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Preschool teachers' reasoning about interactive whiteboard embedded in mathematics education in Swedish preschools

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Abstract: This paper aims to investigate the ways in which teachers enact the interactive whiteboard (IWB) in Swedish preschools in relation to preschool children's mathematical learning. Data collected from interviews with four preschool teachers have provided the opportunity to consider the potential of IWB to facilitate a creative approach to young children's mathematics education. The findings suggest that IWB use in preschool is mostly viewed as "Space for children to involve in problem-solving situations", "Supporting collaborative learning and mutual negotiation", "Goal-oriented mathematics learning facilitated by IWB" and "Retaining children's interest in learning activities". This study also highlights the importance of teachers' technological knowledge and skills in mediating the interaction and facilitating the use of IWB in preschool pedagogical practices.

Keywords: Mathematics education, interactive whiteboard, young children, Preschool teacher

Introduction

Emerging new technologies, particularly Information and Communications Technology (ICT), have significantly changed the ways we live and learn. By providing a variety of opportunities, ICT is said to support and create rich learning opportunities for young children's mathematics learning (Smith, Gentry, & Blake, 2012). To address this change and possibilities along with the implications for early childhood education, we aim to investigate and discuss how preschool teachers reason about their enacting new technology, such as interactive whiteboard (IWB), in Swedish preschools in relation to preschool children's mathematical learning.

Interactive whiteboard (IWB) has been introduced into many educational settings as one of the emerging educational technologies in practice, and has become a popular technological artefact in both preschools and schools (Dwyer, 2007; Hvit, 2010; Klerfelt, 2010a; Mercer, Hennessy, & Warwick, 2007; Twiner, Coffin, Littleton, & Whitelock, 2010). The IWB is a touch-sensitive board, sensitive to

fingers or specific pen-like devices, used in conjunction with a computer and a digital projector. Despite the growing availability of a wide range of technological artefacts, especially IWB, in Swedish preschools, there has been little adoption of these technologies to facilitate effective teaching strategies and creating meaningful mathematical experiences (Hvit, 2010).

These technologies, such as IWB, are often used as a presentation or display tool, and teachers seem to be unaware of the potential of educational technologies for promoting young children's mathematics learning. This may signify that they have limited competence in using these technologies in their pedagogical activities, especially in mathematics teaching (see Glover, Miller, Averis, & Door, 2007; D Miller, Glover, & Averis, 2005).

Views of young children's mathematics learning have significantly changed in recent decades (Sarama & Clements, 2009). A surge of attention to mathematics in early childhood is highlighted in the global economy, with the vast majority of jobs requiring more sophisticated skills than in the past. Due to this trend, a variety of different actors (e.g. business leaders, policymakers and preschool teachers) have expressed strong concern about students' mathematics achievement (Doig, McCrae, & Rowe, 2003; Kilpatrick, Swafford, & Findell, 2001). Further, the mathematics achievement of Swedish students compares unfavourably with that of students in several other nations, such as East Asian and other Western countries (Grønmo & Gustafsson, 2003). Support for the positive relationship between early childhood development and education on the one hand and children's success later in life on the other is growing (see Krajewski, 2005; White, 2009). Similarly, there is evidence that early mathematics education in preschool can ensure children's later mathematics achievements (Horne, 2005; Krajewski, 2005; National Association for the Education of Young Children & The National Council of Teachers of Mathematics, 2008).

Similarly, the development of young children's mathematical ideas and skills is regarded as one of the core subjects in preschools and schools (Björklund, 2012; Doverborg & Emanuelsson, 2006; National Association for the Education of Young Children & The National Council of Teachers of Mathematics, 2008; NCTM, 2000). According to the Swedish preschool curriculum (Skolverket, 2011) young children's abilities to solving problems and logical thinking should be developed in preschool. New technologies such as IWB may be one way of facilitating reflection and exploration of different problem solving strategies. Within the literature, integrating IWB in classroom is seen to have a potentially positive impact on children's learning (Hodge & Anderson, 2007; Dave Miller & Glover, 2010). Linder (2012), for instance, argues that IWB use can support the explanation of mathematical concepts and ideas and facilitate interaction and learning activities within the classroom.

Despite the great emphasis on young children's mathematical development, many preschool teachers are poorly trained to teach mathematics; they are "afraid of it, feel it is not important to teach, and typically teach it badly or not at all" (Ginsburg, Lee, & Boyd, 2008, p. 3). For instance, before the year 2000 preschool teachers in most of the teacher training programmes in Sweden were not required to take mathematics courses during their teacher training programmes.

Empirical research in the field of interactive technology used as an educational artefact, and more specifically related to mathematics learning in preschool, is very rare. In this study, we address this need to further understand the potential of IWB in preschool mathematics education. This study thus aims to explore the ways in which preschool teachers reason about children's mathematics learning using IWB.

Use of technological artefacts in education within a socio-cultural perspective

The study is situated within a theoretical perspective on teaching and learning which draws mainly from the socio-cultural theory (Cole & Engstrom, 1993; Vygotsky, 1978; Wertsch, 1991). This

perspective can be seen as a useful theory framework for our research, enabling us to describe the complexity of the social context, i.e. preschool teachers' understanding and perceptions of interactive whiteboard. By emphasizing the notion that human action is interactive and fundamentally connected to social and cognitive tools, the socio-cultural perspective entails the idea that all human actions, including learning, take place within a specific context. These actions are mediated by artefacts (John-Steiner & Mahn, 1996). The tools/artefacts can be physical – such as computers, interactive whiteboards, pen and paper – or semiotic, such as language, signs, etc.

Within the socio-cultural perspective, the idea of person-acting-with-meditational-means (Wertsch, 1991) both expands the view of what a person can do and suggests that a person might be constrained by his/her situated and mediated actions. Learning within such an approach is embedded in and dependent on the educational context. The focus is directed at the interaction between people, which is assumed to have great importance for the individual's developing knowledge. Within the socio-cultural perspective, artefacts – such as technological ones – play a significant role in mediating interaction with the outside world (Säljö, 2005).

The idea of ICT as pedagogical artefact can be regarded as a way to investigate the use of technological artefacts in preschools. This idea can be employed in educational technologies like IWB. The ways the educational technologies are used are greatly dependent on a preschool's traditions as well as the preschool teachers' ICT literacy and skills (Sheridan & Pramling Samuelsson, 2003; Vanderlinde & van Braak, 2010). Along the same line of thought, IWB can offer opportunities for young children to explore and learn mathematics. Its use, however, greatly depends on preschool teachers' understandings and attitudes about the ways it can be used in preschool pedagogical practices (e.g. presenting, interacting, annotating, moving or re-sizing objects as appropriate to the current learning object).

ICT in preschools

Currently, most societies put effort into exploiting technology in education for the sake of improving young learners' learning performances (Celik, 2012). 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). The rationale for this attempt is that ICT not only provides learners with the opportunity to control their own learning process but also offers them access to a large amount of information over the Internet (Lam & Lawrence, 2002).

Increasing investments are being made to bring in new technologies, i.e. personal computers, tablets, smartphones, tablet computers and interactive whiteboards, to increase the breadth and richness of educational activities (Gulbahar, 2007; Lam & Lawrence, 2002; Torff & Tirotta, 2010). Research findings (see Glaubke, 2007; McCarrick & Li, 2007; Penuel, Pasnik, Bates, Townsend, & Gallagher, 2009; Sarama, 2004; Smith et al., 2012) indicate that ICT-based technologies can motivate young children, capture their attention, and help construct their learning in meaningful ways. Similarly, a majority of Swedish preschools have invested heavily in digital technologies in the form of personal computers, tablets and interactive whiteboards, as well as preschool teachers' professional development (Folke-Fichtelius, 2010; Klerfelt, 2010b).

Interactive whiteboard, as one of the most common technologies, has been widely used in educational settings (Palfrey & Gasser, 2008; Preston & Mowbray, 2008; Spears, 2009). By providing multi-dimensional learning tools and effective demonstrations (Stephens, 2000), presenting a variety of representations (Kennewell & Beauchamp, 2003) and incorporating a range of multimedia tools and resources such as written text, pictures, animations, video, sound, diagrams, online/offline applications

and websites (Johnson, 2002; Levy, 2002), interactive whiteboard opens up new opportunities to promote preschool practices (Latham, 2002; Levy, 2002).

Further, IWB can offer unique facilities for teachers to save and re-use materials that have been created or annotated, which could reinforce and extend learning over a sequence of lessons (Glover & Miller, 2002; Walker, 2002), and to capture and hold pupils' attention much more strongly than when using other classroom resources (Hennessy, Deaney, Ruthven, & Winterbottom, 2007; Preston & Mowbray, 2008). With such advantages, the interactive whiteboard can motivate young children to learn and enhance their mathematical skills by providing a variety of learning opportunities and modelling abstract ideas and concepts in an authentic way (Abrahamson, 2003; Goodwin, 2008; Watson & De Geest, 2005).

It is not sufficient to argue that simply the use of IWB by itself will create a rich learning environment. The effective use of IWB requires that the technology and pedagogy be integrated towards an enhanced and structured understanding. In other words, IWB might enhance young children's mathematics learning if "teachers and pupils engaged with it and understood its potential in such a way that the technology is not seen as an end in itself but as another pedagogical means to achieve teaching and learning goals" (Higgins, Beauchamp, & Miller, 2007, p. 420).

Mathematics in preschool

Employing IWB in preschools can provide teachers and young children with a whole new interactive learning environment, such as collaborative opportunities for reasoning, articulating scientific knowledge, getting feedback from both teacher and peers, and sharing ideas, information, images, animations, audio or video (Hennessy et al., 2007; Preston & Mowbray, 2008), and may thus improve young children's mathematics learning (Goodwin, 2008).

Early childhood mathematics education should be both deep and broad, promoting problem-solving, analysis and communication, which can be integrated into a great variety of learning activities (Clements, Sarama, & DiBiase, 2003; NCTM, 2000). Such experiences can provide *fertile ground for controversy*, whereby children can rely on their mathematical thinking and reasoning processes to justify their ideas and arguments (Artzt, 1999; English, 2004). Young children actively engage in interaction with peers and the surrounding world, in that mathematical reasoning is a necessary ability to develop for every child. Research by Björklund (2007) also shows that children at a very young age strive to interpret mathematical representations they encounter in play and communication. Multiple encounters with different representations are a prerequisite for learning the complex meaning of many mathematical concepts and principles (Björklund, 2010; Fuson & Hall, 1992; Mix, Huttenlocher, & Levine, 2002).

Increasing emphasis is being placed on developing young children's mathematics learning experiences in preschool (Björklund, 2008, 2012; National Association for the Education of Young Children, 2002; Pramling Samuelsson & Sheridan, 2007). This is reflected in the revised Swedish curriculum, with its aim of increasing the role of language and mathematical learning to better prepare preschool children for school (Utbildningsdepartementet, 2008).

Preschool teachers play a central role in supporting young children's developing mathematical ability to lead and follow reasoning, through problematizing the surrounding world and challenging the children's mathematical thinking and learning (Björklund, 2010; Doverborg, 2006). Pramling Samuelsson and Sheridan (2007) argue that preschool teachers should link mathematical concepts to children's everyday life through authentic activities, so that mathematics will be experienced as meaningful content and a useful tool.

If preschool teachers are to follow their professional mandate, stated in the curriculum, they

need to implement a goal-oriented approach that is simultaneously sensitive to the children's experiences, ideas and familiar environment. The object of learning, for instance, some aspect of a mathematical phenomenon must be well defined by the teacher, with a constant awareness of what he/she wants the children to develop an understanding of (Björklund, 2012). Teaching mathematics to young children can thus be conducted in a stimulating environment using available technological resources, but this places demands on the teacher's approach to mathematics and the artefacts and resources the preschool environment offers.

Method

To investigate the ways preschool teachers reason about young children's mathematical learning through interactive whiteboard, we chose to work through a process we refer to as a small-scale qualitative interview. A qualitative interview can give a deep understanding of the ways that teachers argue for embedding ICT when introducing new technologies such as interactive whiteboard in preschool contexts. Due to the small-scale design, this means though, that results may not be possible to generalize as common conceptions among teachers in general, but they may shed light on important issues reflected upon among the participants.

The case that is the object of our analysis is a group of teachers who have chosen to work with IWB in their preschool practice. Two of the teachers were experienced with more than 25 years experiences and two of them were recently educated preschools. The participant teachers worked in two different preschools. Three worked in one preschool and one worked in another preschool, in different areas of the same Swedish city. The preschools were recommended for the study by regional administration, as they displayed a regular and integrated use of interactive whiteboard in their educational practices. Data for analysis were collected from these two preschools through four individual in-depth interviews.

A teacher interview protocol, based on the literature review as well as other scholars' feedback, was developed. The interview questions were semi-structured, aiming to elicit preschool teachers' thoughts and experiences to better understand their use and meaning making of IWB as a pedagogical tool. The semi-structure allows the teachers to focus attention on the themes of the study, yet gives them opportunities to elaborate on the theme based on their own associations, experiences and initiatives (Kvale, Brinkmann, & Torhell, 2009). The interviews were centred mostly on the following questions: the reasons the preschool teachers embed interactive whiteboard in their mathematics education; how/in what ways they believe interactive whiteboard facilitates young children's mathematical learning; their experienced differences in the mathematics classroom, comparing preschool practice with common materials such as paper, pen, Legos, etc. to mathematics teaching with an interactive whiteboard and other digital technologies; and how they organize mathematical activities with interactive whiteboard.

The interviews with preschool teachers were conducted and audio-taped in autumn 2012. Each interview lasted one and a half to two hours, and all were recorded and transcribed verbatim. The transcribed interviews were then examined independently by both authors before a more thorough scrutiny to distinguish the expressed meanings and approaches among the teachers. In alignment with the socio-cultural approach (Dolya, 2010; Wertsch, 1991), the analysis focused on the ways IWB was regarded as an artefact for facilitating learning in preschool settings. The teachers expressed varying ways in which IWB may be used. In line with the recommendations given by the Swedish Research Council (Vetenskapsrådet, 2011), the names of the participating preschool teachers were replaced with pseudonyms. Our analysis does not reveal distinct differences between the teachers' approaches; instead, the same teacher may express a variety of strategies and approaches mathematics teaching

using IWB. Thus, in the following presentation we highlight the variation of approaches on a collective level as one case.

Results

The analysis of preschool teachers' reasoning about embedding IWB in young children's mathematics learning resulted in four main themes: "Space for children to involve in problem-solving situations", "Supporting collaborative learning and mutual negotiation", "Goal-oriented mathematics learning facilitated by IWB" and "Retaining children's interest in learning activities". It should be mentioned that these themes are reflected in all the preschool teachers' interviews.

Space for children to involve in problem-solving situations

Solving problems is a key component of working mathematically with young children. In this category, we examine the preschool teachers' perceptions of young children's involvement in problem-solving situations using interactive whiteboard. Preschool teachers Mona and David point to opportunities that interactive whiteboard can afford young children, allowing them to be involved in mathematical problem-solving. In the following excerpts, Mona and David discuss these opportunities, such as moving, replacing, modifying and minimizing pictures; taking a picture, sharing it, dividing it, moving it, deleting and adding it, and searching on the Internet. Such a learning environment, according to Mona and David, can enhance young children's involvement in the learning activities and encourage them to solve challenging problems. In the following excerpt, Mona highlights that using the interactive whiteboard in problem-solving activities can increase young children's involvement in mathematical learning:

> **Excerpt 1**
> Mona: Interactive whiteboards facilitate and enhance young children's involvement in problem-solving…//…in searching Google Images on interactive whiteboard, in one instance, one of the children saw a statue. We dragged the image from Google Images to the main board. Then, he wondered if it was possible for us to add hands and feet to the statue…//...I showed the gallery, where he could figure out how to attach hands and feet. He found two pairs of hands and feet for the statue…//… The child attached the limbs to the statue, but they didn't fit, they were too small. Here he could resize the hands and feet to match the statue…//…

In the excerpt above, Mona argues that interactive whiteboard works as a resource for enhancing the young children's involvement in mathematical problem-solving. She expresses how a young child, through the active search for suitable feet and hands, realizes that they are too small and will not fit the statue's size, which empowers him to try to resize them. As indicated in the excerpt, the interactive whiteboard allows the child to a gain hands-on understanding of the situation and resources for solving the problem.

The other preschool teacher, David, also expresses an interesting aspect of how interactive whiteboard can afford space for young children to involve in problem-solving situations:

> **Excerpt 2**
> David: We were working on the interactive whiteboard, and there was a girl who was working with our theme "princess". Suddenly she said the princess should have a ring. Yes, and then we looked for a ring on the Internet, and found a ring in the gallery. She could move the ring

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> onto the screen, and then she had to reduce it to fit the princess. I can't describe how happy she was, she was the co-creator, she had created something through her own imagination. You can't see the ring in the book, maybe she had seen the film, in which the princess has a lot of rings, so she added something to the story. She was very proud.

In Excerpt 2, David exemplifies how interactive whiteboard can give children the freedom to make their own choices about the tools in terms of manipulating the size of objects, which would not be as easy to do in the real world. This is reflected in his example of the child adjusting the size of the ring. When she moves the ring from the gallery to the screen, she realizes that it is too big for the princess. The teacher finds IWB useful here, as it offers tools for the child to take action and solve the problem. By reducing the size of the ring, she is considered to be in control of the problem-solving process. David argues for the power of IWB, as activities such as finding and reducing the size of a ring stimulate abstract thinking.

Supporting collaborative learning and mutual negotiation

The interviewed preschool teachers express that interactive whiteboard can offer young children an opportunity to work together on a common project. Within this collaborative process, the children seem to actively take part in discussions about each other's activities and give each other support in using the various interactive whiteboard tools. In this way, interactive whiteboard can foster young children as active observers and participants in the learning activities through dialogue and reflection.

In Excerpt 3, Mona exemplifies how she makes use of the interactive whiteboard to motivate children to work with each other by using the board to illustrate animals known to them:

> **Excerpt 3**
> Mona: When we are sorting animals on the interactive whiteboard, to give a full picture of the animals I show the children five short clips, and then I put the animal pictures on the screen //…So young children can take a cow (one of the pictures) and drag and match it to one of two living environments, in this case the forest or the farm, so they sort and classify animals, it's a type of mathematics ... when they begin to discuss it with each other…Then during our discussions they're asked what they think the correct combinations are. What I as a teacher think, and then what the actual answers are. Maybe the animals are friends and maybe the animals live there. So the young children explore, experience the reality in the interactive whiteboard.

This excerpt suggests that young children often learn and use mathematical ideas in their everyday life, for example when discussing where farm animals live and which animals belong together, which is a sorting and classifying activity. The children were asked to classify animals based on their unique characteristics, e.g. length, weight, colour, type of food, and so on. Mona believes that the group discussion, the negotiation of meaning and the mutual support between the children can be created through the use of the interactive whiteboard. According to her, these factors are important for young children's mathematical learning. By incorporating young children's language and mathematical ideas and skills into the actions on the interactive whiteboard, preschool teachers can administer a rich environment for the children's mathematical education. Different suggestions are tried out within this context, giving an excellent opportunity to take into account the child's point of view. In such rich environments, as highlighted in the excerpt above, mathematics education for young children is centred on challenges, joy and authentic learning activities.

IWB allows young children to gather around a common activity, which gives them the opportunity to support each other in carrying out the activities and to take collective responsibility for completing the activities. Cooperation and mutual negotiation in classifying the animals and problem-solving is one way of taking into account young children's initiatives and flow of ideas, which is considered important in Swedish preschool practice. Collaborative learning implies participation and the sharing of relevant knowledge and skills, which is also a desirable approach to adopt in early childhood education.

Another interesting aspect of collaborative learning while using the interactive whiteboard is expressed as children taking part in mutual negotiation and argumentation. This is considered an important aspect of the learning process, since such activities facilitate dialogue characterized by reflection and mutual understanding. The preschool teacher Matts links the use of interactive whiteboard to the potential of IWB to support productive discussions and the exchange of experiences when young children actively engage in each other's contributions and argumentation. Matts therefore argues that the interactive whiteboard can both create and support socially constructed learning situations and facilitate mathematical reasoning among young children:

> **Excerpt 4**
> Matts: Interactive whiteboard can definitely develop collaboration amongst young children and motivate argumentation techniques, it can facilitate collaboration among them…//… they discuss things with each other, and learn together…//… definitely, motivating the children to collaborate is very important for mathematics learning... and interactive whiteboard somehow facilitates young children's discussions, collaborations and mutual support.

As indicated in Excerpt 4, the interactive whiteboard can offer children an opportunity to work and learn together. Matts expresses that using the interactive whiteboard in preschool seems to encourage children to find arguments for their ideas and suggestions, and thus stimulates collaboration in mathematical learning. According to Matts, introducing problems like sorting or classifying on the interactive whiteboard encourages the young children to actively discuss the problems and scrutinize how they can solve them. He reasons that interactive whiteboard creates opportunities for children to learn from each other, and simultaneously fosters a culture of involvement and includes everyone in the learning environment. This may open up for even more learning opportunities. Collaborative learning and mutual engagement (as with any learning process) draw on different types of skilful thinking, which may be supported by the interactive whiteboard's available tools for gathering and organizing relevant information and constructing and managing a plan of action or strategy that will help solve the problem. In high-quality collaboration these skills may be shared and used by the children, supporting their developing understanding of both the available tools and the mathematical content at hand. This is expressed in the following excerpt:

> **Excerpt 5**
> David: There are some educational games that we usually run on the interactive whiteboard. The kids like them. For instance, they like games that centre on comparing the pictures and their details. The children can discuss which details fit a specific picture. They articulate together, "it's not, no, not that one", indicating that the dots are too small, they discuss things together, and there's mathematics as well, of the highest level, where they learn together and argue for and against. This can only be done on the interactive whiteboard.

David gives an example of the ways mathematical games are employed. The idea of the game is to

compare details and link to a picture. As reflected in Excerpt 5, the children are very engaged in the game. These situations around interactive whiteboard are considered to provide opportunities for argumentation and for contrasting ideas and experiences. The teachers regard the given argumentation and discussion as important keys for mathematics learning.

Goal-oriented mathematics learning facilitated by IWB

By addressing the features of IWB, such as pictures, written text, video, sound and online websites, the preschool teachers exemplify how IWB can enhance young children's learning in general and mathematical learning in particular:

> **Excerpt 6**
> Matts: the use of the IWBs can contribute to children's learning… the interactive whiteboard is a big screen and an intelligent media … the IWB has the capacity to enhance children's visual learning... it has certain distinctive features, such as the facilitation of opportunities to employ the multimodal dimensions of language, image, sound and gesture known to be important for communication and young children's mathematical learning.

As indicated in Excerpt 6, Matts argues that IWB can provide a variety of opportunities to demonstrate mathematics concepts and applications in a textual, audio and visual manner. According to Matts, these multimodal opportunities are used to cater for the different learning styles of the children. Some features on the interactive whiteboard, such as its visual nature, colour and touch-sensitive board, are regarded by the teachers as particularly valuable as means to enhance young children's learning. Sandra, another preschool teacher, expresses this in the following excerpt:

> **Excerpt 7**
> Sandra: Having a multi-touch, colourful display and large graphics, the interactive whiteboard can provide a unique environment in which to learn and interact physically with the board, manipulating images, texts, pictures etc. I think interactive whiteboard can facilitate learning more than the other digital technologies because of its size and multi-touch capabilities.

According to Sandra, the interactive whiteboard gives young children opportunities for visual-spatial and bodily-kinaesthetic learning, which can be difficult in a print-based environment. The multimodality opportunities of IWB are thus considered a valuable pedagogical tool for facilitating young children's mathematical learning.

Retaining children's interest in learning activities

The starting point as well as the result of mathematical learning activities has to be traced in terms of the young children's perspective in the preschool environment. Preschool is a pedagogical practice whereby the child's perspective is very closely related to the teacher's actions. For instance, the interviewed preschool teachers highlight that IWB is a useful tool that can retain young children's interest and motivate them to learn. Motivation, fun, attention and interest are considered key factors in young children's mathematics education, and IWB is valued as a way to address these factors. Active participation in sharing and modifying pictures, searching the Internet and collecting findings on the IWB are considered to enhance young children's learning and enable them to create lively and exciting learning opportunities:

> **Excerpt 8**
> David: Interactive whiteboard offers wide-ranging possibilities. Different options have been

gathered in one place…//…Interactive whiteboard can motivate young children..//…they seem more focused.

As Excerpt 8 suggests, the use of the offered features of interactive whiteboard can help preschool teachers capture children's attention, maintain their concentration and motivate them to learn. In creating a space for new and exciting learning, as indicated in Excerpt 8, interactive whiteboard can enhance young children's level of engagement in the learning activities. The teachers especially describe the visual features and the large screen as keys to capturing and holding the children's interest and engagement in interactive processes in the learning activities. Sandra expresses this in Excerpt 9:

Excerpt 9
Sandra: Interactive whiteboard with its large screen can attract young children's attention and motivate them to engage in the intended learning activities because of the high level of interactivity.

IWB allows the interactive movement of objects and enhanced visuals on its large screen. As Sandra highlights, interactivity, as a key feature of IWB use, is found in the give-and-take between the preschool teacher and the young children that leads to learning, and with the IWB young children receive support in being in command of their learning process as it allows them to touch the screen as well as holds their attention.

In another excerpt David illustrates another interesting aspect of IWB, its ability to attract children's interest in learning activities. He argues how preschool teachers can use IWB to design learning activities that can motivate young children to learn:

Excerpt 10
David: IWB can enable preschool teachers to create interactive and imaginative learning activities that attract young children's attention. Such attractive learning activities can encourage young children to learn and easily concentrate on the given activities.

As indicated in Excerpt 10, David argues that the preschool teacher can use the interactive whiteboard to create interesting learning activities. In this way, the teacher can retain the young children's attention and provide learning activities that might otherwise not have been attainable.

Discussion

This study has outlined preschool teachers' reasoning about embedding IWB in young children's mathematics education. Their reasoning is reflected in four key approaches that appear significant for understanding the experienced pedagogical practice from a socio-cultural perspective where context, mediation of meaning, communication and artefacts are essential (Engeström, 2007; Säljö, 1997). The most emphasized rationale for embedding IWB highlights providing "Space for children to involve in problem-solving situations". Interactive whiteboard seems to afford preschool teachers a variety of opportunities and multimedia possibilities to initiate, share and solve problems. This creates a context of sharing meaning and inviting children to communicate and explore in collaboration with others, which we recognize in the second approach "Supporting collaborative learning and mutual negotiation". The preschool teachers argue strongly for group discussions, negotiation of meaning, and mutual support between the young children that can be created and enhanced through the use of IWB. Negotiation of meaning is central in the socio-cultural understanding of learning where meaning-

making is facilitated through communication about common projects.

Considering the focal role of dialogue around the represented objects, IWB can contribute to constructing an active learning environment by exploring and representing the physical and virtual objects and subjects for young children. It can also be used as a resource with which to provisionally discover and permanently represent learning events. Additionally, it has the capacity to support the preschool teacher's review of key points, allowing them to be presented as a series of cumulative and connected thoughts and concepts.

The third approach "Goal-oriented mathematics learning facilitated by IWB" underlines the possible opportunities that IWB can offer in young children's mathematics learning. By providing attractive features such as its visual nature, colour and touch-sensitive board, IWB offers a number of opportunities to present and teach mathematics concepts and applications to young children. By addressing specific features of IWB in motivating and attaining young children's interest, the last approach is focused on "Retaining children's interest in learning activities". However, there is a risk that the use of the technology and exciting applications becomes the main purpose, whereas the object for learning (mathematics) is found to be unfocused, limiting a deeper development of understanding used concepts and principles (Björklund, forthcoming).

The analysis of the preschool teachers' reasoning suggests that young children's knowledge and understanding of mathematics, as well as their skills in mathematical thinking, can all be enriched through the use of technological artefacts such as interactive whiteboard. By addressing the specific features of IWB, the preschool teachers highlight the opportunities it can offer in presenting, retrieving, documenting and sharing information. Moreover, the teachers argued that using IWB can engage young children in active learning processes. They give examples of ways to engage children in learning situations, but give limited explanations to how meaning of mathematical phenomena is mediated through the technology. Findings in other studies show that IWB *can* improve young children's learning, and mathematical education in particular (Glover et al., 2007; D Miller et al., 2005), but it seems that the opportunities are closely related to the teachers' knowledge of the mathematical content and possible learning objectives.

According to the interviewed preschool teachers (e.g. in Excerpt 3), interactive whiteboard can help teachers create a meaningful and authentic learning environment to achieve preschools' pedagogical goals. Creating such authentic learning practices as reflected in the literature depends mostly on the preschool teacher's skills and competencies for making the mathematics visible in a variety of forms and in an entertaining way (Goodwin, 2008; Watson & De Geest, 2005).

The need to take into account young children's interests was another interesting point emphasized by all the interviewed teachers. Taking young children's interest as a point of departure, interactive whiteboard can be used to motivate and teach mathematical ideas and concepts such as shapes, measurement, the meaning of numbers, and how numbers work. As Sheridan and Pramling Samuelsson (2003) contend, young children learn with play and through play, and IWB can provide a game-like situation for mathematics learning. Thus, it can be said that the successful embedding of IWB in preschool practices can also depend on the ways it accommodates young children's interests (Goodwin, 2008) and includes the technology in the social context of children's lives.

All the interviewed preschool teachers praised the importance and significance of embedding technological artefacts such as IWB in creating a rich learning environment and facilitating young children's mathematical education and logical thinking. However, it seems that introducing IWB on its own cannot change young children's learning environment but that it rather, as a pedagogical means, can enhance preschools' pedagogical practices (Higgins et al., 2007). In other words: IWB, as a technological artefact that mediates the learning process, may very well be situated in the context of young children's mathematical education (Cole & Engstrom, 1993; Vygotsky, 1978).

In short, integrating interactive whiteboard into preschool can reinforce or facilitate learning new skills and ideas; help children think analytically, engage and motivate; promote mathematics literacy; and offer opportunities for preschool teachers to individualize instruction. However, IWB cannot be viewed as a panacea that can transform preschool educational practices on its own. Preschool teachers' pedagogical knowledge, as well as their technical skills and attitudes, play a critical role in how the IWB is and can be used in preschool.

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