often seen as a teaching artefact (Yang, Wang & Kao, 2012). They bring together a wide range of possibilities, and are argued to have the potential to extend preschool teachers' opportunities to support children's learning (see Gillen, Staarman, Littleton, Mercer & Twiner, 2007; Hvit Lindstrand, 2015). Despite the increasing number of international studies about the use of IWBs in schools and preschools (see Ahlbäck, 2018; Camilleri, 2018; Deaney, Chapman & Hennessy, 2009; Miller & Glover, 2010), there are still only a small number of Swedish studies that examine preschool teachers' use of IWBs.

In theoretical terms, this thesis is based on the sociocultural theorising on learning (Säljö, 2000, 2010; Vygotsky, 1978; Wertsch, 1991). By addressing the ways learning can take place, sociocultural learning theory maps how teaching practices can be structured and mediated in a specific context. An idea of how learning occurs is critical in structuring and forming the preschool educational environment and teachers' teaching practices. Within sociocultural theorising, teaching practices are close to what Mercer (1995) calls a guided construction of knowledge where teaching practices are mediated by physical and intellectual artefacts (that is, tools and signs in a particular context). Technological artefacts, from a sociocultural perspective, can extend our capabilities and enable us to reach beyond our limits. Wertsch (1997) introduced the concepts of mediational means and mediated actions to portray this process of using artefacts to scaffold children's learning and where technological artefacts can be appropriated by teachers in different ways.

1.1. Research aims and questions

The thesis aims to contribute to our understanding of the ways in which digital technology interplays with preschool teachers' teaching practices. Four research questions are posed in the study, each examining how a particular digital technology, the IWB, interplays with preschool teachers' teaching practices:

- How do preschool teachers reason about the embedding of IWBs into their teaching practices? (addressed in article I)

- How do preschool teachers use IWBs to structure their teaching practices? (addressed in article *II*)
- How do preschool teachers scaffold children's learning processes in a context where IWBs are used? (addressed in article *III*)
- How do IWBs mediate teaching actions? and What is privileged in the IWB-mediated teaching actions? (addressed in article *IV*)

1.2. Disposition of the thesis

The current thesis consists of two parts. The first part is made up of ten chapters. Chapter one introduces the thesis' theme and areas of knowledge. The second chapter presents a background to the specific research area and identifies some contextual ideas including teaching in preschool and the use of digital technologies in preschools. Chapter three provides a review of the literature about using digital technologies in educational practices. The fourth chapter gives an account of the theoretical framework used in this study.

In line with the study's aim, some of the concepts and premises of the socio-cultural approach to learning are discussed. Chapter five outlines the methodological approach of this study. It explains the process of conducting this study, including issues and problems in conceptualizing it, data collection methods, and ethical concerns. An account of the way the analysis was carried out is given. Chapter six provides an extended summary of the four written articles. This is then followed by a final discussion of the findings in chapter seven and the contribution of the study to the research field and the potential for future research. The last three chapters provide a short summary of the study in Swedish, the list of references and the appendices.

- Article *I*- Bourbour, M., & Björklund, C. (2014). Preschool teachers' reasoning about interactive whiteboard embedded in mathematics education in Swedish preschools. *Journal of Nordic Early Childhood Education Research*, 7(2), 1-16.
- Article *II*- Bourbour, M., Vigmo, S., & Pramling Samuelsson, I. (2014). Integration of interactive whiteboard in Swedish preschool practices. *Early Child Development and Care*, 185(1), 100-120. doi:10.1080/03004430.2014.908865
- Article *III*- Bourbour, M., Högberg, S., & Lindqvist, G. (2019). Putting scaffolding into actions: Preschool teachers' actions using

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2. BACKGROUND

This chapter acts as a background to the research area covered by this thesis and identifies some contextual ideas about teaching and digital technologies. Initially, a brief introduction about teaching in preschool as a complex concept will be presented. Then the nexus between digital technologies and early childhood education in Sweden will be provided.

2.1. Education and teaching in preschool

Preschool education became the formal first stage of the Swedish education system when it received its first curriculum in 1998. In 2010, preschool became a school form of its own within the Swedish educational system. According to the Swedish Education Act (SFS, 2010:800) preschool education should stimulate children's development and learning and offer children a safe care environment. Educational activities should be based on a holistic view of the child and the child's needs and be designed so that care, development and learning form a whole (SFS, 2010:800). Early childhood education is offered for all children aged 1- 5 years; more than 84% of all children – in this age range take part in preschool education (The Swedish National Agency for Education, 2018).

Swedish preschool education is grounded on a model that is internationally known as 'educare', which is recommended by the United Nations as a preferred approach (UNICEF, 2008). The educare model challenges the notion that care and education are separate components of early childhood education. This model provides a conscious balance between children's 'becoming' (meaning care, with its connotations of supporting children's natural development and learning) and pre-planned educational practices in line with educational goals (Doverborg, Pramling & Pramling Samuelsson, 2013).

Two broad approaches to early childhood education, as Bennett (2004) puts forward, can be identified: the pre-primary approach and the social pedagogic approach. The pre-primary approach promotes curriculum and goal-oriented practices where the cognitive as well as subject-related abilities necessary to prepare the child for school are underlined. In this approach preschool teachers play an active role in developing and organizing educational practices. The social pedagogic approach focuses on the child's centeredness, underlining the importance of children's interaction. Accordingly, early childhood education should be built on children's interests in order to empower them as active actors in their community. According to

Bennett (2010), the Scandinavian preschool tradition, and the Swedish one in particular are mostly aligned with the social pedagogic approach where the focus has been on play-based activities, children's identity and democratic education.

The Swedish Education Act characterises preschool education as an activity within which teaching is conducted on the basis of specific objectives (SFS, 2010:800). Education and teaching, are thus intertwined, although education can also be used as an umbrella term that includes teaching. In each of the official Swedish preschool curriculums (see Swedish curriculum for 1998, 2010 and 2018), a number of educational goals have been underlined. All children, accordingly, should be given the opportunity to develop their understandings and abilities independently and preschool teachers are expected to support and facilitate the achievement of these educational goals. However, the concept of teaching in preschool is only explicitly introduced into the curriculum for the first time in 2018 (The Swedish National Agency for Education, 2018).

The introduction of the term teaching into Sweden's preschool regulations can be seen to signify a kind of pedagogical change, which relates to the development of innovative teaching and learning strategies which have promoted awareness of teaching as a nuanced practice. These changes have led to the strengthening of preschool teachers' professional development and identity (Pihlgren, 2017; Vallberg Roth, 2011). Sheridan, Williams, Sandberg and Vuorinen, (2011) state that "historically, the meaning of teacher competence has changed and is continuously being re-constructed along with changes in society as well as with shifting values and intentions in preschool guidelines and curricula" (p. 415). Thus, teaching in preschool may be a new term in the legal regulations but is an old phenomenon which has been part of the preschool tradition since Friedrich Fröbel established his first kindergarten in 1826 (Fröbel, 1995/1826; Hammarström Lewenhagen, 2013). The 2018 Swedish preschool curriculum uses the concept of teaching to underline preschool teachers' educational responsibility.

Teaching means stimulating and challenging the children, taking the goals of the curriculum as a starting point and direction, and is aimed at encouraging development and learning among the children. Teaching should be based on content that is planned or appears spontaneously, as children's development and learning takes place at all times. Preschool teachers should be responsible for the educational content of teaching and for targeted work to promote development and learning in children (The Swedish National Agency for Education, 2018, p. 20).

Teaching, therefore, provides a road map which runs through the current curriculum and enables core values and educational goals of preschool to be seen. This signifies that teaching informs the curriculum's different aims including its core values of play, learning and care (Sheridan & Williams, 2018). Doverborg, Pramling and Pramling Samuelsson (2013) draw attention to the fact that teaching in preschool needs to be contextualized and attuned in relation to given activities, situations and contexts and that it can happen at any time and in any situation (indoor or outdoor). The interplay between preschool teachers, children and learning environments are key factors in organising teaching in preschool (Pramling & Pramling Samuelsson, 2011).

The previous Swedish curriculum for preschool, introduced in 2010 (The Swedish National Agency for Education, 2010), identified four knowledge domains which should be taken into account in preschool education: mathematics, natural science, language and technology. The current curriculum for Swedish preschools (2018) continues to endorse these four knowledge domains but suggests a more concrete approach in teaching them.

Teaching in preschool however, is a complex notion (Doverborg, Pramling & Pramling Samuelsson, 2013; Hedenfalk, Almqvist & Lundqvist, 2015; Pramling & Wallerstedt, 2019; Öqvist & Cervantes, 2018). On the one hand, the longstanding tradition of care and free play within a preschool environment inspired by the ideas of Friedrich Fröbel and Jean-Jacques Rousseau (Doverborg & Pramling Samuelsson, 2009; Sheridan & Williams, 2018) highlights children's free learning, development and becoming without any external steering. It, accordingly, can be argued that the character of teaching in preschool differentiates it from school education, and thus teaching in preschool should be organised and implemented according to the characteristics and needs of the preschool children (Doverborg, Pramling & Pramling Samuelsson, 2013). This approach to early childhood education is aligned with the social pedagogic approach (Bennett, 2010). By addressing the child's development as whole, preschool teachers should create a rich and open learning environment in order to facilitate children's development. By creating an open learning environment, preschool teachers encourage children to make active choices and to engage with different people, resources, events and ideas (Schweinhart & Weikart, 1988).

On the other hand, as the first step in the formal educational system, preschool is also interpreted as a vital stage in the achievement of given

educational goals. For instance, according to the Swedish curriculum, teachers should create a learning environment that develops children's "responsibility for and interest in sustainable development and active participation in society" (The Swedish National Agency for Education, 2018, p. 13). Having such a goal-oriented approach to preschool, with its focus on schooling or school readiness, can be associated with what Bennett (2010) calls a preprimary approach. Teaching in preschool, accordingly, can be seen as an instruction procedure where thematic work on sequenced events and direct teaching is encouraged.

The polarization of preschool teaching into this two-fold approach, however, does not accurately capture the Swedish preschool educational environment. Both the social pedagogic and the pre-primary approach can be identified in Swedish early childhood education. The Swedish *educare* model, although taking into account the official curriculum's goals, takes a holistic approach to children's learning and development and is often seen as adopting an innovative approach to thinking which integrates children's cognitive, social and emotional development. By embedding this combination of approaches, the *educare* model ensures that preschool teachers' practices are grounded on children's interests and active participation and targeted at supporting and developing them (Sheridan, Williams, Sandberg & Vuorinen, 2011).

Teaching within this model, taking as it does early childhood education in its broadest sense, is seen as a set of goal-oriented processes built upon children's interests where children's care, play, learning and development are simultaneously taken for granted (SFS, 2010:800). The preschool teachers, as part of this goal-oriented process, play a critical role in translating the curriculum's educational goals into practices where children's needs are taken into account in a specific context using a combination of resources. This signifies that preschool teachers, taking into account the child's development as a whole, use a variety of teaching methods and resources to help children strive towards the identified goals.

The School Inspectorate's quality reviews (2016) identified a number of challenges in relation to teaching in Swedish preschools which I think we should take into account when thinking about teaching in preschool in general. The inspectorate found that what teaching means and how it should be conducted in preschool is not clear for preschool teachers. Teaching and learning are often seen as the same thing and are approached in a similar way by preschool staff. More importantly, the report highlights that preschool managers do not/cannot provide teachers with the resources required

to take responsibility for teaching based on the curriculum's aims and guidelines. It is significant that the preschool managers themselves also do not have a clear picture of what teaching in preschool is and how it should be conducted.

2.2. The digitalisation of education

The digitalisation of schools and preschools in Sweden has been in a state of flux over the past two decades. On the one hand, techno-promoters have highlighted the opportunities digital technologies have to offer and have touted the ways these technologies can revolutionize children's learning and development (Collins & Halversson, 2018; Cuban, 2018; Selwyn, 2012). This is partly driven by educational companies seeking to profit from the sale of technological artefacts and software in the educational market. On the other hand, there are more cautious voices that have articulated the possible harms and constraints which the introduction of digital technologies can cause, either directly or indirectly. They have expressed concerns about the replacement of outdoor and authentic activities with virtual ones and have suggested that this has contributed to the decline in children's overall intellectual capacity levels (Di Bari, 2019; Skanz Åberg, 2018).

Critics have also expressed concerns about the cost of digital technologies and whether or not the gain is worth the investment that schools and preschools, with their often limited resources, need to make. For instance, the OECD (2015) states, about using computers in education, that:

where computers are used in the classroom, their impact on student performance is mixed at best. Students who use computers moderately at school tend to have somewhat better learning outcomes than students who use computers rarely. But students who use computers very frequently at school do a lot worse in most learning outcomes, even after accounting for social background and student demographics (p. 3).

The report further claims that using digital technologies, such as a computer, in some cases was impeding learning. A growing body of literature (Domingues-Montanari, 2017; Levin, 2011; Lissak, 2018), makes the similar point that excessive screen time can cause neurological, physical, psychological, and socially adverse consequences. All of these findings suggest that the poor use of digital technologies in educational settings can do more harm than good.

Nonetheless, digital technologies have been widely introduced into Swedish preschools. It is assumed that these technologies can effectively enhance

the teaching and learning processes (Agelii Genlott & Grönlund, 2016). It is, further, believed that the introduction of digital technologies can prepare children to work and live in a knowledge-based society. In addition, some promoters underline the importance of providing access to ICT for all children, particularly for those who may not have access to digital technologies at home (Government Offices, 2017). In a democratic society, it is argued, all children should have the right to receive equal educational opportunities (Forsling, 2011; Kjällander, 2019; Ljung-Djärf, 2004). It is thus asserted that introducing digital technologies into preschools and schools is not creating a further stratification of society, such as those based on class, gender, and place of residence (Kjällander, 2019). It is, in fact, a levelling out of the playing field and giving all children, regardless of status, access to a key component of modern society.

2.3. Digital technologies in children's lives

A report from the Swedish Media Council (2019) shows that young children's access to and daily use of digital technologies has increased significantly. Unsurprisingly, children's access to mobile technologies has grown most during the period 2014-2019. According to the report, 7% of children one year old or less had their own or shared smartphone in 2014. By 2016 this figure had dramatically increased to 54%. During the same period the proportion of children aged between 2-4 years who had their own or shared smartphone increased from 11% to 58%, while for those aged between 5-6 years it increased from 23% to 52%. This dramatic increase slowed down somewhat between 2016-2018. That said, having their own or shared smartphone among children aged 5-8 increased from 16% in 2016 to 20% in 2018.

To a large extent this increase can be attributed to the widespread availability of smartphones. It also reflects a growing access to tablet devices in the home. According to the Swedish Media Council, access to tablets in the home increased in all age groups between 2012 and 2014. Between 2014-2016, 67% of Swedish children aged between 2 and 4 used tablet computers at home. Children's access to tablets increased still further, from 67 % in 2016 to 80 % percent in 2018. The figures also show that children's internet usage in almost all age groups has notably increased during the period 2010 to 2018 where in 2018 more than 85 % of children aged 1-6 used the internet each week.

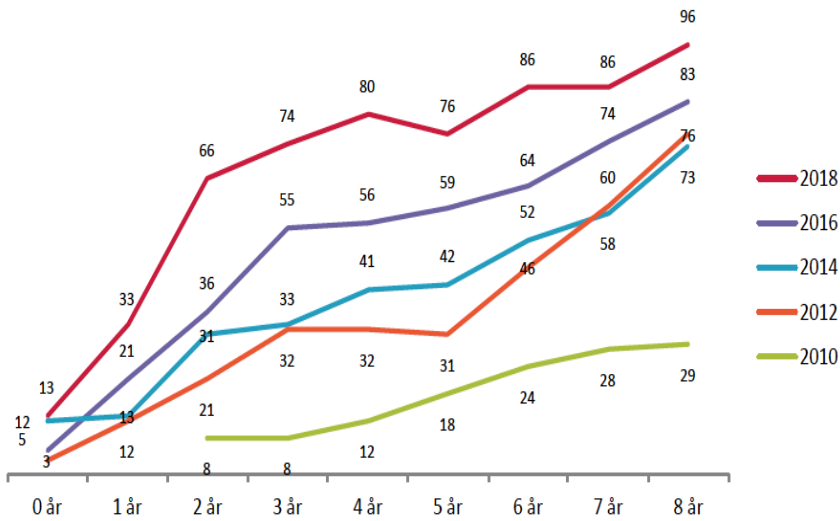


Figure 1: Weekly use of the internet in Sweden, by age and year (Swedish Media Council Annual Report, 2019)

As indicated in Figure 1, weekly internet use has increased for children of all ages. The greatest increase can be seen among children aged 2-6 where weekly use has grown from around 20 % in 2010 to more than 86% in 2018. Children's daily use of the internet and digital technologies is likely to continue and could be much greater by 2020.

These trends signify that digital technologies are becoming an increasingly essential part of our and our children's everyday lives. As young children grow, the increasing presence of digital technologies not only constructs and modifies their habits from an early age but also impacts and shapes their ways of playing, communicating and learning. The question is, however, whether technology in and of itself can improve children's learning.

On the assumption that technology can improve children's learning, many developed societies, as a consequence, have put much effort into embedding digital technologies into their educational practices (Celik, 2012). Many of these initiatives have assumed that these technologies can make teaching and learning processes more efficient and productive. As Cuban (2001) and Selwyn (2012) argue it has been assumed that the increased

availability of digital technologies in educational settings will lead to an increased use of these technologies. More use of technologies could in turn make teaching and learning processes more productive. As a result, it is presumed that technology-enhanced educational systems will develop children's competences so that they can compete in a knowledge-based society. They could even provide learners with the opportunity to control their own learning process (Haelermans, 2017; Kjällander, 2011).

Given how important digital technologies are in contemporary developed societies, digital competence has been considered one of the eight key competences for lifelong learning by the European Union (European Commission, 2004). Digital competence can be defined as the “confident, critical and creative use of ICT to achieve goals related to work, employability, learning, leisure, inclusion and/or participation in society” (Ferrari, 2013, p. 2). This competence is often seen as a transversal key competence which enables the acquisition of other key competences such as language, mathematics, social skills and creativity. The Europe 2002 objectives of the Lisbon Summit stipulate that all “school-leavers must be digitally literate in order to be prepared for a knowledge-based economy” (Commission of the European Communities, 2000, p. 8).

2.4. Digital technologies in Swedish preschools

The growing trend to develop children's digital competence for an increasingly complex and technology-dependent society is clearly visible in the Swedish preschool context. As mentioned earlier, it is assumed that the use of digital technologies can support preschool teachers to go beyond their everyday roles in supporting children's learning (see Caiman & Kjällander, 2019; Hermansson & Olin-Scheller, 2019). Current efforts to integrate digital technologies into preschool environments are aimed at promoting children's competence with digital technology and bridging the gap between their use of that technology in the classroom and the outside world, a process which is complicated by the opportunities and constraints which children themselves pose (Forsling, 2011). In their seminal article, Rosen and Jaruszewicz (2009) argue that the use of digital technologies is “appropriate when it both capitalizes on children's natural desire to actively, collaboratively construct knowledge, and respects the unique challenges presented by children's levels of development” (p. 169). Since the late 1980s a number of national and international efforts have been made to introduce digital technologies into Swedish preschools. In the late 1990s the Swedish educational authorities invested heavily in digital technologies for preschools, and the

Swedish government set up the IT Commission to develop a roadmap for ICT (SOU, 1994: 118). Since then, the investment in digital technologies has continuously increased. In 2008, the Swedish National Agency for Education was tasked by the government to promote the use of ICT in schools and preschools (U2008 / 8180 / S). Its aim was to develop different actors' competences, such as those of preschool teachers, and to enable them to design and use digital technologies in preschool educational practices.

The IT Commission set up and implemented a national action plan to support and stimulate all municipalities to embed digital technologies into their local pedagogical practices. This initiative was later taken over and funded by the Swedish Knowledge Foundation (Swedish: Stiftelsen för Kunskaps- och Kompetensutveckling). In all of the Swedish preschool curriculums (1998, 2010 and 2018) the integration of digital technologies has been highlighted. The use of digital technologies in the 1998 and 2010 curriculums for preschool stated that multimedia and information technology can be used in the preschool, both in the development and application of creative processes. The current curriculum for preschool (2018) introduced the idea of developing children's digital competences. As a result, digital technologies have become a common feature in Swedish preschools. These technologies were initially mostly used for documentation and communication purposes rather than in children's learning, until the digital tablet was introduced into the Swedish market in 2010 (Marklund & Dunkels, 2016).

The current curriculum for Swedish preschools (The Swedish National Agency for Education, 2018) underlines the integration of digital technologies for communication and creativity. Addressing the development of children's competences to communicate, learn and co-operate, the curriculum highlights the importance of developing children's digital skills. It further suggests that preschool education should provide children with a learning environment that supports their digital competences adequately through the provision of opportunities to develop an understanding of the digitalisation that they encounter in their everyday lives. Children should be given opportunities to build a critical and responsible approach to digital technology, in such a way that they are able to recognize the benefits and risks of using digital technologies in the long term as well as being able to evaluate information.

According to a report from The Swedish National Agency for Education (2016), however, just 34% of Swedish preschools had an IT plan mapping out how they intended to implement digital technologies into their educational approach. More than 50% of the preschool teachers surveyed noted

that they needed further in-service training if they were to integrate digital technologies into their educational practices. Unlike in 2008, when preschool teachers called for the development of their competence in areas such as the management of video, film and sound with the help of computers, in 2016 they noted their desire to develop their ability to use digital technologies as educational artefacts and how to prevent and stop online harassment or cyberbullying (The Swedish National Agency for Education, 2016). This may signify that preschool teachers' digital competence has grown in comparison with previous years, but that teachers need further help and support to critically realise the opportunities and risks of using digital technologies in their educational practices (The Swedish National Agency for Education, 2016).

2.5. Interactive whiteboards in education

The interactive whiteboard (IWB) was designed and manufactured in the 1980s. IWB systems are a multimodal technology with a large touch-sensitive interactive display which can be used either as a standalone touch-screen computer or as a connectable device that attaches a large interactive display surface to a desktop computer or laptop. As a touch-sensitive smart board, sensitive to fingers or pen-like devices, IWBs can provide a variety of multi-dimensional teaching and/or learning possibilities. The IWBs functionality can be grouped into three key themes including: “increased pace of delivery; increased use of multimodal resources, incorporating image, sound and movement in new ways; and a more interactive style of whole class teaching” (Moss et al, 2007, p. 6). The IWB, accordingly, is seen as a teaching artefact rather than as a learning artefact.

Within two decades after its introduction, the use of IWBs had become widespread in educational settings. IWBs were initially introduced into British schools in the late 1990s and early 2000s. The introduction of IWBs in the UK was founded on political initiatives that sought to reform existing educational practices (Beucher, Arya & Wang, 2019). In a similar fashion, IWBs, supported and funded by the state, were increasingly introduced into Swedish schools and preschools (The Swedish National Agency for Education, 2013). According to the Swedish Media Council (2019) about 85 % of preschools have access to big screen projectors, TVs and IWBs. The same report indicates that over 20% of Swedish preschools have access to IWBs.

3. REVIEW OF PREVIOUS LITERATURE

Research about digital technology and its use in preschool has significantly increased in recent years. However, studies about how preschool teachers use digital technologies in preschool teaching practices are rare. This literature review sets out to explore the research undertaken on the use of digital technology in educational settings.

A systematic search of the existing research literature was conducted using a selection of databases over three broad categories: digital technology, IT and ICT in preschool; digital technology in early childhood education; and, interactive whiteboards in preschool. In a later phase of the research process, the search was extended to include words and phrases such as teaching, teachers' role, teaching practices and scaffolding process. These served as a framework for the selection of published research. The categories were aligned with the primary focus of the current study. A variety of electronic resources and databases, including Google Scholar, ProQuest Central, EBSCO, ERIC, and Science Direct, were searched. Published lists of references as well as articles cited in other relevant work, research reports and books were examined.

Based on the aim and research questions of my thesis the relevant literature was explored and the studies which were most closely connected to my thesis were read. The reviewed literature, as reflected in Figure 2, is presented in two main themes including: 1) Research on digital technologies in education practices and 2) Research on IWBs in school and preschool.

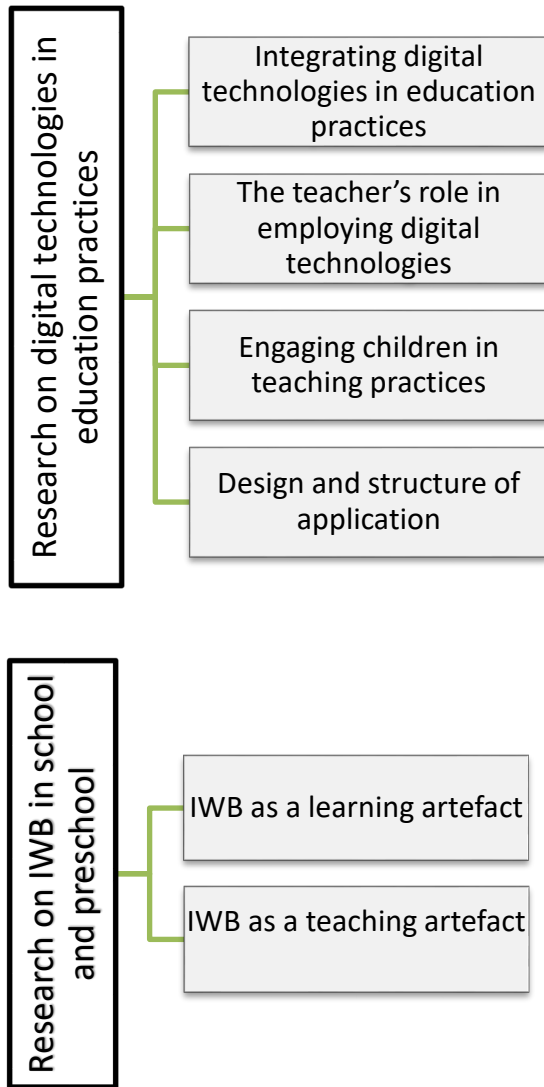


Figure 2: An overview of the research field

There are a number of studies in each of the two main themes. To reflect the main concerns within the published literature, each theme has been broken down into a number of sub- categories.

The first theme comprises research about digital technologies in education practices. This is articulated in four sub-categories. The second theme includes the studies that focused on IWB in school and preschool and is subdivided into two sub-categories.

3.1. Research on digital technologies in education practices

Research on early childhood education and digital technologies, as pointed out earlier, has shifted focus from questions concerning whether or not digital technologies can enhance young children's learning to questions relating to how best to integrate digital technologies for teaching and learning in preschool settings (Camilleri, 2018; Dong & Mertala, 2019; Gialamas & Nikolopoulou, 2010; Kjällander, 2019; Mertala 2017, 2019; Stephen & Plowman, 2008). On a global level, the United Nations Educational Scientific and Cultural Organization (UNESCO) has considered digital technologies in education as a way of tackling access, equality and quality and has addressed what is thought to be a digital divide (UNESCO, 2011).

Following on from this, the integration of digital technologies into educational settings has been widely endorsed and as a result heavily studied (Camilleri, 2018; Flewitt, Messer and Kucirkova, 2014; Fullan, 2013; Grönlund, 2015; Haelermans, 2017; Jack & Higgins, 2019; Kjällander, 2011; Mertala, 2019; Nikolopoulou, 2014; Nilssen, 2018; Plowman & Stephen, 2007, 2013; Preradović, Lešin & Boras, 2017). These studies have mostly focused on the teachers' role in terms of teachers' attitudes, their digital skills and the ways they use or argue for the use of digital technologies in teaching and learning as well as the ways digital technologies motivate and engage children in teaching practices. From a design perspective, a number of studies look at how digital technologies are designed and used in the structuring of educational environments. The findings of the relevant studies will be discussed under the following categories.

3.2. Integrating digital technologies in education practices

The use of digital technologies has been investigated in a number of studies. The introduction of digital technologies can be seen as a game changer which can contribute to teaching (Jack & Higgins, 2019; Selwyn, 2015).

However, the findings of some studies suggest that the successful implementation of digital technologies mostly depends on the type of tasks being done and the ways those tasks are implemented (Means, 2008; Sherman, Cayton & Chandler, 2017).

Addressing the innovative opportunities of digital technologies, Flewitt, Messer and Kucirkova (2014), in an exploratory study, investigate how tablets are used in early literacy learning. Their research focused on three different types of classroom: a children's center; a primary school reception class; and a special school. Their findings demonstrate that using touch-screen devices in each of these learning contexts can provide key opportunities to promote children's literacy learning. Digital technologies, by decreasing the knowledge and power imbalance between teachers and children, create opportunities to empower children's expert role. This shift in role motivates children to explore the intended learning activities themselves in a close collaboration with peers. According to the authors, tablet-based literacy activities, which are facilitated and guided by teachers, stimulate a number of positive attitudes and behaviours among children such as sharing activities, taking turns, supporting each other's learning activities and delighting in the successes of others. Furthermore, Flewitt et al (2014) claim that the provision and uptake of digital technologies in the classroom promotes children's ICT knowledge and skills.

Similar results are reflected in Neumann's (2014) research. Her research aimed to explore how touch-screen tablets enhanced early literacy skills. Her findings suggest that greater access to tablets could be a potential resource to promote children's literacy skills, including pronunciation and writing abilities. However, as her work also shows, the ways that digital technologies are structured can significantly impact children's learning. In another study Neumann and Neumann (2014) suggest that using tablets is closely related to young children's verbal literacy skills. This suggests that the type and quality of digital teaching activities in which children engage may influence their literacy learning.

These studies have shown different examples of the ways that the provision and uptake of digital technologies can contribute to young children's learning. They highlight in particular the potential benefits of digital technologies, including extending teachers' pedagogical resources, motivating learners to engage in the teaching practices, promoting collaboration among learners, and extending teachers' ability to scaffold children's learning. The integration of digital technologies into classroom practices, however, is a

complex process which for its success depends on a variety of issues. A number of studies suggest that using digital technologies can enhance children's learning when technologies are used along with teachers or more experienced peers (Jack & Higgins, 2019; McCarrick & Li, 2007; Preradović, Lešin & Boras, 2017).

3.3. The teachers' role in employing digital technologies

The teachers' importance in the integration of digital technologies in educational environments has featured strongly in previous studies. Early research examined the teachers' role in using the potential benefits of digital technologies in educational settings (Camilleri, 2018; Fullan, 2013; Grönlund, 2015; Haelermans, 2017; Kjällander, 2011; Nikolopoulou, 2014; Nilssen, 2018; Plowman & Stephen, 2007, 2013).

To provide an account of the different aspects of this critical role, this discussion will first consider studies about teachers' beliefs and attitudes towards digital technologies. Then, research that explores the complex alignment between a teachers' pedagogical approach and their use of digital technologies will be reviewed. Lastly, studies about teachers' ICT skills as well as the ways they use digital technologies in their teaching practices will be discussed.

The importance of teachers' beliefs and attitudes for the use of digital technologies in educational practice has been extensively addressed in the literature. A teacher's positive or negative attitude towards the use, or not, of digital technologies, can be seen to either facilitate the use of digital technologies in education or to act as a barrier to the integration of digital technologies. Ertmer (2005), for example, investigates the relationship between teachers' pedagogical beliefs and the ways they use technology in their practice. His findings show that their understanding of what is suitable and feasible in the classroom setting informs their use of technologies in their teaching practices. He concludes that changing teachers' pedagogical beliefs is a vital first step towards the integration of technologies into teachers' teaching practices. Corresponding results have been indicated by Beschorner and Hutchison (2013) and Masoumi (2015). Their work also highlights that teachers' beliefs shape what they do, and how, in educational settings. It is clear we need a deeper understanding of the beliefs and reasoning that inform teachers' practices in the classroom.

In a survey study, Jack and Higgins (2019) argue that teachers are accessing a wider range of digital technologies in preschools, especially technolo-

gies that are being used for educational purposes. According to their findings, preschool teachers are becoming more interested to the use of digital technologies in their educational practices. However, such interests are associated, for the most part, with a “social rationale, that children need access to technology because they are surrounded by it in everyday life” rather than a “pedagogical rationale, that technology enhances learning” (Jack & Higgins, 2019, p. 1). In a similar vein, Jones’s (2004) findings, about the barriers to the uptake of ICT in educational settings, suggest that teachers’ inherent resistance to change can hinder the use of new technologies in educational practices. As a result, teachers’ lack of interest or negative feelings towards digital technologies can be seen as a significant barrier to the integration of ICT into education.

However, building on the earlier findings about the relationship between teachers’ beliefs and their ICT use, it can be said that the process of integrating digital technologies into educational practices cannot only be explained by teacher’s beliefs. Other factors such as teachers’ ICT knowledge and skills and access to a timely support network can consistently promote or restrict teachers’ abilities or willingness to use digital technologies. Vrasidas (2015), for instance, in a large-scale survey about the challenges that teachers face in integrating ICT in teaching and learning practices, finds other factors which affect teachers’ use of digital technologies. These include the lack of time, the ill-structured design of the school curriculum, the lack of access to ICT and support. He suggests that promoting teachers’ digital competences in ways that enable them to appreciate the value of technology and the ways it can be employed in teaching can facilitate the integration of digital technologies into educational practices.

The teachers’ pedagogical approach is another issue which is associated with their use of digital technologies in the classroom (see Corbo 2014; Ljung-Djärf, 2002, 2004; Nir-Gal & Klein, 2004; Plowman & Stephen, 2007, 2013; Voogt & McKenney, 2008). Aiming to examine the relationship between teachers’ pedagogical approaches and their use of computers, Tondeur, Hermans, van Braak and Valcke (2008) find that teachers often choose those applications (software) which are most closely aligned with their educational preferences. That is, they choose those applications which promote what they think is good education.

Mapping teachers’ approaches to using digital technologies in the classroom, the findings of Ljung-Djärf, Åberg-Bengtsson, and Ottosson’s (2005) study suggest that a large number of teachers consider digital technologies

as an important part of the educational environment which can shape preschool practices. That said, their study also found that many teachers considered digital technologies as a threat to other educational practices and as having the potential to adversely affect children's physical, cognitive, social, and emotional development. Yan's and Zhao's findings (2006) point to a similar conclusion: some teachers are more suspicious about using digital technologies in educational practices than others. Preschool teachers with a critical approach to using digital technologies may try to protect children from its possible harms simply through maintaining the status quo and avoiding the use of digital technologies in educational practices. When teachers see digital technologies as a threat, Yan and Zhao conclude that using digital technologies should not be prioritized.

The knowledge a teacher has of ICT and their skill in using it is another aspect which affects the ways teachers integrate digital technologies into their practices (see Camilleri, 2018; Edwards, 2013; Kaumbulu, 2011; Masoumi, 2015; Plowman & Stephen, 2003; Samsonova, 2017; Voogt & McKenney, 2008). Jones' (2004) meta-analysis demonstrates that teachers with limited ICT knowledge and skills are uncomfortable with the use of digital technologies. Teachers who do not have sufficient ICT skills are often very anxious when using ICT in their educational environments especially when children might be more competent in this field than them (Jones, 2004). Teachers' lack of confidence is also reported in other studies (see Balanskat, Blamire & Kefala, 2006; Cox, Preston & Cox, 1999; Erbas, Ince & Kaya, 2015; Lopez & Krockover, 2014; Osborne & Hennessy, 2003). It is seen to be one of the main barriers to integrating digital technologies into educational practices. A further concern is demonstrated by Karsenti and Fievez (2013) who indicate that planning to use digital technologies in the classroom is challenging for teachers.

The teachers' presence and active support of children's interactions using digital technologies is a further issue which is frequently referred in the published literature. By highlighting indirect (distal) and direct (proximal) forms of guided interaction, Plowman and Stephen (2007) investigate how preschool teachers' presence and active support can promote children's learning opportunities when ICT is used. They found that such interactions are mediated by digital technologies when teachers and children work together. Their later research (see Plowman & Stephen, 2013) coined the concept of 'proximal guided interaction' to describe the ways teachers facilitate children's reading and give them different options in games or programmes.

Accordingly, they argue that children acknowledge the use of digital technology when there is strong guided interaction from teachers or adults who can facilitate the learning process. As a complement to Plowman and Stephen's (2013) findings, Nir-Gal and Klein (2004) argue that children who engage in adult-mediated computer activities have better cognitive performance in comparison with children who engage in computer activities without adult support.

3.4. Engaging children in teaching practices

Engaging children in teaching practices is often seen as one of a teacher's main responsibilities. Teachers' ways of using digital technologies to engage children in teaching practices have been studied from different angles. In this section I will address the literature which focuses on the ways teachers use digital technologies to promote children's participation and engagement in teaching practices.

In their studies, Walldén Hillström (2014), Masoumi (2015) and Nilsen (2018) examine the ways teachers organise educational practices with digital technologies. Walldén Hillström (2014) investigates how preschool teachers used tablet computers. Her findings show that preschool teachers organized their teaching practices differently. According to the study, the preschool teachers used a variety of resources and strategies to engage children in the given practices and to motivate them to collaborate with each other. In particular, a number of teachers, by being sensitive to children's questions and ideas, engaged and supported children's activities indirectly. The findings show that children's digital competencies can be enhanced by working with peers on digital activities. Nilsen's (2018) doctoral research similarly concludes that the ways that preschool teachers organize teaching practices using digital technologies can significantly shape children's engagement in those practices.

This pattern of results is in line with the Sarama and Clements (2004) finding, which claims that teachers' use of the manipulative features of computers, when integrated into a mathematics curriculum, can create opportunities to engage children in learning mathematical ideas. Using digital technologies can help teachers to support children's appropriation of mathematical concepts. Sarama and Clements also argue that the way digital technologies are designed and structured can interplay with children's learning.

In another study, regarding the ways digital technologies can help teachers to engage children in mathematics practices, Hundeland, Carlsen and

Erfjord (2014) found that through their orchestration of educational activities and by challenging children, the teachers engaged children in the given practices. Using the digital artefacts, children had multiple opportunities to engage and actively participate in the process of appropriating. Similar findings are indicated by Lange and Meaney (2013) regarding children's interactions with the different applications on a tablet. They find that using applications on a tablet can enable teachers to enhance children's engagement in teaching practices and to help them to collaborate with other children. In accordance with the findings of Lange and Meaney (2013), Kucirkova, Messer, Sheehy and Panadero (2014) use different applications to examine the different levels of engagement exhibited by 4-5 year old children. Their findings demonstrate that children experience a higher quality of peer (child to child) talk when open ended applications are used.

In another study about how IWB as an instructional artefact impacts on students' engagement in teaching practices, Beeland (2002) shows that the use of IWB in the classroom enhanced students' engagement. Teachers who were interviewed highlighted the importance of IWB in motivating and engaging students in teaching practices. Using IWB, then, helped teachers to act as the facilitators of knowledge rather than its source. The study further indicates that embedded features in IWB such as saving notes and other information can also provide students with the opportunity to use these saved learning resources whenever they want.

These studies address not only the potential of digital technologies to enhance children's participation and engagement in teaching practices. There are, however, critical reports and counter arguments that suggest the use of digital technologies may lead to passive rather than active, learning experiences. Several studies (Higgins, Beauchamp & Miller, 2007; Sundberg, Spante & Stenlund, 2012). Sundberg et al. (2012) articulate the view that teachers using digital technologies spend more time dealing with the technologies rather than with what and how children learn. This issue can be more challenging when introducing new technologies, when teachers need to further develop their technical skills in order to use the technologies in their teaching practices.

In another study about the positive and negative aspects of the IWB and tablet computers in a primary school first-grade class, Fekonja-Peklaj Fekonja-Peklaj & Marjanovič-Umek (2015) argue that technical problems when using digital technologies can undermine students' motivation to engage in the teaching practices. In the next section the literature regarding the significance of application design will be addressed.

3.5. Design and structure of application

There are numerous learning programmes and applications that have been designed for the variety of digital technologies now available for use in schools and preschools. The way these applications are designed can have an influence on teachers' and children's use of these technologies (Jernes, 2013; Palmér & Ebbelind, 2013). A number of key aspects in the design and development of applications have been addressed in earlier research. This includes studies of structured or unstructured design of applications, children's control over the applications and the level of classification and framing. By acknowledging the teachers' role, these studies have shown that the design of an application can bring about interactivity and enable the achievement of the intended learning objectives through promoting children's collaboration, problem solving and experiences in different learning situations (Jernes, 2013; Palmér, 2015).

The ways the design and structure of educational applications can influence teaching practices is another issue which Jernes (2013) investigates in her thesis. She discovered that digital technologies are used in preschool practices in two different ways: a very structured or controlled use of digital technologies and an unstructured or free use of digital technologies. Jernes (2013) shows that taking either approach in designing and structuring applications can form teaching practices differently. In alignment with a behaviouristic approach - that is, a line of Stimulus and Response - it seems that a majority of the developed applications are fully structured.

In such applications, in response to a specific stimulus, such as providing the right answer to a specific question, a bond is often established between the given stimulus and a series of possible yet pre-determined responses, such as 'applaud' or 'well done'. When using more unstructured applications, on the other hand, the teachers' and children's interactions are not predefined and they have the freedom to structure and conduct different types of educational practices. Finding appropriate educational applications which are not fully structured is a challenge all on its own. By addressing the design of applications used on tablet computers, Palmér (2015) examines how the design of applications interplays with the interactions and dialogues between teachers and children. The findings show that application design plays a key role in children's participation and communication. Preschool teachers' interactions with children are, accordingly, framed by the type of applications used. Furthermore, the structure and content of the dialogues between teachers and children as well as children's ways of partici-

pation are affected by these applications. The findings demonstrate that educational applications with weak framing can increase a child's participation in a given pedagogical activity. In such applications, there are no right or wrong responses, nor any time restrictions which might cause preschool teachers to be both reactive and proactive. Feedback to children in such applications is usually provided by preschool teachers rather than the application itself. The study concludes that the design of the applications can affect the learning and teaching process in educational settings. Similar conclusions are drawn by Palmér and Ebbelind (2013) who underline the point that framing and classification in the development of applications can have a significant influence on learning mathematical concepts.

In a quasi-experimental study involved teachers in the co-design of technology-rich learning activities, the findings of Cviko, McKenney and Voogt (2015) show that co-designed digitally rich educational activities contribute to children's learning. They also show that teachers' pedagogical perceptions affect their participation in the co-design process (Cviko, McKenney & Voogt, 2015).

It can be concluded that applications per se cannot create a motivating environment for teaching and learning. Rather it is the teachers' actions in using applications which makes the greatest contribution to teaching practices. Several scholars (see Jernes, 2013; Palmér, 2015; Palmér & Ebbelind, 2013) argue that it would be beneficial for teachers to use educational applications and games built upon constructivist and social constructivist notions. These applications can give more space to teachers to enhance children's collaboration, investigation and experience.

3.6. Research on IWB in school and preschool

IWBs are becoming increasingly popular both in Swedish preschools and schools (Ahlbäck, 2018; The Swedish National Agency for Education, 2016) and internationally (Camilleri, 2018; Chou, Chang & Chen, 2017; Lee & Huai Jen, 2014). There is a growing research interest in IWBs in preschool and school. These studies seem to have been largely inspired by ongoing studies in the UK (Ahlbäck, 2018). In the following section the literature about IWB use will be outlined in two main categories: studies focused on learning and those focused on teaching. There have been few studies conducted on IWB use in preschools, which is why research on IWB use in schools has been included.

3.7. IWB as a learning artefact

If and in what ways IWBs contribute to children's learning is one issue which is addressed in the existing literature. A review of the current literature shows a gradual shift from addressing the different features of IWBs to how IWBs practically integrate into educational practices. The focus of the existing research is mainly on the ways that the IWB as a technological artefact can be utilized to create a motivating learning environment, engage children in learning activities, and promote interactions among children and between children and teachers (Bunce, Flens & Neiles, 2010; Camilleri, 2018; Demonte, 2013; Harlow, Cowie & Heazlewood, 2010; Higgins, 2010; Lopez & Krockover, 2014; Samsonova, 2017; Terreni, 2011). IWBs can also facilitate children's active learning and creativity in a learner-centred environment (Berson, Cross, Ward & Berson, 2014; McCrea, 2014; Yang & Teng, 2014). In addition, as Teck (2013) in his study indicates, the IWB can serve as a practical artefact which offers a platform to assess children's learning efficiently and easily. His research findings, further, suggest that an IWB can enhance whole class learning activities for children (Teck, 2013).

In a multi-method study administered by Higgins (2010), the impact of an embedded IWB on the attainment levels of children aged between 9-11 is evaluated. Almost all teachers in the study (99%) indicated that they believed that the use of an IWB in their teaching practices motivated students to learn further. The teachers also noted that using the IWBs' diverse possibilities provided more opportunities to meet students' different needs. This helped them to capture and maintain the students' interest in the given educational activities. Eighty-five percent of the teachers who took part in the study believed that the use of an IWB could contribute to students' attainment. The interviewed students were also very positive in their assessment of the IWB and believed that they could learn better when it was used in educational activities. They particularly noted that the IWB helped them to pay more attention during lessons. The aggregated national test results demonstrated that introducing an IWB into the classroom improved children's learning within the experimental group a little more than for the control group. However, these differences "were not found after the second year of the project, suggesting that the early improvement was due to the initial intervention, or that sustained improvement is harder to achieve, especially in relatively high performing schools and as measured by national tests" (Higgins, 2010, p. 95).

By examining how IWBs can support young children's visual art learning in a preschool in New Zealand, Terreni (2011) demonstrates that the IWB's

features provide children with new types of experiences which are different from the traditional art media. According to Terreni (2011), the use of IWB in preschool practices motivated and assisted young children with visual art learning. Terreni (2011) particularly notes that as children spend more time and effort in working with this technology, the multimodality features of the IWB give children satisfaction. The researcher further claims that when children work with the IWB's big screen and engage in lively conversation, this supports their socially constructed learning. Similar findings were highlighted in Chou, Chang and Chen (2017) and Luo and Yang's study (2016). The findings of these studies particularly suggest that the use of IWB is an effective learning artefact for enhancing children's interest and engaging them during educational practices. Luo and Yang's study (2016), further, argues that basic interactive functions help children to develop positive learning attitudes.

In a study about the reasoning that teachers and students adopted for their use of IWBs in their educational practices, Bell (2002) claims that the features of embedded IWBs provide a range of multimedia resources to help students to learn. Thus, a wider range of student learning styles can be accommodated through the use of IWBs in alignment with students' needs. The study further claims that well-organized, connected and relevant learning activities using IWBs not only supports students' learning but also helps them to develop higher-order thinking skills. The researcher argues that IWBs can be a mindtool to encourage students' critical thinking. According to Bell (2002) attributes of mindtools can include their ease of use, group interaction and the ready availability of software. She further contends that the creative use of IWBs can be limited only by the imaginations of teachers and students. Corresponding results are reported by Burden (2002), who attempts to identify the effects of multimedia technology on IWB practices. The findings demonstrate that the presentation of stimulating visual images on IWBs can promote students' recall. One participant teacher remarked, "when I talk to the children about what helps them remember, they say they can still see the images in their mind, even after we have finished a lesson" (Burden, 2002, p.17).

There are few studies that underline the challenges that the use of IWB might pose for children's learning. Tertemiz et al. (2015) reported that the technical difficulties with IWBs can negatively affect students' learning and disrupt their learning environment within the classroom. They particularly indicate that pop-up advertisements that appeared during the use of free applications or the Internet can negatively affect children. Further, the ways

teachers use the IWB's interactivities can affect children's learning. Bidaki and others have found that the lack of interactivity can diminish children's motivation and negatively impact their learning (Bidaki & Mobasheri, 2013; Samsonova, 2017).

This research portrays a diverse picture of how IWBs can contribute to children's learning. On the one hand, it shows that the multimedia and multi-sensory capacity of IWBs such as colour, visual images, animation, annotate, conceal, manipulate, move, zoom in and zoom out or focus on images can support children's learning. On the other hand, researchers also highlight several challenges concerning IWB and argue that children's learning cannot be realized without taking into account the teachers' key role and the ways they use IWB in their teaching practices. Despite the claims for and against the use of IWBs in educational settings, it is important to consider if IWBs can contribute to teachers' teaching practices and how they might do this, something which is dealt with in the next section.

3.8. IWB as a teaching artefact

IWB as a teaching artefact has been widely addressed in the published literature. A number of studies have pointed out that teachers have been keen to have access to IWBs in their teaching practices (Balta & Duran, 2015; Higgins, 2010). Researchers have argued that the use of IWB as an innovative teaching artefact can promote both teaching quality and learning efficiency in educational settings (Beucher, Arya & Wang, 2019; Holmes, 2009; Jang, 2010; Jang & Tsai, 2012). However, understanding how IWBs can contribute to or transform such educational practices is a challenge all on its own. Further, teachers, as key agents of change, are often not prepared to integrate IWB in their teaching practices (Beucher, Arya & Wang, 2019).

Some of the literature has addressed the multimedia or multimodal character of the IWB (see Camilleri, 2018; Deaney et al., 2009; Gillen, Staarman, Littleton, Mercer & Twiner, 2007; Hvit Lindstrand, 2015; Littleton et al., 2007; Morgan, 2010; Morrison 2003; Murcia, 2008, 2010, 2014). The features of IWBs that support multimedia or multimodal presentation, for instance, are highlighted in Morrison's (2003) work on the teaching of history. The findings show that using a range of IWB features can give life to the teaching of secondary-level history lessons. As one of the interviewed teachers reflected, "I can take pupils into a First World War trench and give them a 360-panoramic view. I can then instantly enable pupils to hear a veteran evoke the sights, sounds and smells of warfare" (Morrison, 2003,

p. 93). In a similar vein Deaney et al. (2009) show how using annotated IWB slides and other saved resources in teaching practices can draw on students' shared experiences and previously co-constructed understandings.

The findings of a study by Murcia (2008) about elementary school teachers' use of IWBs in their science curriculum demonstrate that IWBs can bring together digital technologies to support students' production of drawings, animation, graphs, written text, verbal and video accounts. Murcia (2008) argues that the use of IWBs provided opportunities to develop creative science educational resources that linked directly to online activities. Accordingly, IWBs made it possible to build multimedia resources into a sequence of learning activities in science education. This gave teachers a wide range of choices to enrich their teaching practices. It also demonstrated that using IWBs in teaching science can create a fluid space which facilitates children's and teachers' communication. It enables them to explore "science ideas together, pose questions and reconcile scientific and informal ideas" (Murcia, 2008, p. 20). Similar conclusions are drawn in Camilleri's (2018) study where she examines if and how the IWB supports teachers into transforming their teaching practices. The findings particularly show that by stimulating and engaging children in the learning process, the use of the IWB supports and transforms teaching practices.

The actual interactivity of IWBs is another issue which is emphasised in the existing research (Hwang, Wu & Kuo, 2013; Kennewell & Beauchamp, 2007; Kennewell, Tanner, Jones & Beauchamp, 2008; Moyles, Hargreaves, Merry, Paterson & Esartes-Sarries, 2003; Sarsa & Soler, 2011; Scott, Mortimer & Aguiar, 2006). This area encompasses research into the educational and the technical interactivity of the IWB as an interface between the user and the computer (Hwang, Wu & Kuo, 2013; Smith, Higgins, Wall & Miller, 2005). Most of the existing research refers to educational interactivity, by which is meant the way of structuring teaching practices using IWBs to involve children in learning activities.

The ways IWBs can be used in lesson planning and delivery is explored by Miller, Glover and Averis (2004). The researchers identify six common techniques in IWB which teachers use in their teaching practices: drag and drop; colour, shading and highlighting; matching equivalent terms; hide and reveal; movement or animation; and, immediate feedback. By structuring the educational activities in a course using IWBs, these techniques aim to enhance interactivity between teacher, learning resources and children. The findings show that teaching with IWBs can be conceptualized as a three-

stage process: a) supported didactics, wherein the IWB has replaced the traditional chalkboard to facilitate the teaching and learning process: b) the teacher recognizes some of the additional benefits of the IWBs, and endeavours to motivate and involve children in the learning and teaching process: and c) enhanced interactivity, where the teacher moves from an instructional to a participational role and uses technology to stimulate, integrate and develop the interactive learning environment. By restructuring the teaching environment, children can actively participate in learning and teaching practices (Miller et al., 2004).

In another study regarding the ways that IWBs can support the interactivity of teaching, Kennewell, Tanner, Jones and Beauchamp (2008) suggest that the level of interactivity in the lesson is mainly determined by the teachers' way of teaching rather than the interactive features of the IWB. Highly interactive software per se did not provide the sort of possibilities that could shape students' actions and reflection-in-action in order to achieve the intended learning objectives. This suggests that technical interactivity, such as interactive displays, cannot assure the success of teachers' teaching. Rather, it is the teachers' orchestration of the learning resources which does that. This research concludes that the orchestration of features in IWBs rather than the features themselves is what can best help teachers to develop their teaching practices.

Saving and reusing teaching resources is another feature of IWBs which is addressed in the existing literature. Deaney, Chapman and Hennessy (2009) show that by providing archiving and revisiting capacities, IWBs allow teachers to save, improve and reuse teaching resources over multiple sequences of learning. In alignment with Deaney et al (2009), Murcia (2010) shows that using IWBs enables access to the resources and teaching materials stored in their hard drive or cloud storage. Saving and reusing teaching resources can also be seen as a kind of investment for producing multi-dimensional teaching resources which can be continuously enhanced.

While studies demonstrating the advantages of IWBs are frequent, published research has also voiced challenges and possible constraints (see Al-Faki & Khamis, 2014; Camilleri, 2018; Gillen et al., 2007; Karsenti, 2016, Slay, Siebörger & Hodgkinson-Williams, 2008; Smith et al., 2005). Some of these challenges focus on issues arising from cost, technical difficulties and support. Purchasing an IWB and IWB applications or software can be more expensive than other display technologies and there can be difficulties in supporting teachers with low ICT literacy (Samsonova, 2017). Further,

Samsonova (2017) states that planning a lesson on an IWB, including finding appropriate pictures, sound and fonts, can be challenging and time-consuming for teachers.

Examining the role of the IWB on preschool teachers' teaching practices, Camilleri (2018) argues that most of the preschool teachers did not have the opportunity to develop their technological knowledge and thus could not use digital technologies in a meaningful way in the classroom. By highlighting the importance of the preschool context, including the ways preschool leaders enact the integration of digital technologies in preschool, she concludes that teachers' active use of digital technologies was not supported.

Furthermore, a number of studies have drawn attention to the challenges related to installing IWBs, maintaining them and then supporting teachers to use them in educational settings (Karsenti, 2016; Samsonova, 2017; Slay, Sieborger & Hodgkinson-Williams, 2008). Some of this research points to the scarcity of technical support and the amount of time teachers need to spend in order to prepare the learning material within the technological environment (Dostal, 2011; Karsenti, 2016; Sundberg, Spante & Stenlund, 2012). In his study, Karsenti (2016) argues that the integration of IWB into the classroom can be more complicated and time-consuming than other digital technologies. He argues that teachers often do not have enough time to learn how to use the IWB in their teaching. Karsenti adds that developing a lesson using the IWB usually takes too much time, and due to frequent technical problems, which teachers often could not resolve themselves, meant that teachers had to develop a reserve teaching plan in case the IWB did not work.

In her study about how U.S. elementary school teachers use and perceive IWBs, Samsonova (2017) underlines the insufficient technological and pedagogical support to help teacher use IWB in their teaching practices. By examining teachers who did not gain such support and found the use of IWB troublesome and complicated, she further argues that providing a technological and pedagogical support including troubleshooting guides, introducing best practices and whiteboard tutorials can help teachers get the most out of IWB. This is consistent with Corbo's (2014) findings. Examining students' and teachers' perceptions about the use of IWBs, Corbo (2014) suggests that in the classroom, where children were not given opportunities to interact with the IWB, they were mostly passive and looked disinterested.

Teachers' competence in using aspects of the IWB is another challenge which is highlighted in some studies. When teachers are unable to interact

with the full range of the IWBs functionality, the IWB becomes, as Glover, Miller, Averis and Door (2007) state, a technological teaching artefact. Slay, Sieborger and Hodgkinson-Williams (2008) identify some of the technical problems that occur when connecting an IWB to the internet and other interfaces. Addressing the point that many teachers are at the beginning stages of implementing IWBs, Sad and Özhan's (2012) study suggests that teachers need ongoing technological and pedagogical support to integrate IWB into their teaching practices.

Teachers' ways of using IWB in their teaching practices is another issue underlined in the studies reviewed. In their study, Bourbour and Masoumi (2016) argue that some teachers tend to use IWBs in ways which encourage a more teacher-centric education. Many teachers conceive of the IWB as simply replacing the blackboard, which reinforces a teacher-centred approach to instruction wherein teachers control the teaching and learning activities (Schuck & Kearney, 2007). In such teacher-centred or even content-oriented circumstances children tend to be more passive and reluctant to participate in the given teaching practices.

As indicated in some earlier studies, lessons using IWBs can be more structured and can be aimed towards whole classroom presentations rather than teamwork. This can give the teaching a faster pace. In these teaching practices, the length of time used for group work is decreased when an IWB is used (see Bourbour & Masoumi, 2016; Schuck & Kearney, 2007). By examining how IWB has changed actual teaching in the classroom, the findings of Ahlbäck's (2018) research, similarly, suggests that IWB is used as digital hub in whole-class teaching. The findings of the study, further, suggest that the extent of IWB use and the ways that it is used in teaching practices depends on teachers' digital skills. He adds that teachers' insufficient digital competences may force them to adopt a traditional teaching role, where teachers' focus is directed towards the technology rather than students' learning.

Using IWB in the classroom can increase the complexity of teaching (Ahlbäck, 2018; Schmid, 2008). Ahlbäck's (2018) findings, for instance, show that the technical challenges and difficulties - such as an electronic pen that does not seem to connect or a lack of functionality within a specific application - can restrain the uptake and use of IWB in educational settings. These challenges can be seen as 'technology thresholds' which are associated with teachers' abilities to use the IWB itself. Schmid (2008), further, reports that the use of IWB can increase the risk of providing information overload

to children because they do not have time to process the array of multimodal information that has been presented to them.

3.9. Conclusions of previous research

This section has provided an overview of the literature about the provision of digital technologies in teaching practices and teachers' critical role in using these technological artefacts. The reviewed studies have in particular suggested that teachers' competences and approaches are key factors in determining if and how digital technologies can be used in teaching practices. These studies draw our attention to the fact that digital technologies per se cannot offer any pedagogical added value, it is only the way they are used that can do so.

The research has also indicated that there have been great expectations surrounding digital technologies and what the IWB as a particular type of technology can bring to teaching. A number of the IWB's features, such as its interactivity and multimodality, have been particularly recognised as initiatives which interplay with the teaching process. Studies also highlight critical voices that examine the ways teachers use and structure their educational environments using the IWB. They serve to demonstrate the ways this technological artefact, the IWB, can contribute to teaching practices.

The conclusion to be drawn here is that teachers play a key role in teaching practices where IWBs are used. Despite this, there are surprisingly few studies that empirically investigate preschool teachers' own voices concerning their teaching practices with IWB. Similarly, there are few studies that, in a more elaborate way, investigate how these teachers, as main characters in their own teaching practices, structure their teaching using IWB and how, therefore, this digital technology interplays with preschool teachers' teaching practices.

4. THEORETICAL FRAMEWORK

In this chapter, the theoretical framework of the thesis, that is, the sociocultural perspective, will be presented. A sociocultural perspective is an umbrella term for the theories based on Lev Vygotsky's (1978) cultural psychology. These theories claim that human experiences and knowledge are, throughout history, collectively developed and accumulated in the form of artefacts. As a learning theory, the sociocultural perspective explores and explains the ways learning occurs. Such a characterization of learning is critical in structuring and forming any educational environment and teachers' practices (see Säljö, 2000, 2010; Vygotsky, 1978; Wertsch, 1991).

The sociocultural perspective provides a systematic conceptual framework for the current study. In line with sociocultural notions, the theoretical foundation of this study suggests that teaching and learning in early childhood education is socially situated and mediated by cultural artefacts (Wertsch, 1997). As a result, notions like mediation, zone of proximal development (ZPD), and scaffolding are central points of departure in my analytical work where I seek to understand the ways that preschool teachers make use of IWBs in their teaching practices. In this chapter, the key concepts in the sociocultural perspective are elaborated upon and the ways that the concepts are used in the analysis are highlighted.

4.1. Learning as a socially-situated practice

The sociocultural perspective centres on the assumption that learning is a constant social process which takes place in cultural contexts, which can be mediated by different tools (Vygotsky, 1996). Learning is understood as the appropriation of cultural tools through interaction and communication. Learning is a socially and culturally situated process which is mediated by different artefacts such as language, paper, pen and computer. These cultural tools have been developed in different contexts over time (Daniels, Cole & Wertsch, 2007). Thus, children's learning in the sociocultural perspective is located "in the interplay between culture and individuals, and it implies the transformation of individuals and collectives in terms of the nature of the tasks they master" (Säljö, 1999, p. 149). The process of learning occurs twice, or rather in two planes. First, it appears on a social level. That is, as a result of active participation in a social practice which is mediated by cultural artefacts. As such it is intermental. Second, it appears on an individual level inside the anyone. In this way it is intramental (Vygotsky, 1978).

Socially and culturally embedded learning situations enhance children's abilities to appropriate certain intended learning outcomes. These culturally embedded learning situations, further, inform children's norms and values through interactions with adults or knowledgeable peers. Children internalize knowledge they have acquired through engagement and participation in a context. In some cases, children participate actively in activities designed specifically for them. In other cases, they just observe and learn from what they are observing, preparing to engage in upcoming activities (Rogoff, 2003).

Human experiences can be represented as cultural artefacts such as language, signs and symbols. These can then be transferred to other people. Artefacts, in other words, are more than just physical things that humans create. They also comprise the ways they can extend human beings' abilities (Daniels et al., 2007). This signifies that not everyone needs to have a direct experience in order to learn something new. It is possible to learn from what others have experienced, and to have these experiences represented to us in the form of cultural artefacts (Fleer & Pramling, 2014).

Vygotsky's theory is grounded on the premise that social, cultural, and historical contexts cannot be detached from children's cognitive development (Rogoff, 1990; Vygotsky, 1978; Wertsch, 1985). In sociocultural approaches, cognitive development takes place not only through interaction with others, but also through engaging and participating in activities with socio-historically developed artefacts that mediate children's intellectual activities (Rogoff, 1990). Children's development is, accordingly, seen as a process of interaction among people and artefacts rather than something that emerges autonomously within a child's head. The idea of interdependence between the individual and wider social processes is considered to be a key issue in the sociocultural approach in which children's development is seen as a process of internalizing socially shared knowledge and cultural practices (John-Steiner & Mahn, 1996). Vygotsky (1978) emphasizes the dynamic interaction between children and their surrounding environment. Children's social partners and the cultural contexts they inhabit, accordingly, play a key role in children's development (Rogoff, 1990). This, however, does not mean that children's previous experiences and understandings are unimportant when learning. It simply means that these relationships are complex.

As noted above, sociocultural theorising includes certain important notions regarding the learning process, which can inform, and somehow be

used to shape, learning environments and teaching practices. This perspective outlines certain understandings of learning and the ways in which learning occurs in a specific context. Such a characterization of learning is critical in structuring and forming preschool environments and preschool teachers' practices, that is, teaching activities.

4.2. Cultural artefacts and mediation

The notion of an artefact in sociocultural theory refers to the means needed to achieve a purpose in a specific context. Artefacts are gradually acquired, developed and passed on to the next generation. Thus, human history is formed by the construction, use and accumulation of cultural artefacts (Vygotsky, 1978). These can be best understood when investigated in their historical development (John-Steiner & Mahn, 1996). Vygotsky (1978) differentiates between two different types of artefacts: physical and psychological. Physical artefacts refer to means that help us to achieve specific objectives, for instance, using a knife to slice a piece of meat. The technological means as physical artefacts extend our physical and intellectual craftsmanship. Psychological artefacts refer to symbols such as signs, languages, and norms that help us to understand the world. These cultural artefacts not only make it possible for the upcoming generation to integrate into a culture but they also affect and frame children's opportunities to develop. According to Vygotsky (1978), the acquisition of cultural artefacts extends children's mental capacities and helps them to master their behaviour in a certain way.

Artefacts are not seen as neutral or passive objects in human practices. Rather, they are seen to be active agents which privilege specific values, knowledge and approaches (Säljö, 2010). They provide a variety of opportunities to transform people as biological, social and cultural beings. Artefacts, however, should not be seen as "some kind of single, undifferentiated whole but rather, in terms of the diverse items that make up a tool kit" (Wertsch, 1991, p. 93). As individuals we have no direct or immediate contact with the world and other human beings except that which is mediated through various physical and psychological artefacts, which are embedded in our social practices (Säljö, 2000). Vygotsky, initially, makes a distinction between tools and signs in defining the relationships of object and subject.

The tool's function is to serve as the conductor of human influence on the object of activity; it is externally oriented: it must lead to changes in objects

... The sign, on the other hand, changes nothing in the object of a psychological operation. It is a means of internal activity aimed at mastering oneself; the sign is internally oriented ... The mastering of nature and the mastering of behavior are mutually linked, just as man's alteration of nature alters man's own nature (Vygotsky, 1978, p. 55).

By addressing the intermental and intramental, Vygotsky explains how intermental becomes intramental in child development as “children learn to regulate the mediational cultural tools with their own social and mental activity” (Lantolf, 2003, p. 350). To a large extent artefacts interplay with what we know and how we know it. Enabling us to tackle and solve problems, created artefacts can extend both our physical and intellectual capabilities. However, the use of cultural artefacts cannot be taught to children independent of society. Learning about cultural artefacts is part of a socially mediated process (Hedegaard & Flear, 2013).

Mediation is a key concept within sociocultural theory. It addresses the use of cultural artefacts to regulate the relationship between the individual and the social-material world (Lantolf & Thorne, 2007). Mediation refers to physical and psychological artefacts that can contribute to qualitative changes in the development process. As Bruner (1962) states, mediation is shaped by

(T)he tools and instruments that he comes to use, and neither the mind nor the hand alone can amount to much ... And if neither hand nor intellect alone prevails, the tools and aids that do are the developing streams of internalized language and conceptual thought that sometimes run parallel and sometimes merge, each affecting the other (Bruner, 1962, vi-vii).

Wertsch uses the concept of “toolkit” in mediational means and mediated action to connect Vygotsky's social view to a child's development into the notion of intertextuality. Mediational means, accordingly, refer to whatever resources people have at their disposal, and mediated action indicates the use and employment of these mediational means. The relationship between mediational means and mediated action is “so fundamental that it is more appropriate, when referring to the agent involved, to speak of individual(s)-acting-with-mediational-means than to speak simply of individual(s)” (Wertsch, 1991, p. 12). Based on Vygotsky's perspective, we cannot separate mediated action from mediational means. This is because action cannot be detached from the context in which it is carried out (Wertsch, 1991).

Digital technologies, such as IWBs, mediate teaching and learning processes, which are purposefully employed to achieve intended pedagogical

aims (Wertsch, 1997). In article I, mediation and the way IWBs as digital artefacts mediate preschool teachers' teaching is used as an analytical concept in a broader sense. The preschool teachers' different patterns of reasoning about how the employment of these digital artefacts mediates their teaching practices were taken as units of analysis. These meaning units consisted of what preschool teachers said about the ways IWBs contributed to preschool pedagogical practices.

Furthermore, mediation, mediational means (that is, a specific aspect of IWB) and mediated actions (that is, teachers' handling of the specific aspect of IWBs in teachers' teaching) is utilized in article IV. Mediation in this article, then, is an analytical tool used to understand how the IWB as a mediational means mediates teachers' teaching actions. To put the mediated teaching action at the centre of my analysis I use, like Wertsch (1997), the term 'privilege' as a neutral concept with offers the potential to explore the possible consequences of a mediated teaching action in terms of both restrictions or possibilities.

4.3. The zone of proximal development (ZPD)

An essential feature of children's learning, as Vygotsky (1978) argues, is the interaction with more capable others. Vygotsky (1978) suggests that children's daily interactions with knowledgeable partners or more capable others provide a great source of experience to draw upon to promote children's cognitive skills. By providing appropriate help children can often get enough support so they can accomplish a task (Inagaki & Hatano, 2002; Rogoff, 2003).

Vygotsky (1978) argues that the interaction between more capable others and less competent children creates "the zone of proximal development; that is, learning awakens a variety of developmental processes that are able to operate only when the child is interacting with people in its environment and in collaboration with his peers" (Vygotsky, 1978, p. 90). For Vygotsky the zone refers to the difference between what children can do on their own and what they can do with support from an adult or a more competent peer (see Figure 3).

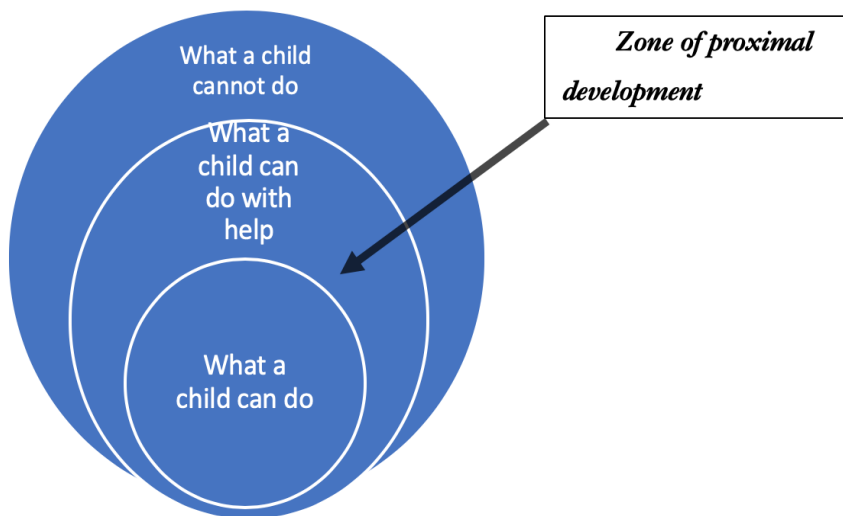


Figure 3: The zone of proximal development (design based on Vygotsky, 1978)

Vygotsky (1978) further suggests “what is in the zone of proximal development today will be the actual development level tomorrow - that is, what a child can do with assistance today she will be able to do by herself tomorrow” (p. 87).

Mercer and Fisher (1992) consider the introduction of the zone of proximal development (ZPD) as a paradigm shift, where teachers can facilitate children’s learning process. In this process, which occurs through the interaction between different actors and their use of artefacts, children’s learning and development is socially created. A teacher using a variety of “artefacts, such as books, videos, wall displays, scientific equipment or a computer environment intended to support intentional learning” (Brown et al., 1993, p. 191) can assist children with varying degrees of expertise.

In operationalising the process of the ZPD, teachers act as a mediator between the child’s existing levels of communication and those which are beyond their level of actual development. In this process, children’s learning

and development can be seen as the transition from intramental to intermental, together with more knowledgeable teachers and peers. Collaboration between and getting support from preschool teachers to help children to reach a greater understanding is critical.

In article II, Vygotsky's zone of proximal development is used to elaborate the ways preschool teachers help children to fulfil activities which they could not do on their own. In this article particularly, ZPD is operationalized to analyse teachers' different strategies to structure their teaching on interactive whiteboards. Strategies that the preschool teachers used to structure their teaching activities using IWB to support children's learning within their ZPD were identified.

4.4. Teaching as a socially-situated practice

The ways children learn in early childhood educational environments, according to the sociocultural perspective, happens in a dialectic process within a cultural context that has a set of specific values and traditions. Accordingly, the quality of the educational dialogues and interactions defines the success or failure of the educational practices (Mercer, 1995). Through interactions, teachers motivate and engage children in teaching activities and help children to construct their understandings in a learning process.

The developed and accumulated artefacts to a large extent form the teaching and learning process (Säljö, 2010). The artefacts can include not only tangible objects, such as toys, but also intangible cultural issues such as traditions, values and the ways that artefacts are used in a specific context. The question, however, is how technological artefacts can mediate teachers' teaching actions in early childhood education. In a networked society, preschool teachers need to use the functionality of digital technologies to develop a rich learning environment. However, to use these technological artefacts in teaching environment, both teachers and children need to master the technological artefacts.

Teaching activities in a preschool context, where children are taught indirectly through play and in interaction with others, can be very different from those at school. The teaching practices, as defined by a sociocultural perspective, ought to be linked to and based upon the child's daily life experiences. Children are often eager to engage and interact with peers in a given teaching activity when those activities are linked to their real-life environment. Without taking into account children's interests when designing

educational environment and activities, it may be hard to motivate children to engage in these practices.

4.5. Scaffolding

The concept of scaffolding refers to an interactive process where a more skilled or experienced person supports a less skilled or knowledgeable person to master a competence or solve a problem (Stone, 1998). Scaffolding is here seen as a “way of operationalizing Vygotsky’s (1987) concept of working in the zone of proximal development” where it can be seen to provide individual support to children based on their ZPD (Wells, 1999, p. 127). Bruner’s studies on scaffolding (1985), demonstrate, in a detailed way, a process for applying Vygotsky’s theory to the classroom context.

The way teachers teach, according to the sociocultural perspective, is consequently understood as a way of assisting children within their ZPD and supporting them to perform successfully (Siraj-Blatchford, 2009). For Vygotsky, when an adult tries to promote a child’s learning, natural scaffolding always occurs. In a one-to-one context, scaffolding is seen as the temporary support provided by the teacher in order to enable the child to fulfil a task. The support can be given in different ways such as modelling, questioning and providing the right feedback.

Due to its broad interpretation, scaffolding has become an umbrella term for any kind of support (Wood, Bruner & Ross, 1976). Scaffolding can refer to the adoption of those “elements of the task that are initially beyond the learner’s capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competency” (Wood, Bruner & Ross, 1976, p. 90). Teachers simply encouraging children to engage wholeheartedly in an activity support children’s learning. Children, however, are not passive receivers of information. They are active actors in the construction of their understandings through intermental and intramental dialogue. In the scaffolding process, not only the teacher but all the children are continuously involved in evaluating and clarifying each other’s understandings (Hogan & Pressley, 1997). Rogoff (1990) emphasizes the importance of guided participation in the scaffolding process within the ZPD. Guided participation refers to the ways that preschool teachers or competent peers structure situations and change their role through their engagement in an activity. In order to scaffold an activity, the teacher or competent peers should come to the child’s ZPD and then scaffold from there.

Scaffolding, accordingly, as Stone (1998) suggests, is a dynamic process which is adjusted to a child's ongoing progress in a specific task. The dynamic nature of scaffolding is grounded on the ways teachers adjust their scaffolding based on feedback from a child. Thus, the scaffolding process cannot be applied in every situation in the same way. By reducing degrees of freedom, marking critical features or demonstrating examples, children can gradually be given opportunities to solve problems. Scaffolding can cover a large number of preschool activities including simplifying a task, highlighting certain elements or parts of the activity that the children can manage, demonstrating how to solve parts of a task or helping the children to deal with any difficulties that emerge during the course of a task (Wood et al., 1976).

Wood et al (1976) have discerned six different actions which teachers use to scaffold their teaching practices. These six scaffolding functions are:

- *Recruitment*, in which the teacher acts in order to enlist children's interest and engagement in an activity.
- *Reduction in degrees of freedom*, in which the teacher acts in order to simplify the task by reducing the number of constituent acts or reducing the size of the activities required to reach solutions. The teacher might fill in the blanks or let the learner perfect the component sub-routines that they can manage.
- *Direction maintenance*, in which the teacher acts in order to guide children in the pursuit of a particular objective.
- *Marking critical features*, in which the teacher acts in order to mark or highlight certain features of the task to help children solve the problem and identify correct responses.
- *Demonstration*, in which the teacher acts in order to demonstrate and model solutions so the child can imitate them.
- *Frustration control*, in which the teacher acts to enable children to save face in order to reduce a stressful activity and help it to become less dangerous.

With the supportive role of the teacher acting to extend children's learning (Edman Stålbrandt & Hössjer, 2007), scaffolding is understood as customized support based on a child's ZPD. The teacher's ways of acting, accordingly, can assist children within their ZPD and support them to fulfil a task successfully (Siraj-Blatchford, 2009).

Consequently, scaffolding is seen as a key feature in designing and conducting teaching activities which can cover a variety of actions by preschool teachers. Opportunities for widening preschool teachers' actions might also arise from the fact that digital devices are brought into preschool settings, providing various kinds of learning environments as artefacts. Scaffolding as a teaching method can be applied to just about any task (van de Pol, Volman & Beishuizen, 2010). Preschool teachers' actions are also linked to the possibility of removing the scaffolding function, when children start to master a given task, since the scaffolding is no longer needed when they can accomplish the task on their own.

Scaffolding is used as the conceptual framework in article *III*. In this article, the focus is placed on preschool teachers' scaffolding actions in order to support children's learning using IWBs. Teachers' actions are linked to what has been described as the functions of the scaffolding process. The theoretical framework on scaffolding generated by Wood et al (1976) partly serves as the foundation for the different classifications of preschool teachers' actions. Then, by characterizing preschool teachers' actions referring to what teachers say and what teachers do, the analysis maps a number of relationships between functions and actions.

5. METHOD

This chapter deals with the design of my study, the procedures I followed and the essential concerns I dealt with before and during the research process. This includes discussing my data collection methods, my approach to participants, my ethical considerations, and the analytical processes that I performed.

5.1. Research design

This is a qualitative study. Its aim, characteristics and, most importantly, its approach to its central characters, that is, preschool teachers, is qualitative (Larsson, 2005). As a consequence, a qualitative approach to data collection and the analysis of empirical material is used in this study. A qualitative approach refers to the exploration of “things in their natural settings, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them” (Denzin & Lincoln, 2011, p. 3). This approach tends to describe and interpret the meanings people attribute to events as well as the ways events occurred or are constituted (Denzin & Lincoln, 2011; Wiliig, 2013).

This thesis aims to contribute to our understanding of the ways in which digital technology interplays with preschool teachers’ teaching practices. The following four research questions are addressed in this study:

Research question *I*: How do preschool teachers reason about the embedding of IWBs into their teaching practices?





Research question *II*: How do preschool teachers use IWBs to structure their teaching practices?

Research question *III*: How do preschool teachers scaffold children’s learning processes in a context where IWBs are used?

Research question *IV*: How do IWBs mediate teaching actions? and What is privileged in the IWB-mediated teaching actions?

To address these research questions three sets of empirical data were obtained. The first two research questions - questions *I* and *II* - were addressed within the framework of my licentiate thesis (2015). To answer these research questions, I collected two sets of data through interviews and observations in 2012 and 2013. As a development of my work towards a doctoral thesis, in which research questions *III* and *IV* were added, I collected another set of data through observations in late 2017 and early 2018 (see Table 1).

Table 1. An outline of the collected datasets in relation to the research questions

Research question I (Dataset I), 2012		Interviews with preschool teachers
Research question II (Dataset II), 2013		Observations of preschool teachers
Research question III (Dataset III), 2017-2018		Observations of preschool teachers
Research question IV (Dataset III), 2017-2018		Observations of preschool teachers

5.2. Mathematics education as context

In this doctoral thesis, mathematics education has been chosen as a way to limit the study and to provide a context in which to explore the ways preschool teachers use a particular digital technology, the IWB, to structure their pedagogical practices. However, the thesis' primary aim and research questions are directed towards knowledge about the use of digital technologies in preschool. Two of the articles in the thesis, which were part of my licentiate thesis, give the discussion around mathematics education a more central role. When I progressed to a doctoral degree, the decision was made to focus my research on the use of digital technologies and assign mathematics education a more contextualizing role. This is the background to the differing emphases given to mathematics education in the four articles.

5.3. Dataset I - Interviews

To investigate the first research question, I carried out semi-structured interviews with preschool teachers. I used the interview as a tool to gain a deeper understanding of how preschool teachers reason about the embedding of IWB in their teaching practices (see Marton & Booth, 1997; Uljens, 1989). Previous scholars have argued that preschool teachers can make sense of their experiences (Kvale, 1997; Marton & Booth, 1997). Conducting interviews made it possible to collect data through direct verbal interaction and allowed me, the interviewer, and the interviewee to immediately respond to each other's reactions (Kvale & Brinkman, 2009; Kvale, Brinkmann & Torhell, 2009; von Wright, 1983). This helped me to probe complex phenomena. Further, the closeness of the interaction (Gubrium, 2012; Kvale, 1997) gave me the flexibility to formulate both purposeful and detailed questions and gave the interviewee the freedom to answer in their own way.

The semi-structured interview format that I adopted provided the preschool teachers with the opportunity to share their understandings with me. Using semi-structured interviews further allowed me to engage in a dialogue with teachers, enabling them to explore their reasoning and experiences about the use of digital technologies in preschools. The personal nature of the interview and its flexibility can, however, increase the risk of subjectivity and bias (Björndal, 2002; Kvale et al., 2009).

Furthermore, conducting interviews needs a great deal of time which can limit the number of people who can or wish to participate in the study. How interview questions are constructed and asked may influence the way they are answered, which can lead to biases in the eventual findings. To avoid such biases, based on the literature review and supervisors' reflections on the early outline of the interview questions, I initially built and pilot tested an instrument to examine preschool teachers' reasoning. The interviews often concluded with follow-up questions to see if there were common understandings of the addressed questions and answers. The preliminary results have been discussed with both the participant teachers and with my supervisors.

5.4. Participants and procedures

The sampling was done based on the availability and the suitability of the research aim (Bryman, 2016). To find preschools where the use of IWB was part of their educational practice, contacts were made with the regional Centre for School Development (Center för Skolutveckling). These Swedish-based research centres support the integration of ICT in schools and preschools. Based on information given by the Centre, contact was made with a number of regional preschools. Some of the preschools declined participation for a variety of reasons, including the reorganisation of their administrative departments and the pressure of other educational activities. Two preschools agreed to take part in the study. The preschools were located in different socioeconomic neighbourhoods in a larger Swedish city. One of them (preschool A) is located in a mainly immigrant-populated suburb with a relatively low socioeconomic status. The other (preschool B) is located in the centre of the city in a middle-class area.

The teachers who took part in the study used IWB as part of their teaching practices. Information about the aim, method and procedure of the study was given to the preschool teachers, both verbally and in written form. All of the participants were qualified teachers with different levels of teaching experience. Two of the teachers had more than 25 years of teaching

experience each while two of them had only recently completed their teacher education programme. Three of the participant teachers worked in preschool A and one worked in preschool B.

An interview guide based on the literature review and the study’s aim was developed. Before carrying out the interviews, pilot interviews were conducted with three teachers. The interview design was then discussed extensively with my supervisors and, as a result, revised accordingly.

During each interview, a rich array of questions from different perspectives was asked in order to explore preschool teachers’ reasoning about the embedding of IWB in their teaching practices (Bryman & Nilsson, 2011; Esaiasson, Gilljam, Oscarsson & Wängnerud, 2007). The interview questions were particularly centred on the following themes: the preschool teacher’s reasoning for using IWB in their teaching practices; the ways that they believed IWB mediated young children’s learning in general and mathematical learning in particular; the teacher’s experience in using IWB in their teaching practices, particularly in mathematics; and, the ways they organised mathematical activities with IWB.

Table 2: An overview of the conducted interviews with preschool teachers

Participating pre-schools	Preschool teacher	Length of inter-view	Date of inter-view
Preschool A	Mona	90 minutes	6 th June, 2012
	David	90 minutes	29 th June, 2012
	Matts	80 minutes	30 th June, 2012
Preschool B	Sandra	180 minutes	28 th June, 2012

Table 2 provides an outline of the interviews that were held with the participating preschool teachers in preschool A and preschool B. The interviews were audio-recorded. Each interview lasted, on average, for little more than an hour and the recorded interviews were transcribed.

5.5. Data analysis

To explore the preschool teachers’ reasoning about the embedding of IWB into their teaching practices the collected data was analysed using content analysis (as described in Creswell, 2012). This kind of analysis seeks to obtain a deeper understanding of the studied phenomenon. As earlier mentioned, the collected data - six hours and twenty minutes of recorded interviews with four preschool teachers - were initially transcribed. The transcribed interviews were subjected to a continual filtering system by reading, where the transcribed texts were separately read and interpreted by me and

the co-author, Björklund. The theoretical framework, as well as my experiences as preschool teacher and as researcher, helped me to analyse the collected data. All of the conducted interviews were in Swedish. Selected parts were then translated into English.

The analysis process was structured into four steps:

Step 1- Meaning units - that is, the preschool teachers' different patterns of reasoning about how the IWB as a technological artefact mediates preschool practices - were selected. These meaning units consisted of what preschool teachers said in relation to the ways IWB contributed to preschool pedagogical practices.

Step 2- The meaning units - that is, the teachers' reasoning - were made less voluminous whilst keeping their original meaning.

Step 3- Concise versions of these units were constructed and coded to define content.

Step 4- All codes were sequenced. No meaning units were left out or used multiple times.

As a result, four main categories were specified

5.6. Datasets II & III - Video observations

Dataset II and III, addressing research questions II, III, and IV, were collected through video observation. Video recording as an observational and interpretational instrument makes it possible to explore, explain and understand fundamental aspects of the ways digital technologies interplay with preschool teachers' practices (Lindahl, 2002; Otsuka & Jay, 2017). Accordingly, using video observations provides an opportunity to explore what actually happens when an IWB is used in a preschool setting, rather than relying on what preschool teachers describe (Bakeman & Quera, 2011; Björklund, 2007; Creswell, 2013). Other forms of data collection may not provide such a detailed picture of the interactions undertaken around IWB. Video observation, therefore, represents entire episodes of interactions using digital technologies to structure teachers' teaching practices. Using video observation, I as a researcher could scrutinise the phenomena over and over again at different speeds and explore the phenomena studied from different angles.

Video observation gives direct access to preschool teachers' and children's practices using technological artefacts such as IWB while at the same time recording what happens on the IWB screen. Apart from recording what happens around IWB use, the recorded videos provided additional information, including children's body language and facial expressions. Such

signs and expressions have been transcribed and used in the analytical process (Björklund, 2010; Creswell, 2013).

Video observation, however, has certain disadvantages which can have an impact on the collection and analysis of empirical materials. First of all, video observations capture just a part of the practices studied (Björndal, 2002; Cotton, Stokes & Cotton, 2010; Creswell, 2013). Based on the camera's frame, only part of what happened in a given context could be recorded. Furthermore, I often selected some episodes and discarded others, which may have influenced the findings of the study (Duranti, 2012). In an effort to avoid this sort of selectivity, the camera was set up in the corner of the classroom so as to get a wider, and at the same time more accurate, picture of the ways teachers structure their teaching practices using IWB. The camera was fixed on a tripod in a way that did not disturb the teacher and children's ongoing interactions (Heikkilä & Sahlström, 2003).

My physical presence in the room, along with my camera, is another concern which may have had an influence on the way in which teachers and preschool children acted (Jordan & Henderson, 1995). To minimise these effects, I took part in some of the preschool's activities. On these occasions, I participated in children's in-door and out-door activities along with their teachers. By doing this, I tried to initiate relationships based on trust and respect with the children before commencing video recordings. Establishing trusting relationships with children is time consuming but has been highlighted as important by several researchers (Clark & Moss, 2001; Lancaster, 2006).

5.7. Dataset //

The video data was used to address the second research question - How do preschool teachers use IWB to structure their teaching practices? The data provided detailed information of what teachers did.

5.7.1. Participants and procedures

Empirical data was collected from preschool A in early 2013 (see also Participants and procedures in an earlier part of this chapter). The video observations were carried out in only one of preschool A's departments (see Table 3). Due to the reorganisation of the physical learning environment, preschool B was not able to take part in this study.

Table 3. An overview of empirical data collected

Preschool teacher	Date of video observation	Length of video observations
Mona	12 th March, 2013	25 minutes
David	13 th March, 2013	20 minutes
Matts	19 th March, 2013	35 minutes

Observations of three preschool teachers (two men and one woman) and their respective participant groups using IWB in their teaching practices provide the data sources. The participant preschool teachers had different levels of teaching expertise. In Swedish preschools, each of the teachers are expected to demonstrate knowledge and skills in the given core subjects including mathematics, nature, digital technologies and Swedish (The Swedish National Agency for Education, 2018). In this case David was the preschool teacher responsible for digital technologies and mathematics. Matts was responsible for Swedish language and Mona was responsible for natural sciences. Based on the preschool's existing routines and planning, most of the teaching practices with IWB took place before noon.

In order to gain a deeper understanding of the ways in which interactive whiteboards are used to structure teaching practices, the actions of both preschool teachers and children were taken into account. On the occasions when video recordings were made, I was behind the camera and did not intervene in the ongoing interaction. The studied department had 21 registered children aged three-six years old. The participating preschool teachers planned and conducted their own mathematical activities session using the IWB, without any interventions or suggestions from me.

5.7.2. Data analysis

After each video observation, the collected material was reviewed once and first impressions of the recorded events were written down. Then all of the collected material was reviewed again. This review enabled an account of the teachers' different strategies to structure teaching practices to emerge. The sequences that focused on the ways the teachers structured their educational activities using IWB were marked and transcribed.

Interaction Analysis (IA) (Jordan & Henderson, 1995) was used as a conceptual tool to analyse the transcriptions. IA is an interdisciplinary method for the empirical investigation of people's interactions and communications. The video recordings were transcribed and the preschool teachers' activities, children's activities, the talk and the verbal and non-verbal interactions were

represented precisely. The transcripts were studied in-depth and some sequences which were not totally clear were double checked.

The analysis of the collected data was done in the following steps:

Step 1- The ZPD activities, where the preschool teachers' verbal and nonverbal actions and reactions to enable children to fulfil activities which they could not do on their own, were particularly marked.

Step 2- Strategies that the preschool teachers used to structure their teaching activities using IWB to support children within their ZPD were identified. This was done through identifying and drawing what and how teachers used IWB features and applications in their teaching to support children within their ZPD.

Step 3- Finally, the different strategies that the teachers used to structure their teaching activities were identified and placed into three categories. These categories map different ways that the observed preschool teachers structure their practices to support children based on their ZPD.

5.8. Dataset III

To address the research questions *III* and *IV* a series of observations were conducted in late 2017 and early 2018. The observation of five preschool teachers and 22 preschool children's work with IWB provides the core data for these research questions.

5.8.1. Participants and procedures

Contacts were made with the regional Centre for Educational Development which operates across Sweden as well as online forums dedicated to enhancing teachers' competences using IWB (for example, Smartboardklubben in Swedish). Based on the information gathered, contacts were established with a number of preschools in different cities in Sweden. Finally, three preschools were chosen to participate in the study. However, two of them turned out not to be suitable for this part of the study since the preschool teachers did not actively use an IWB in their teaching practices. To address the research questions *III* and *IV*, then, the data was collected in one preschool located in central Sweden.

The fieldwork included five preschool teachers and 22 children aged four-six years old and took place across five months in 2017 and early 2018. Observations of preschool teachers (one man and four women) and their respective participant groups using interactive whiteboards in their teaching practices provided the data sources (see Table 4).

Table 4: Teaching practices with IWB and total time recorded

Preschool teachers	A	B	C	D	E
Observed teaching practices					
1	15 min and 33 sec	15 min and 44 sec	25 min and 12 sec	15 min and 23 sec	18 min and 2 sec
2	16 min and 51 sec	20 min and 51 sec	14 min and 26 sec	12 min	16 min and 24 sec
3	13 min and 5 sec	13 min and 55 sec	24 min	19 min and 12 sec	
4	6 min and 54 sec		20 min and 51 sec		
5	19 min and 5 sec				
6	14 min and 23 sec				

All of the participant teachers were qualified preschool teachers with a three and a half year university degree in early childhood education. Four of them had worked in the observed preschool for some years and one of them (called teacher E) was quite new. All of the observed occasions were conducted between 9.30-11.00 because the preschool teachers' teaching practices with the IWB occurred at this time. In order to meet the requirements of the study, the preschool teachers' ongoing and regular teaching when working with mathematical concepts using the IWB were observed in 18 teaching practices for a total of 306 minutes.

5.8.2. Data analysis

Research question *III* is focused on the ways preschool teachers scaffold children's learning processes in a context where IWB are used. The collected data - that is, the video-recorded observations - were analysed in the following four steps.

Step 1- A number of the total 772 meaning units - that is, units of analysis in the form of short sentences - were selected. These meaning units were chosen on the basis of Wood et al.'s (1976) six scaffolding functions. Each meaning unit consists of either an excerpt of what the teacher said or a

description of what the teacher did in relation to the ongoing activity next to the IWB. Further, the combination of talk and a particular physical action performed by the teacher was taken into account when meaning units were constructed.

Step 2- The teachers' actions in relation to the teaching practices were described.

Step 3- The central verb that was used to describe the meaning unit in Step 2 was extracted and regarded as a summary of the teachers' actions. In some cases, the verb was combined with a clarifying noun or preposition. All the verbs identified were then considered as different categories which, as a final fourth step in the analysis, were evaluated in relation to Wood et al.'s (1976) six different scaffolding functions.

Step 4- Similar verbs that formed a shared category were Included. The final analysis resulted in 21 different categories of teachers' actions. As a result of this process, when a handful of teachers' actions did not fit into Wood et al.'s scaffolding functions, two further scaffolding functions were identified.

Research question IV centred on the ways IWB mediate teaching actions and what is privileged in the IWB-mediated teaching actions. The video-recorded observations were reviewed in detail with a focus on mediational means. The focus was placed on the ways that the IWB mediates preschool teachers' teaching actions. The analysis process was conducted in three steps.

Step 1- The mediational aspects of IWB were identified, resulting in seven mediational aspects of IWB being specified.

Step 2- The next step was to identify how these mediational aspects of IWB mediated teachers' teaching actions. It was discovered that some mediational aspects of IWB can contribute to different mediated teaching actions.

Step 3- Finally, what was privileged in relation to IWB-mediated actions was clarified.

5.9. Validity, reliability and generalizability

Reliability and validity in qualitative research take into account precision, credibility, and transferability in the design, implementation and analysis of a study. The notion of reliability and validity have been developed in relation to collecting, analysing and interpreting quantitative data. Validity in qualitative research refers to the appropriateness of the tools, the process of collecting empirical material and the analysis of collected data which

demonstrates that the study is credible (Creswell, 2013). It corresponds to the question “how can an inquirer persuade his or her audiences that the research findings of an inquiry are worth paying attention to?” (Lincoln & Guba, 1985, p. 290). Qualitative research methods are often designed to capture the complexity of a phenomenon or setting and not to establish its generalizability to other settings (Shadish, Cook & Campbell, 2002). In qualitative studies, internal validity in the form of the authenticity of the data and the soundness of the research design, are critical.

Kvale and Brinkman (2009) show that the validation process takes place in seven stages, including thematization, planning, interviewing, printing, analysis, validation and reporting. In this thesis, my intention is to give a transparent and detailed account of the data collection and data analysis process. Through providing a detailed description of my samples, sampling procedure, ethical issues, process of data collection as well as data analysis process and results, I demonstrate that the collected empirical data has been generated and processed appropriately and as a result can be seen as credible (Creswell, 2013).

In the same vein, and in order to achieve high validity and reproducibility, I have made an attempt to describe my role as a researcher, and the methods I used to generate the data and its analysis precisely. For instance, to avoid interacting with and intervening in the interplay between preschool teachers, digital technology (IWB) and children, I tried to act as an observer who observed the preschool teachers’ teaching practices without engaging in their teaching. However, in practice, sometimes the participant children in the preschool context interacted with me. This encouraged me to step into the role of the participant observer.

By discussing my conclusions from the data collected with the participating preschool teachers, further, I tried to confirm my understandings from the preschool teachers’ reasoning and their ways of using IWB in their teaching practices. The design of the study, its methods, theoretical frameworks, analysis process and findings have been regularly discussed in a number of national and international conferences as well as at internal postgraduate seminars, including SMED¹ at Örebro University and preschool education seminars at Dalarna University.

The findings of this study, however, are not intended to be generalized into other educational settings. For statistical reasons, this study does not allow inferences to be drawn about the prevalence of particular views or

¹ Studies of Meaning-making in Educational Discourses

experiences (Smith, 2018). This was not the point of the study. Rather, as Lewis Ritchie, Ormston & Morrell (2014, p. 351) points out “the value of qualitative research is in revealing the breadth and nature of the phenomena under study”. The results of this study are built on a small number of preschool teachers in three preschools; the statistical-probability generalisation is neither applicable to this qualitative study nor is it an aim of it.

The findings of this study, as Larsson (2005, 2009) puts forward, can only be related to the studied cases. However, the rich detail which I provide in the current study can make the findings relevant to other preschools. In other words, by providing a detailed account of the ways a particular digital technology, the IWB, interplays with preschool teachers’ teaching practices, the findings of this study can be extended to other educational settings. Merriam (2002) points out that “the general lies in the particular; what we learn in a particular situation we can transfer to similar situations subsequently encountered” (p. 28). By providing detailed descriptions of the ways a particular digital technology interplays with teachers’ teaching practices, the findings and implications of this study can be transferred to other educational contexts and allow wider inferences to be drawn. Furthermore, by constructing new dimensions in scaffolding theory (Wood et al., 1976), the findings of my study contribute to the expansion of this theory, a process which is significant for other studies.

5.10. Ethical considerations

This study is conducted in accordance with Swedish regulations of, and guidelines for, research ethics (SFS, 2003:460; The Swedish Research Council, 2017). According to the Ethical Review Act (SFS, 2003:460) studies that do not include sensitive personal data, do not involve a physical intervention any physical or psychological impact, or do not carry obvious risks of harming the participants, do not need to be formally approved. The research data in this study include interviews with preschool teachers about using IWB in teaching and observations of preschool teachers’ teaching practices using IWB. The data does not cover any sensitive personal information², and there is a limited risk of harm to the study’s participants. Correspondingly, the study did not need to undergo formal ethical review. However,

² My data collection was conducted before the introduction of the General Data Protection Regulation (GDPR). Therefore, the participants’ explicit consent to collection and processing of personal data was not sought.

this does not mean that I did my data collection without considering its ethical aspects, including consent and confidentiality.

5.11. Informed consent

The informants and participants in this study were given information about their participation and the terms and conditions for their contribution. This information addressed the issues which were most likely to impact on their willingness to participate (The Swedish Research Council, 2017).

Similarly, information about the aim, method and procedure of the study was given to the participants, both preschool teachers and children's guardians. The information was supplied both verbally and in writing. The information was given partly on pre-planned occasions, such as when I had a meeting with the participant preschool teachers. The participant preschool teachers were informed about everything relevant to their participation in the study so that I was assured that participants were willingly taking part as research subjects (Gustafsson, Hermerén & Petersson, 2006; Johansson, 2013; Quennerstedt, Harcourt & Sargeant, 2014). The participant preschool teachers, accordingly, received a separate consent letter in each of the given data collection periods. Letters addressing the aim, the method of conducting the study, and ethical issues in the study were also sent to the participant preschool teachers. Both in the letters and on pre-planned occasions the teachers were informed that they could withdraw from the study at any time, that all data collected was confidential and that no unauthorized persons would be able to access the collected data.

I organized a meeting with preschool teachers and children's guardians in each of the preschools to present the aim, process and meaning of the study and the ways in which it could influence the children's education in the preschool. It was highlighted that children's participation in the study was very important in order to gain a deeper understanding of the ways digital technologies, IWB, were used in preschool practices. Teachers and guardians were told that studies like this can, further, enhance researchers' understanding of children's engagement with digital technologies, which can then be used to inform policy and future practice. They were also informed that the collected data would only be used for academic purposes. To ensure that all informants were aware of what the purpose of the study was and what their children's participation meant, the information letter for those guardians who did not have Swedish as their native language was sent both in Swedish and in their respective mother tongues. Since the children were very young (most were under the age of five) and there was a risk

that they did not fully understand the meaning of their participation in the current study, the written consent of the children's guardians was required. The children's parents or legal guardians were, accordingly, given consent forms to sign, allowing children to participate in the study.

To make the children familiar with me, I visited the preschools on a number of occasions before data collection and participated in various activities with the children as part of their daily practices. By participating in their daily activities, I tried to interact with the children and preschool teachers. By using a variety of examples, the aims and significance of the study for the children was explained. For instance, in some cases I asked questions, such as if they had heard the words 'research' and 'researcher'. Then I indicated that I was interested to learn more about how the children and their preschool teachers used the IWB (Johansson, 2013).

Getting young children's consent became vital when it came to the video recordings. Children always have the right to decide whether they want to be video filmed or not by giving or not their verbal consent. Notwithstanding the children's guardians' written consent, data collection should not be carried out if children do not want to take part in the study. The children were, accordingly, informed that they could withdraw from the video recording whenever they wanted. Similarly, at each of the data collection occasions, I asked the children's permission to video record their activities with the IWB. Sometimes interpreting the children's approval was problematic. In these situations my interpretation was based on children's non-verbal signals as well as their actions (Johansson, 2013). On some occasions, a few of the children were unsure of what should happen next and stayed away from the IWB just when I started video recording. In such cases, I understood that they did not want to participate in the video observation and stopped recording.

5.12. Confidentiality

Confidentiality and protecting the participants' identity was another important ethical issue which was taken into account in this study. Confidentiality means that empirical material and data should be de-identified and presented in a manner so that participants' identity cannot be revealed. In alignment with the Swedish Public Access to Information and Secrecy Act (2016/679) the collected data regarding teachers and personal data relating to the children, including coded information, was regarded as confidential. To do this through transcribing and coding, the individuals were detached from the collected data.

The preschools' names, preschool teachers' names and all the names of the children were changed in the produced texts. During the analysis of the data, I kept all material on a password-protected computer. After completion of the study, research data, primary materials and research records such as the video films, participant lists and consent forms will be stored in accordance with the regulations at Örebro University.

Before and during data collection, it was clearly stated that the data collected on individuals would only be used for research purposes (The Swedish Research Council, 2017). Furthermore, during the fieldwork stage of the research, the collected data, both recorded interviews and recorded videos, were only used for academic ends. Finally, it should be stressed that ethical issues have been taken into account throughout the entire study process. They have underpinned the design of the study, the collection of empirical materials, the analysis of the data and the report of the findings (see Gustafsson et al, 2006).

5.13. Reflections on the methodological approach

The methodological concerns and procedures, including transferability and validity, are partly addressed in the earlier research methodology chapter. This section includes reflections on the study's methodological approach.

Before conducting video observations, I did interviews with a small number of preschool teachers from one municipality who already work with IWB. This study was limited to a few preschool teachers who were known to be actively working with IWB and willing to participate in the study. This became a limitation of the study because of its potential to lead to incomplete or biased results (Larsson, 2009). A randomly selected sample of preschool teachers from several municipalities could have been a more representative study group.

Another concern and a potential limitation in examining research questions II, III, and IV is about conducting video observation in early childhood education. Video observation has its many advantages but it also has significant challenges (Creswell, 2012). One of the risks is that the presence of a researcher, as well as video camera, may affect the ways preschool teachers enact IWB in their teaching practices as well as the ways children communicate with IWB or with their preschool teachers. The researcher effect is well documented in the literature (see Bryman & Nilsson, 2011). To minimise the possible negative effects, I took part in indoor and outdoor

activities at the participating preschools. On these occasions, I tried to initiate relationships based on trust and respect with preschool teachers and children so that they become comfortable with having someone who participates in their educational practices (Clark & Moss, 2001; Lancaster, 2006). In addition, based on my frequent and long-term presence in the preschools during the observations, preschool teachers and children gradually became accustomed to my presence as a researcher.

Moreover, collected data from video observations covers a wide range of information which can be analysed from different perspectives. My theoretical framework, as well as my experiences as a preschool teacher and as an educator in early childhood teacher education programmes, helped me to analyse the collected data from one perspective at a time. This has facilitated the process of analysis and interpretation of the collected data. My experiences as a preschool teacher who worked closely with digital technologies helped me to understand preschool teachers' actions and procedures in a given context. Being aware of the preschool teachers' actions brought about a kind of closeness to the collected data. Such closeness could, however also lead me to see and analyse the observed phenomena based on what I already knew or what I wanted to see. To avoid such pitfalls, I tried to be critically aware of the impact of the research context as well as my earlier experiences and background. In addition, my data and findings have been continuously discussed with other scholars during the research process.

Data for this study has come from a small number of preschool teachers. Thus, the findings cannot be generalized to other educational settings in a strictly statistical sense. Through rich descriptions of the ways a particular digital technology interplays with teachers' teaching practices, however, the findings and implications of this study can be transferred to other educational contexts. This study, contributing to developing of the theoretical framework, provides further opportunities for wider inferences to be drawn.

6. SUMMARY OF THE ARTICLES

In this chapter, a summary of the four articles included in the thesis is provided. In answering the study's four research questions, the summary focuses on the articles' results. The theoretical framework and research methods are presented in previous chapters. The findings are discussed in the next chapter.

6.1. Article /

Bourbour, M., & Björklund, C. (2014). Preschool teachers' reasoning about interactive whiteboard embedded in mathematics education in Swedish preschools. *Journal of Nordic Early Childhood Education Research*, 7(2), 1-16. DOI: <https://doi.org/10.7577/nbf.608>

This article examines teachers' reasoning about the embedding of IWB in preschool education. Semi-structured interviews were carried out with preschool teachers. The sampling of preschool teachers was done based on the availability and the suitability of the research subjects where the use of IWB had to be part of their educational practice. The interviews were carried out with four teachers in two preschools in spring 2012. Mediation and the way IWB as a digital artefact mediate children's education was used to analyse the empirical data.

The findings show that teachers consider the use of IWB in preschool as something which can create space for children to get involved in problem-solving situations. According to the teachers, using IWB's multimedia features - such as moving, replacing, modifying and minimizing pictures; taking a picture, sharing it, dividing it, moving it, deleting and adding it; and searching the Internet - offer a variety of opportunities to initiate, share and solve problems.

They further argue that the use of IWB can support collaborative learning and mutual negotiation where children can explore and share their understandings with each other in a collaborative process. Within this collaborative process, using IWB can motivate children to actively take part in defining and solving problems where meaning-making is facilitated through communication about common projects. According to the preschool teachers, working on common projects on the IWB's big screen can also foster a culture of collaborative learning and mutual engagement. This may open up opportunities for even more learning opportunities. The preschool teachers

argue that group discussions, the negotiation of meaning and mutual support between children can be facilitated and enhanced through the use of IWB.

The teachers also state that children's goal-oriented mathematics learning can be facilitated by IWB. They believe that IWB's multimedia and interactive features, such as its visual nature, colour and touch-sensitive board offers a number of opportunities to represent and exemplify mathematics concepts in a concrete way, and that these multimedia features can support the different learning styles of children.

According to the interviewed preschool teachers, the use of IWB can help preschool teachers to retain children's interest in learning activities. The teachers particularly highlight the IWB's large screen and its visual features as key aspects in capturing children's attention, motivating them to engage, and maintaining their concentration in the teaching sessions. They argue that through the use of IWB's features, preschool teachers can retain children's attention and provide learning activities that might not otherwise have been attainable. The teachers, moreover, underlined the importance and significance of using technological artefacts such as IWB to create rich learning environments in early childhood education.

6.1.1. Research question /

The first research question, addressed in Article I, concerns how preschool teachers reason about the embedding of IWBs into their teaching practices. All of the interviewed preschool teachers demonstrated an overwhelmingly positive approach to the role that IWB can play in their teaching practices. A large number of studies (see Corbo 2014; Nir-Gal & Klein, 2004; Plowman & Stephen, 2007, 2013; Voogt & McKenney, 2008) show that teachers' own approach to digital technologies is significant for their use of IWB in teaching. The interviewed preschool teachers in this study did not raise any possible challenges and barriers connected to the use of IWBs in preschool educational practice.

The benefits of using IWB that the teachers expressed include several areas. They thought that the IWB could be beneficial because of the potential it had to create an interactive space for children that involved them in problem-solving situations in which they could actively participate and make active choices. They pointed to the IWB's multimedia features as offering a variety of opportunities to visualize and animate educational practices. They further noted that the use of IWBs could help preschool teachers to capture children's attention, maintain their concentration and motivate

them to learn. Taken together, the preschool teachers demonstrated a positive perception of the interplay between the interactive whiteboard and teachers' opportunities to design a rich learning environment where children can actively engage in the given teaching activities.

6.2. Article //

Bourbour, M., Vigmo, S., & Pramling Samuelsson, I. (2014). Integration of interactive whiteboard in Swedish preschool practices. *Early Child Development and Care*, 185(1), 100-120. DOI: <https://10.1080/03004430.2014.908865>

This article aimed to investigate the ways that preschool teachers structure and make use of IWB in their pedagogical practices. Empirical data for this study were collected from observations of three preschool teachers and their respective groups using IWB in their educational practice. The studied preschool department had 21 children aged three - six years old. In this article, Vygotsky's zone of proximal development is adopted to examine the ways preschool teachers help children to fulfil/do activities which they could not do on their own.

The analysis of the video-recorded material shows that preschool teachers employed diverse strategies to structure their teaching practices using IWB based on children's ZPD. The findings demonstrate that preschool teachers frequently used the IWB's multisensory resources in their teaching practices. They employed the multisensory resources of IWB to help children handle problem-solving activities. The teachers using these resources, further, scaffolded children's learning activities in different ways, such as stimulating them by asking challenging questions and giving them necessary information and feedback, thereby engaging them in discussions with each other.

The preschool teachers, according to the findings, employed the IWB's features to structure their teaching practices so that they challenged young children to engage in problem-solving activities. By representing and highlighting the given teaching activities on the IWB, the participating preschool teachers invited children to solve given problems. The way these preschool teachers used IWB, however, affected children's engagement in the problem-solving activities. One of the observed preschool teachers integrated IWB into their preschool teaching practices in a significantly different way than the others. This teacher to a great extent used the IWB as a presentation or display artefact, while its other potential features were not deployed. This may suggest that teachers' ICT competence may impact on their ways of structuring teaching practices using IWB.

The analysis of collected data, further, shows that preschool teachers structure their teaching practices on the IWB by taking the child's interest

as their starting point. This exemplifies how the use of IWB's multimedia features can increase children's opportunities to make their own choices about what and even how they would like to engage in the problem-solving activities. Moreover, children's active participation in searching the Internet, sharing and modifying pictures, and putting together their findings on the IWB can promote their learning.

One of the greatest challenges to Swedish early childhood education is developing goal-oriented teaching practices wherein children's perspectives, initiatives and ideas are taken into account. This process, as indicated by the findings of this article, can be facilitated by the use of digital technologies. However, its accomplishment is dependent upon skilled preschool teachers who not only have a solid pedagogical knowledge but also have sufficient technological skills.

6.2.1. Research question //

The second research question, reflected in Article II, asks how preschool teachers use IWB to structure their teaching practices. The preschool teachers use IWB's features to structure their teaching practices in different ways. In a number of teaching situations, the preschool teachers employ the IWB's multisensory features to engage children in the problem-solving process based on their ZPD. In other instances, using the IWB's visual nature, colour and touch-sensitive board, teachers highlight and represent the given teaching activities on IWB and invite children to solve the given task. A number of the preschool teachers, further, employ IWB's features to structure role-play activities in order to support children's learning within their ZPD.

By exemplifying the different ways teachers use the IWB to structure their teaching, the findings underline the preschool teacher's key role in integrating digital technologies into early childhood education. The findings, on the one hand, illustrate that the ways preschool teachers use the IWB's various features to structure their teaching practices can encourage children to be actively and passionately engaged in the given teaching activities. In these teaching practices, preschool teachers employ the IWB to structure their teaching based the children's perspective. On the other hand, the findings also show that teachers who use the IWB to structure their teaching can do so without fully taking into account children's interests or their active participation in the given activities. In these teaching activities, the IWB is employed simply as a presentation tool, and in the observed situations in this study, did not maintain children's interest. This became evident when the children left the teaching situation.

6.3. Article ///

Bourbour, M., Högberg, S., & Lindqvist, G. (2019). Putting scaffolding into action: Preschool teachers' actions using interactive whiteboard. *Early Childhood Education Journal*. 47(5), 1-14, <https://doi.org/10.1007/s10643-019-00971-3>

This article examines preschool teachers' actions supporting children's learning processes in a context where an interactive whiteboard is used. The empirical data consists of video observations in one preschool. Five preschool teachers and 22 children aged 4-6 were video observed over a period of five months in 2017 and early spring 2018. The preschool teachers were observed teaching mathematical concepts using IWB in 18 teaching situations for a total of 306 minutes. In this article, scaffolding is used as the conceptual framework. The focus is placed on preschool teachers' scaffolding actions in order to support children's learning processes using IWB. Based on Wood et al.'s (1976) six scaffolding functions, the analysis of the collected data resulted in 21 different categories of teachers' actions.

By characterizing teachers' actions in relation to different scaffolding functions, the relationship between action and scaffolding function is clarified. Six of the identified functions (direction maintenance, recruitment, reduction in degrees of freedom, marking critical features, demonstration and frustration control) were aligned with Wood et al.'s (1976) theoretical framework.

The scaffolding function *direction maintenance* addresses the ways preschool teachers act to challenge children's perceptions, concretise the task, question and instruct children in the given task. *Recruitment* covers actions such as inviting children, providing space for reflection, providing feedback and affirming children's actions and reflections. *Reduction in degrees of freedom* covers actions such as simplifying the task, filling in the blanks and confirming children's responses to fulfil a task. *Marking critical features* addresses the ways preschool teachers act to challenge children's perceptions of the given task and clarify its possible causes and consequences on the IWB. *Demonstration* includes actions such as displaying a solution, explaining a solution and referring back to the previous activity on the IWB. *Frustration control* covers actions to minimise children's stress including physical proximity, such as standing or sitting beside them.

The study identified two scaffolding functions not identified in Woods et al.'s previous work (1976) and contributes thereby to the development of this theoretical framework. The two additional scaffolding functions are

mutual enjoyment and participation in the activity. *Mutual enjoyment* addresses the ways that the preschool teacher is emotionally involved in the given educational tasks, by being responsive and sensitive to children's actions and reflections. *Participation in the activity* reflects the finding that preschool teachers not only support children in an activity by their physical proximity but also by participating actively in the given teaching activities as contributors.

6.3.1. Research question III

The third research question, addressed in Article III, explores how preschool teachers scaffold children's learning processes in a context where IWB is used. The analysis of empirical material shows that preschool teachers use a variety of actions to scaffold children's learning using IWB. Teachers particularly use the following actions in the scaffolding process: concretizing, questioning, instructing, providing space, affirming, providing feedback, inviting, watching, laughing together, approaching, standing or sitting beside, simplifying, filling in the blanks, confirming, participating, challenging perceptions, challenging thought, explaining, displaying, explaining, and referring back. According to the findings, providing feedback, approaching, simplifying and challenging are the actions which are most frequently used by preschool teachers in their scaffolding process.

The findings further show that the teachers' actions can have different functions. The relationship between teachers' different actions and scaffolding functions are clarified. Eight scaffolding functions are identified of which six - recruitment, direction maintenance, marking critical features, reduction in degrees of freedom, frustration control and demonstration - were aligned with the Wood et al.'s (1976) theoretical framework. However, some of the preschool teachers' actions in the scaffolding process did not fit into this framework. As a result, two further scaffolding functions - participating in the activity and mutual enjoyment - are identified. By exploring these additional scaffolding functions, the study makes a contribution to Woods et al (1976) theoretical framework.

Interestingly, the findings show that teachers use similar actions in relation to different scaffolding functions. For instance, in some teaching situations teachers challenge children to keep them pursuing a particular task, and in other teaching situations teachers challenge children to highlight certain features of the task. In that sense a similar action of scaffolding appears different because of its related scaffolding function.

6.4. Article IV

Bourbour, M. (Submitted manuscript). Using digital technology in early childhood education teaching: Learning from teachers' teaching practice with Interactive Whiteboard.

This article investigates how a particular digital technology, IWB, mediates preschool teachers' actual teaching in the preschool environment. The research questions were twofold: 1) how does IWB mediate preschool teachers' teaching actions 2) what is privileged in the IWB-mediated teaching actions? The empirical data was collected through observations in a preschool with five preschool teachers and 22 children aged 4 - 6. The empirical material comprised video recordings of 18 teaching situations, with teachers working with mathematical concepts using IWB. The concept of mediation provides the main conceptual framework for interpretation, more specifically mediational means (that is, a specific aspect of IWB) and mediated actions (that is, teachers' actions in relation to the specific aspect of IWB). By identifying the mediational aspects of IWB, this study sheds light on the relationship between mediational means and teachers' teaching actions and has mapped what is privileged in these actions. The seven ways that IWB-mediated teaching actions privilege teaching practices display desirable/undesirable and intended/unintended consequences of using IWBs in preschool educational practices and illustrate how IWBs inform preschool teachers' teaching.

The results have mapped the ways the mediational aspects of IWB mediate teaching actions. The findings, for instance, demonstrated the IWB's big screen and multimodality as a mediational aspect that mediates teachers' actions through visualizing and highlighting the given teaching content. This privileged children's engagement in the teaching situations. The findings further demonstrated that the big screen and interactivity of IWB mediate teaching actions in terms of providing just in time and just in the point feedback to both individuals and the whole group. This IWB-mediated teaching action privileged making visible children's problem-solving processes. The multimodality of the IWB, further, mediated teaching actions to combine and manipulate images, animations and texts from a broad range of sources directly on the IWB's big screen. This IWB-mediated teaching action privileged integrating real-world activities into virtual activities on the IWB's big screen.

The analysis also showed that the interactivity and multimodality aspects of IWB mediate teaching actions in terms of creating and moderating discussion among children. These actions were found to privilege whole class dialogue wherein teachers and children can explore concepts and problems together. Moreover, a mediational aspect of IWB which was found to mediate teaching actions is the IWB's indefinite storage and quick retrieval of educational resources. This was found to mediate teaching actions in terms of storing and retrieving reusable educational resources, which privileged instant access and organising teaching resources.

Pre-prepared teaching materials and fully structured applications were also identified as mediational aspects of the IWB, mediating a teacher role as a controller rather than as a teacher who facilitates children's learning and development. The ensuing teaching actions privileged less discussion between teacher and children and among children. Finally, the inflexible placement of IWB mediated teachers' teaching actions in terms of conducting them within a fixed room/learning environment. An inflexible learning environment was privileged, which limited the teachers' opportunities to create calm and focused learning environments. What was privileged in these IWB-mediated teaching actions can be mapped as displaying both the desirable and (or) undesirable as well as intended and (or) unintended consequences of using IWBs in preschool educational practices and can illustrate how IWB interplay with preschool teachers' teaching.

6.4.1. Research question IV

The final research question, addressed in article IV, asks how the IWB mediates teaching actions and what is privileged in IWB-mediated teaching actions. The IWB mediates teachers' actions in different ways, first, by offering a range of possibilities to be manipulated and highlighting certain activities. This helps teachers to engage children actively in their teaching practices. Second, the IWB mediates teachers' actions by supporting those that provide concrete and constructive feedback to children, which in turn makes problem-solving processes more visible. In addition, this digital artefact mediates teaching that creates and moderates discussion among children, thereby contributing to the enhancement of whole class dialogue. The IWB facilitates the storing and retrieving of reusable educational resources, and this mediation makes it possible for teachers to instantly access and (re)organise the available teaching resources. The IWB also mediates the ways teachers combine and manipulate images, animations and texts on the IWBs

big display. This expands teachers' opportunities to integrate real-world activities into virtual activities on the IWB's big screen.

The findings, moreover, demonstrate that IWB mediates the ways teachers control the flow of the teaching and learning process. This can have the effect of minimising the discussion between teachers and children and among children themselves. The fixed and inflexible placing of IWB, further, forces teachers to conduct their teaching activities in a predefined context. This mediation constrains teachers' opportunities to choose where and even when they can conduct their teaching activities with IWB.

7. DISCUSSION

The research presented in this thesis has sought to investigate the ways digital technologies interplay with preschool teachers' teaching practices. The thesis has focused on a specific digital technology, the IWB. In the following, I will first discuss preschool teachers' reasoning about the embedding of IWB into their teaching practices and the ways they use the IWB to structure their teaching. Then, I will discuss scaffolding in teaching when IWBs are used, as well as the ways IWBs mediate teaching actions and what is privileged in the IWB-mediated teaching actions. In conclusion, the possible contributions of the study as well as the direction of any future studies will be discussed.

7.1. Digital technologies in early childhood education

This thesis contributes to an understanding of the ways digital technologies are perceived and are actually being used by preschool teachers in preschool settings. Introducing and using digital technology as an integral part of the preschool educational environment is a challenge. On one hand, as Selwyn (2010) puts forward "thousands of hours and millions of dollars are directed towards the optimistic exploration of how technology is capable of supporting, assisting and even enhancing the act of learning" (p. 66). On the other hand, it is uncertain whether these investments have transformed the fundamental elements of the teaching process (Cuban, 2006; Selwyn, 2012).

Preschool teachers play a critical role in determining the ways in which digital technologies can be used in early childhood education. The importance of the teachers has been widely endorsed in the published literature (see Camilleri, 2018; Luo & Yang, 2016; Miller et al., 2005; Neumann, 2014; Neumann & Neumann, 2014; Samsonova, 2017) where it is argued that teachers' attitudes to digital technologies will affect how they use these technologies in their educational practices. How preschool teachers reason about digital technologies and the use of these is therefore important knowledge. In accordance with previous studies, this thesis shows that preschool teachers have a generally positive approach to digital technologies. According to the preschool teachers, the IWB can extend their opportunities to capture children's attention and maintain their concentration and motivate them to actively engage in the teaching activities. In addition, teachers state that the IWB's features can contribute to creating an interactive teaching environment.

The preschool teachers in this study used the IWB in very different ways in structuring their teaching practices. By role playing, one of the observed preschool teachers made use of the opportunities that IWB offers to support children's learning. The other preschool teachers, however, used IWB more or less as a whiteboard and accordingly did not employ the additional possibilities that IWB offers. For these teachers, the use of a technological artefact did not change or add anything to the educational practice. Based on the findings of the current thesis, it can be said that the potential advantages of using IWB depend on the ways preschool teachers structure their teaching practices with the interactive board. Also Means (2008) and Sherman, Cayton and Chandler (2017) suggest that a beneficial use of digital technologies relates to the type of tasks being done and the ways those tasks are undertaken. This issue consequently concerns the manner in which preschool teachers use digital technologies to go beyond their everyday roles in supporting children's learning (see Caiman & Kjällander, 2019; Hermansson & Olin-Scheller, 2019).

The interactive features and multisensory resources of IWB, have, in previous studies, been shown to provide teachers with a range of opportunities to motivate and challenge children. This research provides examples of teaching activities in which multimodal aspect of IWB are used in teaching actions to create play-driven activities. In these play-driven activities, play and teaching are linked to each other and play is often seen as a prerequisite for children's learning. This is in line with the current Swedish curriculum (The Swedish National Agency for Education, 2018) which gives prominence to play noting that "the preschool should provide each child with the conditions to develop curiosity, creativity and a desire to play and learn" (p.14). The concept of play and play-based activities in early childhood is one of the key concepts in the sociocultural theorising of Vygotsky (Vygotsky, 1978), who sees play as a motivating frame for children's development. Digital technologies can help teachers to develop motivating teaching activities through asking and visualizing 'what if' scenarios on the IWB's big screen. In a teaching situation (see article III), children are given opportunities to do shopping play using an application on the IWB. In this application, children can choose, count, pay and argue about the selected goods. The children can do these activities as if real. Such instances show that digital technologies can frame children's activities and that children - with help from their teachers - can go beyond the fixed design of the application when they play and act. In this case they can take on the different roles of cashier or customer. This is consistent with the findings of Marsh et al. (2016) who

outline the ways “children treated digital pets as ‘real’ animals and pretended to care for them when using the ‘Talking Tom’ app” (p. 249).

I would argue that the IWB can serve as a platform to support play-based teaching in early childhood education. Digital technologies as an educational resource have the potential to extend preschool teachers’ opportunities to support children’s learning (see Gillen, Staarman, Littleton, Mercer & Twiner, 2007; Hvit Lindstrand, 2015). Many teachers, however, feel they are unprepared to use digital technologies in their educational practices. According to the Swedish National Agency for Education report (2016), more than 50% of the preschool teachers surveyed noted that they needed further in-service training to integrate digital technologies in their educational practices. By addressing preschool teachers reasoning and the ways they use a particular digital technology, the IWB, this study can contribute to enhancing preschool teachers’ digital competences.

7.2. The interplay between digital technologies and teaching practices

The current study has illustrated the complexity of teaching in preschool when digital technologies are used. The idea of ‘teaching’ in a preschool context is a relatively new concept, only formally recognised in Sweden in its current preschool curriculum. But it has a long history, which has seen it linked to the origins of the preschool tradition, when Friedrich Fröbel lunched his first kindergarten in 1837 (Fröbel, 1995/1826; Hammarström Lewenhagen, 2013). Since then, the concept of teaching has included early childhood education’s longstanding tradition with its emphasis on children’s development and becoming without external steering. This is aligned with Bennett’s (2010) social pedagogic approach where the focus is on children’s care and development. Teaching in preschool is from this viewpoint seen in its broadest sense as the development of the child as whole, where children’s balanced growth is facilitated by preschool teachers. But teaching in preschool has also been considered as a goal-oriented process which should develop children’s cognitive as well as subject-related skills. Preparing children for future educational attainment, such as preparation for school or readiness for school, is in line with what Bennett (2010) calls as pre-primary approach. Teaching in preschool is then seen as an instruction procedure where teachers use sequenced events and direct teaching methods. The divergence between these two approaches to teaching in preschool does however not quite capture the Swedish educare approach to preschool education. In the educare model, children’s social, emotional and cognitive

development are all catered for in the quest to achieve the goals articulated in the national preschool curriculum (Doverborg & Pramling Samuelsson, 2009; Sheridan & Williams, 2018).

Even though a large number of studies have investigated the use of digital technologies in educational settings, little attention has been paid to the underlying teaching (Castañeda & Selwyn, 2018). The findings of this thesis shed light on the relationship between preschool teachers' teaching and digital technologies, and makes a contribution to by looking at how preschool teachers' teaching practices affect the use of IWB, on the one hand, and how the use of IWB affects preschool teachers' teaching practices on the other (see articles *III* and *IV*).

The examination of preschool teachers' actions in the scaffolding process provides detailed knowledge about the interplay between IWB and teaching practices. This demonstrates how teachers' actions can give individualized support based on the child's ZPD. As indicated in article *III*, scaffolding is seen as a collaborative process where preschool teachers' active participation and emotional support plays an important role in fulfilling the given activities. Thus, scaffolding, as a teaching model, can be used with almost any task using digital technologies. This demonstrates how the ways preschool teachers scaffold children's learning are connected to the ways they use digital technologies in their teaching practices.

The use of digital technologies in preschool practices is influenced by factors other than the teacher. Preschool teachers are not the only ones who make choices; children are also social actors who make sense of, and actively contribute to, their learning environments based on their different experiences and understandings (Liberg, 2014). Thus, to actualise the scaffolding process in a context where digital technologies (IWB) are used, preschool teachers need to take into account children's needs, interests and prior learning experiences.

Questions about the consequences and usefulness of digital technologies in educational settings are one of the key questions for teachers, stakeholders and policymakers when it comes to digitalisation in preschools (Plowman & Stephen, 2013). There are various arguments and predictions that state that digital technologies will not only change teaching practices but will also transform educational environments. In line with Cuban (2001, 2018), I argue that using digital technologies to their full potential can enrich teaching processes. However, identifying the full potential of digital technologies, how teachers can use this potential and how these technologies can actually contribute to teaching practices is an area that should be

critically examined. The empirical findings of my study have shed light on how a particular digital technology, the IWB, interplays with preschool teachers' teaching practices.

My research also maps what is privileged when digital technologies are used in teacher's teaching practices. The results demonstrate how IWBs contribute to teacher-child and child-child interactions. The findings show that the use of IWB enhances whole-group discussions among children wherein children and preschool teachers can explore and challenge each other's thoughts and actions based on what happened on the IWB. The study exemplifies how the use of IWB enhances dialogue among children and motivates them to actively participate in the given teaching activities. These findings are congruent with the results of previous research (see Chou, Chang & Chen, 2017; Harlow, Cowie & Heazlewood, 2010; Terreni, 2010). Other research has, however, argued that the IWB as a teaching artefact limits the possible communications and interactions among children and between teachers and children (see Beauchamp & Kennewell, 2010; Blau, 2011; Schuck & Kearney, 2007, Zevenbergen & Lerman, 2008). The findings of this research support also these more critical earlier results by highlighting that fully structured applications and pre-prepared teaching materials in the IWB increase teachers' control over the flow of teaching practices. Structured applications and pre-prepared teaching materials are based on the drill and practice principles where children are expected to learn by practicing and repeating the given information. In such controlled circumstances, when the teacher's role is limited to approval or rejection of children's responses, it is less likely that preschool teachers can create an interactive learning environment.

Considering that early childhood education requires a dynamic context, I would consequently argue against using fully structured applications since these may minimise teachers' opportunities to create an active and exploratory teaching environment for children (Jack & Higgins, 2019). These findings endorse the notion that the ways digital technologies are designed are crucial for teachers' teaching practices. Open-ended applications and digital teaching materials, as illustrated in the article IV, can engage children in a variety of problem-solving situations where children do not get direct feedback from the given application but instead are given the opportunity to think and reason about their ways of solving a problem. I would, accordingly, underline the importance of developing preschool teachers' skills in choosing open-ended applications and designing open-ended digital teaching materials.

The consolidation of free activities with goal-oriented learning, whereby children's perspectives, initiatives, and ideas are integrated, is one of the challenges for Swedish early childhood education. Using digital technologies can help preschool teachers to find a balance and connect children's imaginations to reality. This is in accordance with the current Swedish curriculum which gives prominence to play, noting that "the preschool should provide each child with the conditions to develop curiosity, creativity and a desire to play and learn" (The Swedish National Agency for Education, 2018, p. 14). However, its accomplishment requires skilled preschool teachers who not only have pedagogical knowledge but also have the technological knowledge required to select appropriate digital teaching material and use technologies in specific educational situations.

7.3. Contributions of the study

The main contributions of this study are three-fold: I) Contribution to the research field of early childhood education; II) Contribution to the theory; and III) Contribution to the practice. These contributions are further presented in three sections below.

7.3.1. Contribution to the research field of early childhood education

Earlier research about digital technology in Swedish preschool settings, as Vallberg Roth (2017) indicates, are mostly focused on learning rather on teaching. This thesis, by examining how IWB interplays with preschool teachers' teaching practices, turns the focus of attention to teaching and thereby contributes to our understanding of teaching in early childhood education.

The results of this study contribute to ongoing debates about if and how digital technologies should or could contribute to early childhood education. The thesis provides insights about preschool teachers' views on the IWB as a teaching artefact, and what they see as possibilities added by using the board (see article I). The thesis also shows that the debate regarding whether or how digital technologies can solve preschool educational challenges could benefit from considering *how* preschool teachers use the technologies in their teaching practices. By addressing these matters, the thesis can help to bridge the gaps between how teachers reason, how they structure and use IWB in their teaching practices and how the use of this particular digital technology mediates teachers' teaching practices. By so doing, this study suggests that preschool teachers' attitudes and pedagogical and

technological skills shape the ways they structure and use digital technologies in their teaching practices.

Furthermore, this research has shown that early interventions, such as structuring and scaffolding processes, can extend preschool teachers' opportunities to facilitate children's learning within their ZPD (see articles *II* and *III*). By providing details about how digital technologies may mediate preschool teachers' teaching, the thesis provides further understandings regarding how the use of digital technologies affects and contributes to teachers' teaching practices (see article *IV*). These issues have rarely been addressed in earlier studies; by addressing them here, the findings thereby complement previous research.

7.3.2. Contribution to theory

By identifying two additional scaffolding functions, - mutual enjoyment and participation in the activity - this thesis contributes to development of Woods et al.'s (1976) theoretical framework. The development of this framework can have significance for other studies. This research also provides additional knowledge about characterizing preschool teachers' actions in relation to different scaffolding functions using digital technologies.

Another contribution of this work is the way I investigate mediational means, mediated actions and what is privileged. By exemplifying the distinction between mediational means and mediated actions, as well as identifying what are privileged, this study has illustrated the consequences of IWB as a mediational means on preschool teachers' teaching practices. This can contribute to Wertsch's (1997) framework of mediational means and mediated actions. Identifying the possible consequences of mediational means and mediated actions, the current study (see article *IV*) can further the understandings about digitalisation in preschool and schools.

7.3.3. Contribution to the practice

The findings of this study can not only be used as a framework to discuss the actual facts and challenges in using digital technologies in preschools. It can also provide empirical knowledge about how digital technologies can be used in early childhood education as well as in school and other educational settings. For instance, the research illustrating teachers' actions in the scaffolding process provides a framework which can help preschool teachers to provide individualized support based on the child's ZPD when digital technologies are used. The development of Woods et al.'s (1976) theoretical

framework can encourage teachers to take these two functions into account when designing and conducting their teaching practices.

By highlighting what is privileged when a digital technology is used, this thesis can contribute to the enhancement of teachers' understandings and encourage their critical reflections on the use of digital technologies in their teaching. This discussion can be extended to pre-service teacher education which could then provide examples for the adoption of digital technologies in future preschool classes.

The findings, also, can be useful for preschool leaders, pre-service teacher educators as well as policymakers who are the key actors in designing and making transformations at preschool level possible. The detailed description of the ways IWB interplays with preschool teachers' teaching practices, specifically, can be transferred to other educational contexts from where other preschool or school teachers can draw inferences. By mapping how preschool teachers take into account the IWB's features to support children's learning within their ZPD, my study reveals vital details about preschool teachers' actions in the scaffolding process which can help preschool and school teachers to enhance their intended actions in the scaffolding process. This thesis can, by highlighting the relationship between the technology, teachers' reasoning and their ways of teaching, inspire discussions among key actors at different levels (e.g. preschool teachers, preschool leaders, and politicians) about their assumptions and the ways digital technologies can be used in preschools in the future.

7.4. Future research

The findings of this research provide detailed descriptions of preschool teachers' actions in the scaffolding process when a particular digital technology, the IWB, is used (see article *III*). Further empirical studies are needed to examine how implementing the identified actions in the scaffolding process can contribute to children's learning using other digital technologies. Analyses of teachers' IWB-supported scaffolding could be expanded to other educational settings including schools and adult education. This type of research can lead to the development of a comprehensive framework for understanding how teachers can scaffold learner's learning using digital technologies.

My study has explored what is privileged when IWB is used in early childhood education. Additional research can contribute to our understanding

of what is privileged when other digital technologies, such as tablet computers, are used and further nuance our understanding of the actual contribution these technologies make to teachers' teaching.

This thesis has shown how a digital technology, IWB, interplays with preschool teachers' teaching practices. By shifting the focus from teachers' teaching to children's learning, it is also important to examine how and to what extent digital technologies can contribute to children's learning. Examinations of how and in which circumstances digital technologies contribute to children's learning can extend the mapping of possible consequences of the use of digital technologies in early childhood education.

This study was focused only on preschool teachers, but there are other actors, including preschool leaders and policymakers, who shape if and how digital technologies are introduced. Further investigation of their role can broaden the insights into digitalisation in early childhood education. Finally, the findings of this study are based on interviews with and observations of nine preschool teachers from three preschools. It is doubtless that additional aspects of IWB that interplay with preschool teachers' educational practices would have been identified if a larger sample of preschool teachers had been followed for a longer period in their daily work.

8.SUMMARY IN SWEDISH

8.1. Introduktion

Utgångspunkten för denna avhandling är ett intresse för de utmaningar och problem som förskollärare möter när digitala teknologier introduceras i förskolan. Med fokus på förskollärare och deras undervisning syftar denna avhandling till att utforska på vilket sätt en digital teknologi, den interaktiva whiteboarden (IWB), samspelar med förskollärarnas undervisning.

Utbildningen i förskolan ska skapa en rik miljö för att säkerställa att alla barn får lika möjligheter att utveckla sina färdigheter i det första steget i utbildningssystemet (Sheridan & Williams, 2018). Förskollärarnas undervisning är en viktig del av förskolans verksamhet. Det pågår en kontinuerlig diskussion om undervisning i förskolan. Vissa röster varnar för skolifiering av förskolan och förskolepedagogiska praktiker som i allt högre grad fokuserar på att förbereda barn för skolan (UNESCO, 2010). Andra röster menar att undervisning i förskolan är en integrerad del av förskolans verksamhet. Denna diskussion kan ses i ljuset av den senaste förändringen av den svenska läroplanen för förskolan (Skolverket, 2018) i vilken undervisningen i förskolan beskrivs som en målinriktad process som ”ska ske under ledning av förskollärare och syfta till barns utveckling och lärande genom inhämtande och utvecklande av kunskaper och värden” (s. 19). Enligt läroplanen ska omsorg, utveckling och lärande utgöra en helhet och integreras i förskolans verksamhet. Läroplanen kräver att lärarnas undervisning ska baseras på barns behov, erfarenheter och intressen.

De underliggande antagandena i utbildningssammanhang har påverkats av ett antal förändringar i den globaliserade världen. Dessa förändringar är en del av de samhälleliga förändringar som inte bara relaterar till globaliseringen utan också belyser behovet av skicklig arbetskraft, förändringar i vårt sätt att skapa kunskap, större känslighet för frågor om jämlikhet och genusfrågor, samt framväxande av digitala teknologier. Den snabba spridningen och utnyttjandet av digitala teknologier som en central förändringsagent har drivit tillväxten av ett kunskapsbaserat samhälle som i sin tur utlöser omvandling av sociala strukturer och institutioner. En sådan transformation förändrar grundläggande hur människor lever, arbetar och kommunicerar (Castells & Cardoso, 2006; Lambropoulos & Romero, 2010; Selwyn, 2013; 2017). Digitala teknologier har också förändrat hur våra barn leker, kommunicerar och lär sig (Cuban, 2018; Morgan, 2010; Nikolopoulou, 2014; Plowman & Stephen, 2003; Roumbanis Viberg, Forslund

Frykedal & Sofkova Hashemi, 2019; Siraj-Blatchford & Siraj-Blatchford, 2006; Yelland & Kilderry, 2010). Över hela världen har dessa teknologier använts som lösning på utmaningar i utbildningssammanhang (Collins & Halversson, 2018; Cuban, 2018; Selwyn, 2010, 2012, 2017).

Förskolor och skolor har haft en exceptionell ökning av tillgängligheten och användningen av digitala teknologier de senaste tio åren. Det antas att integrering av dessa teknologier i utbildningssammanhang, bättre kan förbereda barn för det ständiga föränderliga informations- och kunskapsbaserade samhället. Resultat från ett antal studier visar pedagogiska fördelar med att använda digitala teknologier i undervisnings- och lärandeprocesser (Fridberg, Thulin & Redfors, 2017; Jahnke & Kumar, 2014; Lindahl & Folkesson, 2012). Det framhävs särskilt att användningen av digitala teknologier, som Collins och Halversson (2018) hävdar, till fullo kan öka effektiviteten i utbildningspraktiker. Det hävdas också att integrering av digitala teknologier kan säkerställa att inget barn lämnas "behind in the rush for technological expertise" (Cuban, 2001, s. 12). Några av dessa påståendena om den digitala teknologins roll i förskolor och skolor är emellertid i linje med kommersiella intressen för vinstdrivande enheter (Cuban, 1986; Lantz-Andersson & Säljö, 2014; Selwyn, 2010, 2012).

Initiativ som uppmuntrade införandet av digitala teknologier i förskole-sammanhang drevs av Europaparlamentets och Rådets Rekommendation (2006) som år 2004 beskrev digital kompetens som en av nyckelkompetenserna för livslångt lärande. Skolverket (2018) understryker vikten av användning av digitala teknologier i förskolans pedagogiska praktiker och säger att:

Utbildningen ska också ge barnen förutsättningar att utveckla adekvat digital kompetens genom att ge dem möjlighet att utveckla en förståelse för den digitalisering de möter i vardagen. Barnen ska ges möjlighet att grundlägga ett kritiskt och ansvarsfullt förhållningssätt till digital teknik, för att de på sikt ska kunna se möjligheter och förstå risker samt kunna värdera information (Skolverket, 2018, s. 9).

Vidare uppmuntrar den svenska läroplanen för förskolan (Skolverket, 2018) förskollärarna att strukturera förskolans lärandemiljö så att digitala teknologier används på ett sätt som stödjer och motiverar barns utveckling och lärande. I enighet med riktlinjerna i läroplanen har svenska förskolor och skolor investerat i interaktiv whiteboards, surfplattor och annan form av digitala teknologier att integrera i skolans och förskolans pedagogiska praktiker (Hvit Lindstrand, 2015; Marklund, 2015; Nilsen, 2018; Walldén

Hillström, 2014). Den ökande tillgängligheten och användningen av digitala teknologier i förskolan, till exempel IWBs, ställer nya krav på förskollärare att stödja barns utveckling och lärande (Otterborn, Schönborn & Hultén, 2018).

Integreringen av digitala teknologier i förskolans pedagogiska praktiker har emellertid utmanats (Cuban, Kirkpatrick & Peck, 2001). Det finns många exempel på initiativ att integrera digitala teknologier i utbildningssammanhang som inte lyckats och därför inte blivit det universalmedel som vissa antog att det skulle bli (Cuban, 2001; Selwyn, 2012). De flesta påståenden om de positiva effekterna av digitala teknologier i förskolans utbildning har inte grundats på robusta och vetenskapliga metoder (Kjällander, 2011; Marklund, 2015). Vidare, när en digital teknologi införs i utbildningssammanhang, finns det enligt Reiser (2001) "great deal of initial interest and much enthusiasm about the effects it is likely to have on instructional practices. However, enthusiasm and interest eventually fade, and an examination reveals that the medium has had a minimal impact on such practices" (s. 62).

Digitala teknologier i utbildningssammanhang kan vara inköpta men underutnyttjade (Cuban, 2001; Olivares & Castillo, 2018). I många utbildningssammanhang verkar de befintliga undervisning och undervisningsprocesserna knappast förändras. Införandet av dessa teknologier kan till och med få nya former av ojämlikhet och mobbing som kan utmana utbildningsprestationer (Mascheroni & Ólafsson, 2016; Selwyn, 2012, 2017). Vidare kan introduktion av digitala teknologier påverka barns känslomässiga och sensomotoriska utveckling (see Domingues-Montanari, 2017; Levin, 2011; Lissak, 2018). På liknande sätt hävdar Levin (2011) "children are being remote controlled by the scripts of others (television, videos, electronic toys), instead of coming up with their own unique stories and problems to solve" (s. 61).

Användning av digital teknologi i förskolan har uppmärksammats både i den publicerade litteraturen och i den svenska läroplanen för förskolan (Skolverket, 2018). Utmaningar i användningen av digitala teknologier i utbildningssammanhang och hur de kan förändra pedagogiska praktiker kan därför ses som nyckelfrågor för lärare, rektorer och beslutsfattare. Tidigare studier har antytt att ett stort antal förskollärare inte använder de möjligheterna som digitala teknologier erbjuder i sin pedagogiska praktik (Blackwell, Lauricella, Conway & Wartella, 2014; Keengwe, Onchwari & Wachira, 2008). Att använda digital teknologi på ett meningsfullt sätt beror på hur lärare använder dessa teknologier (Sinclair, 2009). Med andra ord

är digital teknologi ett verktyg som kan användas men som inte nödvändigtvis kommer att förändra förskolepedagogiken i sig (Camilleri, 2018; McGarr, 2009; Plowman & Stephen, 2007, 2013).

I tidigare forskning understryks förskollärarnas roll i utformningen och utvecklingen av möjligheter för lärande med hjälp av digitala teknologier (Ljung-Djårf, 2002, 2004; Nikolopoulou, 2014; Nir-Gal & Klein, 2004; Plowman & Stephen, 2007, 2013). Ett gap har lyfts fram mellan tillgången på digitala teknologier och lärarnas användning av dessa teknologier i förskolans pedagogiska praktiker (se Ljung-Djårf, 2004; Masoumi, 2015; Palaiologou, 2016). Ett stort antal förskollärare ansåg att de inte var redo att använda digital teknologi i sin pedagogiska praktik. Dessutom betraktades digital teknologi delvis som ett hot eller störande för barns fria lek i förskolan (se Lindahl & Folkesson, 2012; Ljung-Djårf, 2008; Nilsen, 2018). Å andra sidan är förskolans pedagogiska praktiker ofta inspirerade av “embodied hands-on experience based teaching and learning, often using aesthetic means of expression as a way [for children] to learn differently” (Taguchi, 2010, s. 23). Som ett resultat är integrationen av digital teknologi i förskolans verksamhet långsam och begränsad och som Palaiologou (2016) framhåller finns det fortfarande en osäkerhet för om digitala teknologier har en plats i förskolan.

Genom att ta dessa utmaningar på allvar och med hänseende till den aktuella svenska reformen för förskolan, är syftet med avhandlingen att visa hur en viss digital teknologi, Interaktiv whiteboard, samspelar med förskollärarnas undervisningspraktik. Den interaktiva whiteboarden är ett undervisningsverktyg (Yang, Wang & Kao, 2012). Den erbjuder en mångfald av möjligheter och har potential att utöka förskollärares möjligheter i undervisning (se Gillen, Staarman, Littleton, Mercer & Twiner, 2007; Hvit Lindstrand, 2015). Trots det ökande antalet internationella studier om användning av IWB i skolor och förskolor (se Deaney et al., 2009; Miller & Glover, 2010) finns det fortfarande bara ett litet antal svenska studier som undersöker förskollärares undervisning med denna teknologi.

Teoretiskt är denna avhandling baserad på det sociokulturella perspektivet på lärande (Säljö, 2000, 2010; Vygotsky, 1978; Wertsch, 1991). Perspektivet bygger på antagandet att lärande är en ständig social process (Säljö, 2000, 2010). Genom att undersöka hur lärande kan äga rum kartlägger den sociokulturella teorin hur undervisning kan struktureras och förmedlas i ett specifikt sammanhang. En idé om hur lärande sker är avgörande när det gäller att strukturera och utforma förskolans utbildningsmiljö och lärarnas undervisningssätt. Ur detta perspektiv är undervisningspraktik

nära det som Mercer (1995) kallar en vägledd konstruktion av kunskap där undervisningspraktik förmedlas av fysiska och intellektuella föremål det vill säga verktyg och tecken i ett visst sammanhang. Teknologiska artefakter kan därför bidra till att utöka människors förmåga och göra det möjligt att överskrida sina gränser. Wertsch (1997) introducerade begreppen medierande redskap och medierad aktion för att visa processen med användandet av artefakter vilka anpassas av lärare på olika sätt för att stödja barns lärande.

8.2. Syfte och forskningsfrågor

Det övergripande syftet med denna avhandling är att öka kunskapen kring hur en viss digital teknologi, interaktiv whiteboard, samspelar med förskollärarnas undervisning.

Följande forskningsfrågor ställs därför i denna studie:

- Hur resonerar förskollärare om att integrera IWB i sin undervisningspraktik? (behandlas i artikel I)
- Hur använder förskollärare IWB för att strukturera sina undervisningspraktiker? (behandlas i artikel II)
- Hur scaffoldar /stödjer förskollärare barns lärandeprocesser i ett sammanhang där IWB används? (behandlas i artikel III)
- Hur medierar IWB undervisningshandlingar? och vad är privilegierat i IWB-medierade undervisningshandlingar? (behandlas i artikel IV)

8.3. Metod

Inom ramen för min licentiatuppsats undersöktes forskningsfrågorna I och II. För att svara på den första forskningsfrågan genomfördes semistrukturerade intervjuer med fyra förskollärare i två förskolor 2012. För att besvara den andra forskningsfrågan gjordes observationer av tre förskollärare, två män och en kvinna, och deras respektive barngrupper vilka använder IWB i sin undervisningspraktik i en förskola 2013. Inom ramen för min doktorsavhandling har jag undersökt forskningsfrågorna III och IV. För att besvara den tredje och den fjärde forskningsfrågan samlades nya data in i form av observationer av fem förskollärare och deras respektive barngrupper. Dessa data samlades in i slutet av 2017 och början av 2018.

8.4. Resultat och Diskussion

Denna avhandling syftar till att undersöka hur en digital teknologi, IWB, samspelar med förskollärares undervisningspraktiker. Resultaten av denna studie som presenteras i fyra artiklar behandlar olika aspekter av det studerade fenomenet. Studiens huvudsakliga resultat kommer att diskuteras mer utförligt i det följande avsnittet.

Den första forskningsfrågan, som behandlas i artikel I, handlar om hur förskollärare resonerar om att integrera IWB i sin undervisning. Samtliga intervjuade förskollärare visar en positiv inställning till den roll som interaktiv whiteboard kan spela i deras undervisning. Ett stort antal studier (se Corbo 2014; Nir-Gal & Klein, 2004; Plowman & Stephen, 2007, 2013; Voogt & McKenney, 2008) visar att lärarnas egen inställning till digital teknik är betydande för deras användning av interaktiv whiteboard i undervisningen. De intervjuade förskollärarna tar inte upp möjliga utmaningar och hinder förknippade med användning av IWB i förskolepedagogiken. Fördelarna med att använda IWB som lärarna uttrycker inkluderar flera områden. Studiens resultat visar att användningen av IWB kan skapa ett interaktivt sammanhang för barn att involveras i, i givna problemlösningssituationer. Enligt förskollärarna erbjuder IWB's multi-sensoriska funktioner lärare en mängd olika möjligheter att visualisera och animera sin undervisning, vilket kan utöka barns möjligheter att lära. De hävdar vidare att användning av IWB's funktioner i undervisningspraktiker kan hjälpa förskollärare att fånga barnens uppmärksamhet, bibehålla deras koncentration och motivera dem att lära sig. Resultaten från studien visar också att lärare resonerar om att IWB's multimedia funktioner i undervisningssammanhang erbjuder barnen att initiera, dela och lösa problem och/så att de aktivt kan delta i dialoger och göra aktiva val i problemlösningssituationer. På detta sätt anser förskollärarna att barnen kan få en möjlighet att arbeta tillsammans på ett gemensamt projekt och ge varandra stöd i att använda de olika interaktiva möjligheter som IWB erbjuder. Sammantaget visar förskollärarna en positiv uppfattning om samspelet mellan den interaktiva whiteboarden och lärarnas möjligheter att utforma en rik undervisningsmiljö där barn aktivt kan delta i den givna undervisningsaktiviteten.

Den andra forskningsfrågan, som återspeglas i artikel II, är hur förskollärare använder IWB för att strukturera sin undervisningspraktik. Resultaten från denna artikel visar att de deltagande förskollärarna använder IWB's funktioner på olika sätt för att strukturera sin undervisning. I ett antal undervisningssituationer använder förskollärarna IWB's multisensoriska

funktioner för att engagera barn i problemlösningsprocessen baserat på deras Zone of Proximal Development (ZPD). I andra fall, belyser och representerar lärarna med hjälp av IWB's visuella karaktär, färg och beröringskänsliga tavla, de givna undervisningsaktiviteterna och bjuder in barn att lösa den givna uppgiften. Ett antal förskollärare använder vidare IWB's funktioner för att strukturera rollspelaktiviteter för att stödja barns lärande inom deras ZPD. Genom att exemplifiera de olika sätten som lärare använder IWB för att strukturera sin undervisning understryker resultaten förskollärarnas nyckelroll när det gäller att integrera digital teknologi i förskoleundervisningen.

Resultaten å ena sidan illustrerar hur förskollärare använder IWB's olika funktioner för att strukturera sin undervisning på ett sätt som engagerar barn aktivt i den givna undervisningsaktiviteten. I dessa undervisningsaktiviteter använder förskollärare interaktiv whiteboard för att strukturera sin undervisning baserat på barns perspektiv. Å andra sidan exemplifieras lärare som använder IWB för att strukturera sin undervisning utan att ta hänsyn till barns intressen eller deras aktiva deltagande i den givna aktiviteten. I dessa undervisningsaktiviteter används IWB precis som en vanlig whiteboard vilken inte bibehöll barnens intresse.

Den tredje forskningsfrågan, som behandlas i artikel III, undersöker hur förskollärare stödjer barns lärandeprocesser när IWB används. Analysen av förskollärares sätt att stödja barns lärande med IWB visar att förskollärare använder olika sätt att stödja/scaffolda barns lärande bland annat: concretizing, questioning, instructing, providing space, affirming, providing feedback, inviting, watching, laughing together, approaching, standing/sitting beside, simplifying, filling in the blanks, confirming, participating, challenging perception, challenging thought, explaining, displaying, explaining, and referring back. Resultaten visar att vissa av lärarnas handlingar såsom att ge feedback, närma sig, förenkla och utmana oftast används av förskollärare i scaffoldingprocesser. Resultaten visar vidare att lärarnas handlingar kan ha olika funktioner. Förhållandet mellan lärarnas olika handlingar och scaffoldingfunktioner klargörs.

Åtta scaffolding funktioner identifieras där sex av dem - recruitment, direction maintenance, marking critical features, reduction in degrees of freedom, frustration control och demonstration - var i linje med Wood et al. (1976) teoretiska ramverk. Vissa av förskollärarnas handlingar i undervisningspraktiker med interaktiv whiteboard kunde dock inte passa in i Wood et al. (1976) scaffolding funktioner. Som resultat i denna artikel identifierades ytterligare två scaffolding funktioner, *participating in the activity*

och *enjoyment*. Genom att utveckla dessa scaffolding funktioner bidrog studien till utvecklingen av Woods et al. (1976) teoretiska ramverk.

Resultaten visar även att förskollärarna ibland använder samma handlingar i relation till olika scaffoldingfunktioner. Till exempel, i vissa undervisningssituationer utmanar lärarna barnen för att få dem att utveckla sitt tänkande i en viss uppgift, och i andra undervisningssituationer utmanar lärarna barnen för att synliggöra vissa aspekter i uppgiften. I den meningen kan lärares handlingar i scaffoldingprocessen se olika ut i förhållande till scaffoldingfunktionen.

Den slutliga forskningsfrågan, som behandlas i artikel IV, undersöker hur IWB medierar undervisningshandlingar, och vad som är privilegierat i de IWB-medierade undervisningshandlingarna. Resultaten tyder på att den interaktiva whiteboarden medierar förskollärarnas undervisningshandlingar på olika sätt, först genom att tillhandahålla en rad möjligheter att manipulera och markera vissa aktiviteter. Detta hjälper lärarna att engagera barnen aktivt i sin undervisning. För det andra, så medierar IWB lärarens undervisningshandlingar så att de kan ge konkret och konstruktiv feedback till barn, vilket bidrar till att synliggöra problemlösningsprocesser. Dessutom medierar detta digitala redskap lärarens undervisningshandlingar och därmed skapar diskussion barnen sinsemellan som i sin tur bidrar till att förbättra dialogen i hela barngruppen. Den interaktiva whiteboarden underlättar lagring och hämtning av återanvändbara utbildningsresurser, och gör det möjligt för lärare att direkt komma åt och organisera undervisningsresurserna. Den interaktiva whiteboarden medierar också hur lärare kombinerar och manipulerar bilder, animationer och texter på IWB's stora display. Detta utvidgar lärarnas möjligheter att integrera verkliga aktiviteter med virtuella aktiviteter på IWB's stora skärm. Förutom de fördelar som den interaktiva whiteboarden medför visar resultaten även att interaktiv whiteboard medierar lärares kontroll över flödet av undervisning och lärandeprocesser vilket kan leda till att diskussionen mellan lärare och barn och barnen sinsemellan minskar. Den fasta och oflexibla placeringen av den interaktiva whiteboarden tvingar dessutom lärarna att genomföra sina undervisningsaktiviteter i ett fördefinierat sammanhang. Den begränsar lärarnas möjligheter att välja var och även när hon / han kan bedriva undervisningsaktiviteter med interaktiv whiteboard.

Denna avhandling bidrar till att förstå hur digitala teknologier uppfattas och används av förskollärare i förskolans praktik. Att införa och använda digitala teknologier som en integrerad del av förskolan var och är på något

sätt fortfarande ett dilemma. Å ena sidan, som Selwyn (2010) framför, ägnas tusentals timmar åt och miljontals dollar till en optimistisk forskning gällande hur teknologier kan stödja och förbättra lärande. Å andra sidan är det osäkert om dessa investeringar har förändrat de grundläggande delarna av undervisningsprocessen (Cuban, 2006; Selwyn, 2012).

Förskollärarna spelar en avgörande roll för huruvida och hur digital teknologi kan användas i förskolans utbildning. Denna fråga har i stor utsträckning betonats i tidigare studier (se Camilleri, 2018; Luo & Yang, 2016; Miller et al., 2005; Neumann, 2014; Neumann & Neumann, 2014; Samsonova, 2017) där det hävdas att en positiv inställning till och förståelse för digital teknologi kommer att påverka hur förskollärare använder denna teknologi i sin undervisning. En fråga är därför hur förskollärarna resonerar om att integrera interaktiv whiteboard i sin undervisningspraktik.

I enlighet med tidigare studier, visar denna avhandling att förskollärare har en positiv inställning till den digitala tekniken. Enligt förskollärarna kan IWB utvidga deras möjligheter att fånga barns uppmärksamhet och bibehålla deras koncentration och motivera dem att aktivt delta i undervisningsaktiviteterna. Förskollärarna uppger också att IWB's funktioner kan bidra till att skapa en interaktiv undervisningsmiljö. Det finns emellertid ett antal individuella och kontextuella faktorer som spelar roll i användandet av digital teknologi i förskolan (Camilleri, 2018; Luo & Yang, 2016; Nilsen, 2018). Således kan man hävda att förskollärarnas uppfattningar om möjliga bidrag från digital teknologi i sig inte kan garantera deras användning av digital teknologi i undervisningen.

Resultaten av studien visar att förskollärare strukturerar sin undervisning olika, bland annat så tar en av de observerade förskollärarna genom rollspel och öppna frågor tillvara på möjligheterna som IWB erbjuder för att stödja barns lärande inom deras ZPD. De andra förskollärarna använde emellertid IWB mer eller mindre som en whiteboard utan att ta hänsyn till de möjligheter som interaktiv whiteboard erbjuder. I detta avseende förändrades varken lärarens undervisning av en artefakt eller lade till något till den befintliga utbildningspraktiken. Resultaten av den aktuella avhandlingen visar att de potentiella fördelarna med att använda IWB beror på hur förskollärare strukturerar sin undervisning med hjälp av denna teknologi. På liknande sätt menar Means (2008) och Sherman, Cayton och Chandler (2017) att en framgångsrik implementering av digitala teknologier främst beror på vilken typ av uppgifter som görs och hur dessa uppgifter implementeras. Denna fråga, som diskuterats i litteraturen, berör på det sätt som förskollärare använder digitala teknologier för att gå utanför sina vardagliga roller för att

stödja barns lärande (Caiman & Kjällander, 2019; Hermansson & Olin-Scheller, 2019).

Interaktivitet tillsammans med de multisensoriska resurserna på IWB kan emellertid ge lärare en rad möjligheter att motivera och utmana barn. Till exempel gav den aktuella studien exempel på undervisningssituationer där multimodala aspekter av interaktiv whiteboard påverkar förskollärarnas undervisningshandlingar när de skapar lekbaserade aktiviteter. I dessa lekbaserade aktiviteter kopplas lek och lärande till varandra och lek ses som en förutsättning för barns lärande. Detta är i linje med den nuvarande Svenska läroplanen (Skolverket, 2018) som ger lek en framträdande roll och noterar att ”förskolan ska ge varje barn förutsättningar att utveckla nyfikenhet, kreativitet och lust att leka och lära” (s. 13). Begreppet lek och det lekbaserade lärandet i utbildningen i förskolan är ett av nyckelbegreppen i det sociokulturella perspektivet och som innebär att det skapar en motiverande ram för barns utveckling.

En slutsats man kan dra är att IWB kan fungera som en plattform för att stödja lekbaserad undervisning i förskolan. Detta kan betyda att digital teknologi som utbildningsstrategi har potential att utöka förskollärarnas möjligheter att stödja barns lärande (se Gillen, Staarman, Littleton, Mercer & Twiner, 2007; Hvit Lindstrand, 2015).

Dessutom visar denna studie att förskollärarnas positiva inställning till och användning av digital teknologi inte säkerställer att förskollärare kommer att använda digital teknologi på ett meningsfullt sätt i förskolan, även om digital teknologi kan vara effektiv i händerna på de kompetenta lärarna. Resultaten i denna studie kan emellertid ses som ett viktigt motargument i förhållande till tekno-promoternas påståenden. Förskollärare måste förstå varför, vad, hur och i vilken utsträckning digital teknologi kan bidra till deras undervisning.

Ironiskt nog tyder resultaten från tidigare forskning på att ett stort antal förskollärare inte kan använda de möjligheter som digital teknologi erbjuder i förskolans utbildning (Blackwell, Lauricella, Conway & Wartella, 2014; Camilleri, 2018; Keengwe, Onchwari & Wachira, 2008; Sinclair, 2009). Många lärare anser att de är oförberedda att använda digital teknologi i sin undervisning. Enligt rapporten från Statens byrå för utbildning (2016) konstaterade mer än 50% av de deltagande förskollärarna att de behövde vidareutbildning för att kunna integrera digital teknologi i sin undervisning. Detta kan betyda att förskollärarna behöver ytterligare hjälp och stöd för att kritiskt inse möjligheterna och riskerna med att använda digital teknologi i förskolans utbildning.

Den aktuella studien har illustrerat komplexiteten i undervisningen i förskolan när digital teknologi används. Undervisning i förskolan är ett nytt koncept, formellt introducerat i den nuvarande läroplanen för förskolan, men ett gammalt fenomen som har varit en del av förskoletraditionen sedan Friedrich Fröbel introducerades sin första kindergarten (Fröbel, 1995/1826; Hammarström Lewenhagen, 2013). Undervisning som begrepp kan å ena sidan omfatta förskolans långvariga tradition som uppmuntrar barns utveckling utan någon extern styrning. Detta är i linje med Bennetts (2010) sociala pedagogiska strategi där fokus är på barns omsorg och utveckling. Undervisning i förskolan ses i sin vidaste bemärkelse som utvecklingen av barnet som helhet där barns balanserade tillväxt underlättas av förskollärare.

Undervisning i förskolan kan å andra sidan betraktas som en målinriktad process som bör utveckla barnens kognitiva och ämnesrelaterade färdigheter. Att förbereda barn för deras framtida utbildning när det gäller förberedelserna för skolan eller beredskapen för skolan är i linje med vad Bennett (2010) kallar som preprimary tillvägagångssätt. Undervisning i förskolan ses som en instruktionsprocedur där direkt undervisning används av lärare. Polarisering i form av ovannämnda strategier för undervisning i förskolan fångar dock inte riktigt Svensk förskoleutbildning, *educare*, vilket är snarare en innovativ uppfattning om förskoleutbildningen. I denna utbildningsmodell tillgodoses alla barns sociala, emotionella och kognitiva utveckling när man strävar mot de uttryckta målen i läroplanen för förskolan (Doverborg & Pramling Samuelsson, 2009; Sheridan & Williams, 2018).

Ett stort antal studier har publicerats om utbildningsteknologier och som Castañeda och Selwyn (2018) påpekar, så har de underliggande utbildnings- och undervisningsmodellerna fått mindre uppmärksamhet. Denna studie är ett bidrag till forskningsområdet genom att ge en detaljerad bild av hur förskollärare använder en viss digital teknologi, interaktiv whiteboard, i sin undervisning för att stödja barns lärande och utveckling (se artikel III, IV). Förskollärarnas handlingar i scaffoldingprocesser som denna forskning har visat ger detaljerad kunskap om hur lärare använder digital teknologi för att ge individualiserat stöd baserat på barns ZPD för att övervinna möjliga kognitiva, emotionella och tekniska hinder. Såsom återspeglas i resultaten från denna studie ses scaffolding som en samarbetsprocess där förskollärarnas aktiva deltagande och känslomässiga stöd spelar en viktig roll för att genomföra de givna aktiviteterna och leda barns lärande till en högre nivå. Scaffolding/stöttning som undervisningsmodell kan således användas för undervisning i nästan alla ämnen med digital teknologi.

Detta kan innebära att hur förskollärarna scaffoldar barns lärande påverkar hur de använder digital teknologi i sin undervisningspraktik. En närmare granskning på det insamlade empiriska materialet visar att frågan inte handlar om de unika funktionerna i IWB eller annan digital teknologi, utan snarare handlar om hur denna digitala teknologi integreras och används av förskollärarna. Det är uppenbart att förskollärarnas pedagogiska grund och de roller de tillskriver teknologin kan påverka hur en digital teknologi kan användas i deras undervisningspraktik (Kjällander & Moinian, 2014; Miller & Glover, 2010; Morgan, 2010).

Användningen av digital teknologi i undervisningspraktik för förskolan är emellertid en komplex process som formas och modifieras av en rad pedagogiska aktörer och influenser (Castañeda & Selwyn, 2018, s. 3). I en sådan komplex process är inte lärare den enda som gör val. Barn är också sociala aktörer som känner av och aktivt bidrar till sina lärandemiljöer baserat på deras olika erfarenhet och förståelse (Liberg, 2014). För att aktualisera scaffoldingsprocessen i ett sammanhang där digital teknik (IWB) används, måste förskollärare ta hänsyn till barns behov, intressen och tidigare erfarenheter.

Dessa frågor om konsekvenserna och användbarheten av digital teknologi i pedagogiska sammanhang är och bör faktiskt vara en av de viktigaste frågorna för lärare, förskolechefer och politiska beslutsfattare när det gäller digitalisering i förskolor (Plowman & Stephen, 2013). Det finns olika argument och förutsägelser som säger att digital teknologi inte bara kommer att förändra undervisningspraktiker utan de kommer också att förändra utbildningsmiljöer. Cuban (2001, 2018) hävdar till exempel att användning av digital teknologi till full potential kan göra undervisning och lärandeprocesser mer effektiva och produktiva. Att identifiera de digitala teknologiernas fulla potential, hur lärare kan använda den fulla potentialen för digital teknologi och hur dessa teknologier faktiskt kan bidra till undervisningspraktiker är en utmanande fråga som bör kritiskt granskas. Det finns väldigt få studier som fokuserar på den digitala teknologins bidrag till förskollärarnas undervisningspraktiker.

I denna studie undersöks därför hur lärarnas undervisning medieras av IWB's medierande aspekter och vad som är privilegierat i IWB-medierade undervisningshandlingar. Detta bidrar till att kartlägga de önskvärda eller oönskade konsekvenserna av att använda digital teknologi i förskoleutbildningen. Analysen av det insamlade empiriska materialet visar att de önskvärda konsekvenserna av att använda IWB i pedagogiska sammanhang innefattar att *engaging children in educational activities, instant access and*

organising educational resources, and whole-group discussion och att detta resultat överensstämmer med resultaten från tidigare studier (se Chou, Chang & Chen, 2017; Harlow, Cowie & Heazlewood, 2010; Terreni, 2010). Det hävdas att IWB som ett undervisningsredskap inte förstärker gruppdiskussion och samarbete mellan barn enligt flera forskare (se Beauchamp & Kennewell, 2010; Schuck & Kearney, 2007, Zevenbergen & Lerman, 2008). De hävdar vidare att användningen av IWB begränsar möjlig kommunikation och interaktion barn sinsemellan och mellan lärare och barn.

Resultaten från min studie visar emellertid en mångfaldig bild av hur IWB bidrar till interaktion mellan lärare och barn och barnen sinsemellan. Å ena sidan visar mina resultat att användningen av IWB förbättrar diskussioner i barngruppen så att barn och lärare kan utforska och utmana varandras tankar och handlingar i relation till vad som händer på IWB. Studien ger vidare några tydliga exempel som exemplifierar hur lärarnas användning av IWB förbättrar dialogen barn mellan och hur lärarna kan motivera barnen att aktivt delta i den givna undervisningspraktiken.

Å andra sidan visas det att helt strukturerade applikationer på IWB ramar in lärarnas undervisningspraktik i vilka lärarna kontrollerar flödet av undervisnings- och lärandeprocesser. Strukturerade applikationer har ofta baserats på drill and practice - där barnen lär sig genom att öva och upprepa den givna informationen. Under sådana kontrollerade omständigheter är det därför mindre troligt att barnens behov beaktas och undervisningspraktikerna involverar deras kritiska tänkande eller samarbete. Med tanke på att utbildningen i förskolan sker ett dynamiskt sammanhang kan användning av helt strukturerade applikationer inte leda till en flexibel, aktiv och utforskande miljö för barn (Jack & Higgins, 2019). Det betyder att designen av applikationerna i digitala teknologier kan bidra till lärarnas undervisningspraktiker. Detta kan dock ses från ett annat perspektiv; digital teknologi kan inte ge några bidrag i sig men en lämplig användning av artefakten leder till önskvärda resultat (Nührenbörger & Steinbring, 2008).

Så är frågan nu hur förskollärare bäst kan utveckla sina undervisningspraktiker med digitala teknologier och vilken typ av applikationer som kan underlätta interaktionen mellan förskollärare och barn. Resultaten från den aktuella studien visar att de strukturerade applikationerna på den interaktiva whiteboarden bidrar till ökad lärarkontroll av undervisnings- och lärandeprocesser i vilka läraren kan ses som en kontrollant eller objektiv observatör snarare än som en facilitatör som underlättar barns lärande. Helt strukturerade/icke-interaktiva applikationer ger ofta rätt svar, vilket inte

bara kan förändra den möjliga kommunikationen mellan lärare och barn, utan också minimera lärarnas möjligheter att motivera, utmana och ta hänsyn till barns behov och perspektiv. Detta är i linje med vad Palmér (2015) visar i sin studie att applikationer med svag inramning och stark klassificering, kan främja dialog mellan lärare och barn.

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10. APPENDICES

10.1. Informationsbrev till förskolechef vid X-förskola

Jag heter Maryam Bourbour och doktorerar vid Institutionen för Humaniora, Utbildnings - och Samhällsvetenskap vid Örebro universitet. Inom ramen för mitt avhandlingsarbete genomför jag en studie i förskolan som ska öka kunskapen om hur lärare och barn använder sig av digital teknologi i förskolan. Mer specifikt är jag intresserad av att studera hur digital teknologi används, genom interaktiv skrivtavla, i förskolans pedagogiska aktiviteter.

I Sverige har stora investeringar gjorts med syfte att dra nytta av digitala teknologier i lärandesammanhang. Över 80% av alla svenska förskolor har olika typer av tekniska redskap och över 20% av förskolorna har en interaktiv skrivtavla. Trots detta vet vi väldigt lite om hur förskollärare arbetar med att stötta barns lärande med hjälp av den interaktiva skrivtavlan.

Under några månader från november, planerar jag att vistas på förskolan... och följa pedagogerna och barnen i arbetet med den interaktiva skrivtavlan med hjälp av videoobservationer. Vilka dagar och tider jag kommer att vara på... förskola kommer att bestämmas tillsammans med pedagogerna.

Studien följer Vetenskapsrådets forskningsetiska grundprinciper vilket innebär att barnens och pedagogernas deltagande är frivilligt och de har rätt att avbryta sin medverkan när som helst utan att motivera varför. Medgivande från barnens vårdnadshavare kommer att samlas in. Barnen vid förskolan kommer också att få information om varför jag är där. Jag kommer att ta särskild hänsyn till om barnen exempelvis visar motvilja att medverka eller att vara med på film.

Inga verkliga namn från den deltagande förskolan eller deltagande personer kommer att förekomma i avhandlingen. Det insamlade videomaterialet kommer enbart att användas i forskningssyfte och det kommer inte att kunna ses av någon obehörig. Efter avslutad studie bevaras allt material, såsom videofilmer, digitalt och arkiveras vid Örebro universitet.

Har du några frågor är du välkommen att höra av dig till mig på Tel: 073XXXX, E-mail: mabo@du.se, alternativt till mina handledare.

Med vänliga hälsningar
Maryam Bourbour

Mina handledare i avhandlingsarbetet, som också kan kontaktas vid frågor eller synpunkter, är:

Ann Quennerstedt
Professor i pedagogik
Örebro universitet
ann.quennerstedt@oru.se
Tel: 019 30 36 56

Gunilla Lindqvist
Docent och lektor i
pedagogik Uppsala
universitet
Högskolan Dalarna
gln@du.se
Tel: 023 778265

Sören Högberg
Lektor i pedagogik
Högskolan Dalarna
sho@du.se
Tel: 023 778359

10.2. Informationsbrev till pedagoger vid X-förskola

Jag heter Maryam Bourbour och doktorerar vid Institutionen för Humaniora, Utbildnings- och Samhällsvetenskap vid Örebro universitet. Inom ramen för mitt avhandlingsarbete genomför jag en studie i förskolan som ska öka kunskapen om hur lärare och barn använder sig av digital teknologi i förskolan. Mer specifikt är jag intresserad av att studera hur digital teknologi används, genom interaktiv skrivtavla, i förskolans pedagogiska aktiviteter.

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Inför studien har ett antal förskolor blivit tillfrågade om att delta i studien. Bland dessa har din förskola och avdelning valts ut som extra intressant att få fördjupad kunskap om. Under några månader från november eller början i december, kommer jag att vistas på förskolan och följa dig i ditt arbete med den interaktiva skrivtavlan med hjälp av videoobservationer. Vilka dagar och tider jag kommer att vara på din förskola bestämmer vi tillsammans. Tillstånd om att få genomföra studien på din förskola har inhämtats från förskolechef

Studien följer Vetenskapsrådets forskningsetiska grundprinciper. Det innebär att det är helt frivilligt att delta i forskningen. När barn ingår i forskning är det vårdnadshavare som lämnar samtycke, men också barnen kommer att få säga om de vill delta eller inte. Som vårdnadshavare har du/ni också rätt att avbryta ditt/ert barns medverkan när som helst utan att motivera varför. Barnen kommer också att få information om varför jag är där. Jag kommer att ta särskild hänsyn till om barnen exempelvis visar motvilja att medverka eller att vara med på film.

Inga verkliga namn från den deltagande förskolan eller deltagande personer kommer att förekomma i avhandlingen. Det insamlade videomaterialet kommer enbart att användas i forskningssyfte och det kommer inte att kunna ses av någon obehörig. Efter avslutad studie bevaras allt material, såsom videofilmer, digitalt och arkiveras vid Örebro universitet.

Har du några frågor är du välkommen att höra av dig till mig på Tel: 073XXX, E-mail: mabo@du.se, alternativt till mina handledare.

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Tel: 023 778265

Sören Högberg
Lektor i pedagogik
Högskolan Dalarna
sho@du.se
Tel: 023 778359

☐ Jag ger mitt medgivande till att delta i studien

Datum och plats:_____

Namn-teckning:_____

Namn-förtydligande:_____

10.3. Informationsbrev till vårdnadshavare vid X-förskola

Jag heter Maryam Bourbour och doktorerar vid Institutionen för Humaniora, Utbildnings- och Samhällsvetenskap vid Örebro universitet. Inom ramen för mitt avhandlingsarbete genomför jag en studie i förskolan som ska öka kunskapen om hur lärare och barn använder sig av digital teknologi i förskolan. Mer specifikt är jag intresserad av att studera hur digital teknologi används, genom interaktiv skrivtavla, i förskolans pedagogiska aktiviteter.

I Sverige har stora investeringar gjorts med syfte att dra nytta av digitala teknologier i lärandesammanhang. Över 80% av alla svenska förskolor har olika typer av tekniska redskap och över 20% av förskolorna har en interaktiv skrivtavla. Trots detta vet vi väldigt lite om hur förskollärare arbetar med att stötta barns lärande med hjälp av den interaktiva skrivtavlan.

Den förskola där ditt/ert barn går deltar i studien. Under några månader från november eller i början av december, kommer jag att vistas på förskolan och observera pedagoger och barn när de arbetar med den interaktiva skrivtavlan. Jag kommer att videofilma pedagogerna och barnen när de arbetar.

Studien följer Vetenskapsrådets forskningsetiska grundprinciper. Det innebär att det är helt frivilligt att delta i forskningen. När barn ingår i forskning är det vårdnadshavare som lämnar samtycke, men också barnen kommer att få säga om de vill delta eller inte. Som vårdnadshavare har du/ni också rätt att avbryta ditt/ert barns medverkan när som helst utan att motivera varför. Barnen kommer också att få information om varför jag är där. Jag kommer att ta särskild hänsyn till om barnen exempelvis visar motvilja att medverka eller att vara med på film.

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Sören Högberg
Lektor i pedagogik
Högskolan Dalarna
sho@du.se
Tel: 023 778359

- ☐ Jag ger mitt medgivande till att mitt barn deltar i studien
- ☐ Jag vill inte att mitt barn deltar i studien

Datum och plats:_____

Namnteckning:_____

Namnförtydligande:_____

10.4. Intervjufrågor

Bakgrundsfrågor

- Vilken ålder har barnen?
- Hur länge har du arbetat som lärare?
- Vilka åldrar riktade sig din utbildning mot?

Huvudfrågor

- Hur ser du som lärare på ämnet matematik?
- Hur ser du på din egen roll när det gäller att utveckla barns kunskaper i matematik?

Följdfrågor: Är hela arbetslaget delaktigt? Har ni stöd av er rektor i arbetet? Kan du ge exempel från din verksamhet?

- Vilken/vilka lärande teorier utgår du ifrån i ditt sätt att arbeta med matematik med interaktiv skrivtavla?
- Vad anser du att barnen utvecklar när ni har matematik med interaktiv skrivtavla?
- Vilka hinder/svårigheter ser du med den här digitala teknologin?
- Hur stödjer du dig på kurs- och läroplanen när du planerar för barns matematiska
- lärande med interaktiv skrivtavla?
- Har du kommit i kontakt med någon forskning kring detta ämne?
- Hur kommer det sig att du/ni började med matematik med interaktiv skrivtavla?
- Vad är ditt syfte med att ha matematik med interaktiv skrivtavla?
- Hur ser du på variation/olika arbetssätt i matematikundervisningen?
- Upplever du någon skillnad på matematik i klassrummet/förskoleverksamhet med vanliga material som papper, penna, lego... och matematik med interaktiv skrivtavla och andra digitala teknologier?

JA - Vad?

NEJ - du menar att det inte är någon skillnad, kan du utveckla?

- Hur stor del av barns matematiklärande dagligen sker med interaktiv skrivtavla?

Följdfråga; Hur planerar du?

- Hur organiserar du/ni matematiska aktiviteter med interaktiv skrivtavla?

- Hur många barn brukar delta när ni jobbar med matematik på interaktiv skrivtavla?

Följdfrågor: Är det på frivillig basis - eller är det läraren som organiserar?

- På vilket sätt arbetar barnen under matematiska aktiviteter med interaktiv skrivtavla?

Följdfrågor; Har denna koppling till lärarstyrda aktiviteter - eller är det när barnen själva får/kan bestämma?

- I det dagliga arbetet hur använder ni av interaktiv skrivtavla i matematiken?
- Vilket intryck har du fått av hur barnen upplever att jobba med interaktiv skrivtavla i matematiska sammanhang/ i praktiken? Kan du ge exempel?
- Hur sker dokumentation och uppföljning av barns matematiska lärande med interaktiv skrivtavla?

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