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Exploring the 'tool metaphor' for using digital technology in teaching students with autism spectrum disorders (ASD)

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Keywords
digital, technology, teaching, students, metaphor, autism, exploring, asd, disorders, spectrum, tool

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Since computer technologies entered the educational domain, a number of metaphors have been introduced in the literature to explain this newly emerged phenomenon to educators in familiar terms. This chapter explores the ways that the conceptualisation of educational technologies as a teaching 'tool' can assist our understanding of the implementation of a new digital technology, the Interactive Whiteboard (IWB), in teaching children with Autism Spectrum Disorders (ASD). The tool metaphor relates to a socio-cultural concept of a tool mediated purposeful human activity as a unit of analysis in educational research (Vygotsky, 1978). The activity model (Engestrom, 1991) was adopted in this study to focus on the teachers' use of technology. The IWB was then analysed as a teaching tool that can enhance (or hinder) the teacher's pedagogical goals. The chapter then provides a discussion of the use of the IWB in children with ASD using the tool metaphor. The question that we asked was how the tool metaphor can be utilised to assist in our understanding of the pedagogical choices made by a teacher are successful in the process of working with children with ASD.The study demonstrated the usefulness of the tool metaphor for providing insights into what constitutes the effective use of the IWB in teaching children with ASD. The use of the metaphor allowed us to go beyond clinically-based research that has dominated the field of special education, and examine the day-to-day reality of how digital technologies were used in a classroom context with students who have ASD. Nevertheless, it also highlighted that the use of a single metaphor to describe a complex digital technologies might be somewhat limiting and further investigation is required.

Introduction

Since computer technologies entered the educational domain, there have been numerous attempts to conceptualise the place of these complex media in teaching and learning to ensure their successful use. A number of metaphors have been introduced in the literature to explain this newly emerging phenomenon by applying the terms and ideas which were already familiar to educators. In his seminal work, Taylor (1980) pioneered a vision of the computer as a device which assisted the students' learning in three 'modes': as a 'tutor', as a 'tool' and as a 'tutee'**.** While Taylor did not directly use the term metaphor, his work marked the beginning of construing the meaning of rapidly evolving educational technologies in a metaphorical way. By summarising the recent literature, Stevenson (2008) has identified four metaphors for digital technology which have been most commonly used in educational research: technologies as a tutor, as a tool, as an environment, and as a resource. Stevenson (2008) argues that "finding a correct metaphor… is a key aspect" in new technology design and implementation (p. 836).

The types of metaphors that researchers use are inextricably linked to the theoretical approaches that they undertake in their study. There is also a close connection between the

ways that educators think about the place of digital technologies in teaching and learning and the ways in which they integrate the technologies in their classroom. Likewise, the metaphors that educators give credence to and the ways that they conceptualise the role of the digital technologies in education are likely to affect their approach to research in this area (Stevenson, 2008).

This chapter explores the ways that the conceptualisation of educational technologies as a teaching 'tool' (Jonassen, 2000; Stevenson, 2008; Verenikina & Gould, 1998) can assist our understanding of the implementation of a new digital technology, the Interactive Whiteboard (IWB), in a modern special education classroom. We start with the definition of the 'tool' metaphor and discuss it as an integral part of the theoretical framework that underpins our study, a socio-cultural approach and Activity Theory (Vygotsky, 1978; Engestrom, 2001). We then provide an overview of the educational needs of children with Autism Spectrum Disorders and outline the current issues in the use of digital technologies with this cohort of students. The discussion of the 'IWB as a tool' metaphor draws on two classroom examples (stories) from our study to explicate the importance of the metaphor in shaping our views of what constitutes a successful use of digital technologies in teaching children with ASD.

Theoretical framework and the 'IWB as a tool' metaphor

To define a metaphor we follow Lakoff's (1993) reasoning that a metaphor provides the means to "conceptualize one mental domain in terms of another ", for example, the "love as a journey" metaphor (Lakoff, 1993, p.202). Put differently, metaphor is defined as "a systematic mapping from a source to a target domain" (p.210), the target domain being love, and the source domain being the journey. In our case, the 'IWB as a tool metaphor' (herein after called 'the tool metaphor') then allows us to conceptualise the IWB (a target domain of digital technologies) through the attributes and characteristics of the tool (a source domain of human labor). It is the set of "conceptual correspondences" (Lakoff, 1993, p.207) between the domain of digital technologies (IWB) and the domain of teachers' work (labour) which can enable the educators to make personal meaning of the IWB in relation to their pedagogical goals.

The ubiquitous, elusive and ever changing domain of digital technologies cannot be easily captured by a single definition. Cambridge Dictionaries Online define the IWB as "a white surface that can be written on in meetings, classes, etc. and which can display the contents of a computer screen" (Cambridge Business English Dictionary, 2011). However, this definition is not helpful in understanding the complexity of the affordances of this technology and the ways that they can be utilised in the classroom.

The IWB is characterised by multiplicity of attractive features and a large variety of software. Teachers can be overwhelmed and confused by these features particularly when they are coupled with commercial pressures to purchase and executive pressures to utilise this costly technology. In the educational literature there seem to be no simple answers to the question as to what constitutes ‘good practice’ in using digital technologies in the classroom. The view of the IWB as a tool for achieving particular pedagogical goals can provide a valuable perspective to a better understanding the nature of this question.

Tool is defined by Cambridge Dictionaries Online as "a piece of equipment which you use with your hands to make or repair something" or as "something that helps you to do a particular activity" (Cambridge Advanced Learner's Dictionary & Thesaurus, 2011). Conceptualisation of the IWB as a tool allows for cross-mapping of the attributes of a tool (the source domain of 'labour') onto the individual technology such as IWB (target domain) and establishes a conceptual correspondence between these two domains. In relation to the IWB, this brings to the fore the notion of 'the work to be done' (a pedagogical goal), the person whose work it is (the teacher) and the IWB which can be used to help to achieve the teacher's goal.

The tool metaphor relates to a socio-cultural concept of a tool mediated purposeful human activity as a unit of analysis in educational research (Vygotsky, 1978; Engestrom,

2001). An activity model (Engestrom, 1991) proposed within Activity Theory framework was adopted in this study to focus on the teachers' use of technology as a *subject* of their teaching activity (Figure 1). The IWB is then analysed as a *teaching tool* that can enhance (or hinder) the teacher's pedagogical goal (object), i.e. meeting specific needs of children with ASD. Within Activity Theory the integration of a tool into the structure of activity enhances the natural ability of a person (the activity subject) empowering them by extending some pre-existing functioning be it motor or cognitive. Accordingly, the tool can be either physical or cognitive (Vygotsky, 1978; Wartofsky, 1973, cited in Cole,1995). For example for teachers, the IWB can extend heir ability to simply visually display information by writing or presenting some images, or it can assist in achieving (and potentially reshaping) their more complex pedagogical goals related to specific needs of children with ASD.

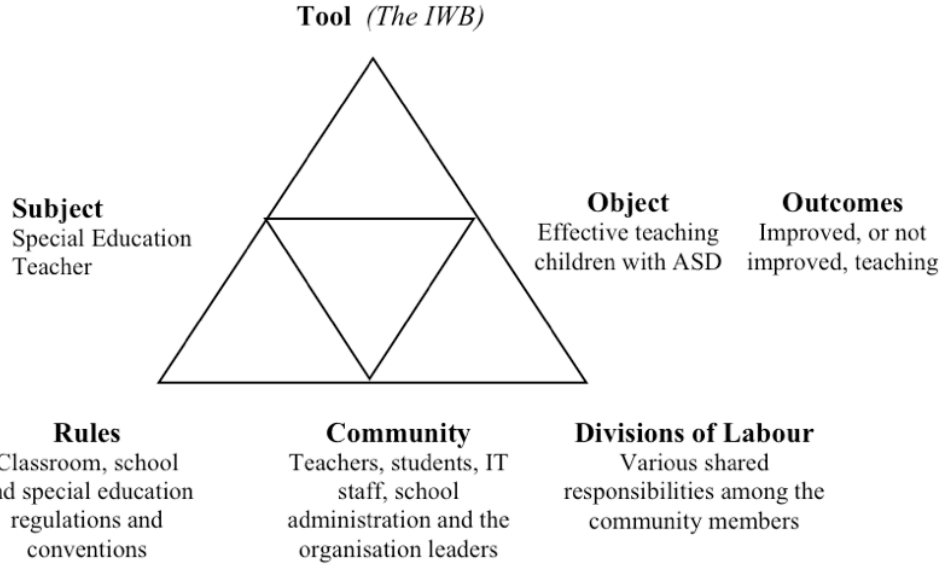

Figure 1. The teacher's activity of using the IWB as a tool to support their pedagogical goal

Whilst in this study we focus on the teacher's pedagogical activity as the subject, it is recognised that the teacher operates in interaction with other people (*community)*, who include the students in the classrooms, other teachers and school executives. *The rules* and the *division of labour,* regulate the use of technologies in relation to the policies and regulations in the special education setting and the social reality of technology use.

Pedagogical needs of children with ASD

The characteristics of ASD are identified by a triad of impairments (Wing, 1996) encompassing social skills, communication skills and repetitive behaviours or obsessions. Broad characteristics include limited or impaired use of verbal and non-verbal cues, difficulties with social interactions and cues including a lack of appropriate responsiveness to people and an inflexibility and rigidity in thought, behaviour and language patterns (Wert & Neisworth, 2003, Attwood 2007). In addition, in childhood and within a classroom context, the ability to understand symbolism linked to play and imagination, is identified as a significant contributor to social difficulties (Jordan, 1999; 2003) as is the physical and emotional discomfort associated with human interaction and proximity (Blakemore et al, 2006; Silva, Schalock & Gabrielsen, 2011) involved in one on one and group teaching.

There are three powerful psychological models which have been used extensively to demonstrate the cognitive functioning of students with ASD. The most influential has been Theory of Mind (Baron-Cohen, 1990), followed by Weak Central Coherence (Frith, 1989) and Executive Functioning Deficit (Ozonoff, 1995). Baron-Cohen, Leslie and Frith (1985) demonstrated that students with ASD lack 'Theory of Mind' or that they have ' Mindblindness". Theory of Mind is the ability to think about other people's thinking and

further to think about what they think about our thinking. It can be difficult for teachers to see the need to teach social interaction skills that they and the other students in their class learnt very naturally. The ways in which the IWB and other digital technologies can assist with learning are that there is total recognition in the field that all interventions must be visually based, it is also acknowledged that you can teach pretending to these students and point out the difference between reality and fantasy if you use visual prompts.

Central Coherence Deficit is another theory which has been used to explain aspects of Autism which were not explained by Theory on Mind impairment.These included insistence on sameness, attention to detail rather than the whole, insistence on routined, obsessive preoccupations and special /savant skills (Frith, 1989). Intervention strategies which are ideally suited to IWB's include , using a model or picture of the end product, using visual cues to highlight meaning as verbal cues are ambiguous, teaching stories using a pictorial sequence for generaliation of skills and knowledge, motives and plot. Some researchers feel that Executive Functioning Deficit is the major deficit in autism as executive functioning influences our ability to plan, self-monitor, inhibit inappropriate behaviour and behave flexibly (Ozonoff, 1995).

All of these difficulties which arise from Theory of Mind, Weak Central Coherence and Executive Functioning Deficit theories affect the ability of the student with ASD to interact socially in the classroom and in the school environment and the ability to benefit from the curriculum. It is also argued that students with ASD do not form a homogenous group and technology usage may need to be adjusted to suit individual learning needs. Therefore the study of the effectiveness of such technologies, based on clinical individual trials with small groups of children, is not sufficient, because of the inability to generalise results across the ASD population (Mineo, Ziegler, Gill & Salkin, 2009; Jacobsen, Foxx & Mulick, 2005; National Research Council, 2005).

Digital technologies in teaching children with ASD

Digital technologies have become a reality of a modern classroom, and special education is no exception. Research into the use and effectiveness of digital technologies in the education of students with ASD has become more prolific, however the majority of research includes clinical studies involving small numbers of students, with very few studies within the applied setting of a classroom. The effectiveness of digital technologies in teaching students with ASD have been identified as beneficial due to their predictability, routine and systems-orientated capacity reliant on visual data (Sansosti & Powell-Smith, 2008; Kimball, Kinney, Taylor & Stromer, 2004; Herrera, Alcantud, Jordan, Blanquer, Labajo & De Pablo, 2008). However, generalising the clinically based findings to the applied setting of the classroom may be problematic to the teachers due to various factors that affect their teaching practice. These include familiarity with the technology, pedagogical views and the classroom makeup. The majority of the research to date has concentrated on the use of individualised computer programs and one-on-one implementation and teaching which create difficulties in employing similar individual programs in an authentic classroom setting (Kinney, Vedora & Stromer, 2003).

Because of the difficulties of teachers implementing technology intervention results in a classroom setting with a group of students with autism, there has been a move to 'remove the human element' such as the teacher, from the applied setting and segregate students to computer-centred, non-social environments (Carnahan, Basham, & Musti-Rao, 2009). However, "removing human beings from the classroom - allowing technology to overwhelm the space - is a recipe for an unhealthy information ecology...maintaining a healthy information ecology requires skilled people to support the use of technology" (Staley, 2004, p.24). Therefore, although recently emerging research demonstrates the imperative role of human mediation in the use of digital technologies in children with ASD (Passerino & Santarosa, 2008), the teacher's perspective is still missing. In our approach based in the metaphor of technology as a teaching tool the teacher has to be the central element to the study of the implementation of the technologies such as the IWB in an educational process.

While the IWB technology has rapidly become an essential component of a modern classroom worldwide, the research of the impact of the use of the IWB on pupil performance is still inconclusive. For example, the study of Moss and colleagues "failed to find any evidence that the increase in the installation of interactive whiteboards …has increased pupil performance in Key Stage tests" (Moss et al., 2007, p.72). Such results imply that simply the saturation of the classrooms with the technology does not bring about a change, but the way that it is used might be the key (Gray et al., 2010; Verenikina, Wrona, Jones & Kervin, 2010).

The use of the IWB in a special education setting: two stories

This chapter presents the data from one case of a larger study of the implementation of the IWB in a special education setting. It was designed as a qualitative research study that included a number of case studies (Verenikina, Tanner, Dixon & de Graaf, 2010). Two stories from one case are reported in this chapter. Three types of data collection were used: observations, a semi-structured interview with the teacher focussed on the perceived effectiveness of the IWB use in their teaching, and collection of artefacts and visual evidence (photographs, video footage and students' work samples).

The teacher in the presented case, Alice, was experienced in providing educational programs specifically for students with ASD and was assisted by a teacher's aide, Sam (pseudonyms are used). The class included 6 students (5 males and 1 female, 12-13 years of age) diagnosed with relatively high functioning autism and presenting with good verbal communication skills. The IWB, positioned at the front of the classroom, was utilised for a variety of activities. The main ongoing activity conducted across the four weeks of observations was a "Rainforest Project'. Presented below are two stories of the use of the IWB in teaching children with ASD.

Story 1: Drawing rainforest pictures and creating a story

Observation snapshot length – 55 min

Alice asked the children to write a story plan using paper and pencils. She used the IWB to model an extended plan of how to write a story. Then she asked children to draw their pictures of a rainforest on the IWB. The teacher asked each child (one at a time) to come to the IWB screen to create a picture based on a provided rainforest background, and save it for the future use, while the rest of the class was engaged in individual story writing. The teacher was walking around the class helping children with their story, however she kept an eye on the child at the IWB and was able to provide the child with support 'just in time' when he or she had difficulties with operating the IWB software or having problems with picture choices.

Other children did not overtly appear to be engaged or watching the child at the IWB, but it was obvious that they kept an eye on what was going on. For example, when C. created her rainforest picture and inserted the figure of the tiger and then increased its size out of proportion by making him really huge, all the children but one, and Alice, focussed their attention and appeared mesmerised saying 'Wow'. She also drew a cage over it to protect others from such a monster! (which was received enthusiastically by other children).

Most of the children were working creatively at the IWB when making their pictures. They carefully selected pictures and experimented changing the size of the animals, birds and insects. Their verbal responses indicated enjoyment. However, four out of six children had difficulties in writing a sustained story and Alice had to get back to, and reinforce the structure of the story. She presented it in a more simple way than the week before, however the children still were having difficulties writing their stories. Alice had to explain again the difference between a real story and fiction and asked children to engage their imagination. Then she, and Sam, the teacher's aide, had to individually scaffold the children towards their story writing and using their imagination. Alice was working with J. on his story. J. tended to

provide a list of facts about the rainforest instead of writing a story with the beginning, middle and the ending.

Sam was working with Z. on his story and the child did not seem to be able to think of a story and looked disengaged when Sam asked him to think of a fiction story. While Sam tried to insist that Z. make a story, the child was getting frustrated. Meanwhile the child who worked at the IWB just finished her picture and was reading out loud her story to Alice. Sam suggested Z. goes to the IWB to create his picture. Z. went to the IWB, calmed down and started to choose his pictures. Alice asked him to match his picture with his story, however Z. did not yet have his story at that point and he started to make the story up while he was doing the picture. Both the teacher and the aide took the opportunity of this 'teaching moment' and supported the child in creating the story while talking and drawing. He created quite a sophisticated story including various animals and drew a fence and many people. Alice scaffolded his work further by moving the monkey in his picture on the fence close to people which prompted Z. to develop his story further. One of the other children who were observing Z's progress commented, "You created a decent story!" Alice wrote the story down for Z. as he verbalised it as they were working at the IWB together. Z. commented, "It is just a small story but I'll go with that". Alison, Sam and the children applauded Z. on creating such an interesting story.

Story 2. Converting handwriting into print text

The length of the observation snapshot – 35 min

While providing instructions for the day's homework, Alice was handwriting on the IWB screen. She wanted to print out her writing to provide children with a handout to take home and she needed to convert her handwriting into print - the feature supported by the IWB software. The handwriting would not convert easily and children responded with laughter. Alice then switched her focus from the initial task of outlining the homework, and asked each child in turn to come to the IWB to write their name on the IWB so she then could convert it into print. The children were not assigned any individual task so they were observing what was happening at the IWB. Two children (C. and B.) hand wrote their name neatly and it was easy to covert their handwriting into print text - both the children received praise from Alice and applause from the class, and they looked proud and happy with their achievements.

However, the other two children (F. and M.) took a long time standing at the IWB trying to write their names in a manner which was suitable for the conversion. The teacher was correcting them asking them to write smaller and neater letters and finally it worked, and the children went back to their seats looking disappointed and with their body language suggesting that they felt belittled for being so clumsy. One child, Z., did not want to go to the IWB, and this was fine with the teacher as she did not insist. The last child, D. had significant difficulties in meeting the standards. He did not seem to be able to follow what the teacher was asking from him and kept hand writing his name in a very uneven way and with fancy letters. Alice was becoming more insistent that D. modify his writing, which looked very colourful and artistic to the observer, but was not suitable for the IWB software to convert it into print. Some children giggled. While D. seemed to enjoy writing the big and colourful letters, he also looked frustrated every time when the conversion failed. The teacher was trying to make the child write in smaller letters and in a clearer way however the child failed to do so. He started to show extreme verbal and gestural signs of frustration and Alice sent him back to his seat without completing the task. While getting back to his seat he looked discouraged and shook his head from side to side.

Discussion of the use of the IWB through the tool metaphor

In the above stories, how can the tool metaphor be helpful in our understanding of whether the use of the IWB was successful in teaching children with ASD? There are various criteria of success highlighted in the literature which assist in forming an opinion. In both the stories the complex features of the IWB were skilfully used by the teacher during a considerable period of time (a criteria of utilising the IWB in teaching and learning). The children were actively engaged in interacting with the IWB in a hands on manner (the criteria of interactivity – children physically interacted with the IWB). The use of the screen images, pictures and colours allowed the teacher to sustain children's attention and to keep them engaged in the lessons (the criteria of student motivation and engagement).

The use of the tool metaphor provides an additional dimension to these criteria of success mention in the previous paragraph. It allows us to look beyond the multimodal phenomenon of the IWB technology with its many attractive and appealing features. A metaphor can be helpful here as it will "enable us to see in a new light what we are doing or experiencing" (Saban, 2006, p.300). The tool metaphor used in this study therefore provides us with the means to explore the IWB as a tool to achieve the teacher's pedagogical goals in a special education classroom. Thus, the criteria of successful use of the IWB becomes whether it afforded the teacher in achieving her pedagogical goals to suit the needs of students with ASD.

In *Story 1* the IWB as a tool was used to support the teacher's pedagogical goal of having the children with ASD create a story about the rainforest to be illustrated with digital pictures as a visual support. The use of the IWB software provided a large number of choices for creating their pictures and enabled manipulation of the images in a dynamic and creative manner. For example, C. chose a very large number of animals and insects for her picture but then deleted about 90% of them thus making her choices in a hands-on manner. The use of the IWB as a visual prompt to support imaginative story writing emerged as a 'just in time' teaching moment which wasn't initially planned. The teacher reflected that for Z. using the whiteboard stimulated and supported his imagination. The simultaneous use of the visuals while creating a story emerged as a successful teaching technique for the students who found the initial process of story writing overwhelming. This resonates with the research by Kuzminsky (2008) who identified the benefits of the IWB for children's story telling who may be visual and kinesthetic learners not just specifically those with ASD. The use of the IWB captured in Story 1 was successful in a way that it allowed for full achievement of the teacher's pedagogical goal of creating an individual imaginative story by all the students in the class, which was a very difficult task for children with ASD given the imitation of their disability (lack of imagination and difficulties in expressing themselves in written language). In this instance the IWB has been used as a tool to support story construction in a pictorial rather than written mode. Without the alignment of the pedagogical goal and the tool (the IWB) such pedagogical success probably was not feasible.

The use of large visuals to support the story writing and demonstrate the creation of a story through animated and attractive visual images also engaged the attention of the rest of the children. Using the large screen increased other students' involvement in their responses to their peers who worked at the IWB. This provided opportunities for children to communicate while creating the pictures and participating in the shared creation of stories with support from the teacher's scaffolding. In relation to the needs of students with ASD, who are often thought to not be able to engage socially, the use of the IWB provided a common focus for shared experience and stimulated social communication. This use of the IWB enabled the teacher to cater for one of the most fundamental needs of the students with ASD. Thus making this story an example of pedagogically successful use of the tool.

The use of the IWB in *Story 2, Converting the handwriting* activity, presents an episode of extended engagement of the teacher and her students with the technology which has been seen as one of the positive criteria of using the technology by many educators, including the school personnel in this study. Having said that, examining the story using the tool metaphor adds a different dimension to the analysis. The initial pedagogical goal of the teacher was to explain and write down the homework on the IWB so that it could be printed out for each individual child. For this purpose she used the text conversion feature which

then took over the initial pedagogical goal. In relation to the teacher's pedagogical activity the IWB did not serve as a tool to support a pedagogical goal, but instead the tool itself became the centre of the teacher's activity and substituted for her pedagogical goal. Obviously, the decision was made spontaneously, within a very short period of time (as often happens in the case of 'just in time' teaching moments). In this case, the exploration of the complex features of the IWB drew the lesson away from its pedagogical goal. It seems that the recently increased advancement in the complexity of digital technology amplifies what was labelled by Olson (1986, in Engestrom & Escalante, 1996) more than a quarter of the century ago the 'tendency of displacement'. This is when an instrument (*tool*) becomes an end in itself (or *the object*, Figure 1). Thus increasingly complex, newly emerged educational technology such as the IWB has the potential of overpowering the pedagogical goals and become a driving force of classroom decisions, and sometimes take place of such goals. This is particularly likely to occur in situations which have not been pre-planned but emerge spontaneously during the lesson.

In this case the fact that the teacher was distracted by the use of the IWB from focusing on the task at hand, was mirrored by an unfortunate social experience for the majority of the children (four out of six). For those children who were unable to meet the standards of handwriting for the conversion, this activity may have exposed them to a negative social experience, thus reinforcing one of their deficits as students with ASD. Additionally, the limitations of the technology in converting the text which did not fit a particular shape and size was not supportive of children's creativity but rather hindered their experimenting with different styles of handwriting enabled by the IWB which some children seemed to enjoy. Such a use of the IWB not only did not meet the teacher's goals, but also worked against the pedagogical principles of working with children with ASD.

Therefore, the tool metaphor allowed us to analyse how the IWB technology can support and sometimes hinder teachers' pedagogical goals. The study highlighted that the teacher's use of the IWB affords children with ASD opportunities to learn story writing in a format that supports their visual modality. It also demonstrated that when pedagogically sound goals are implemented the children can become empowered to interact in the environment that the IWB can provide.

Even though the tool metaphor allowed us to look at the teacher's perspective of using the IWB as a teaching tool, the study of children's learning within the teachers' object oriented activity might be limited. While the tool metaphor provides useful insights into what constitutes the effective use of the IWB in relation to teacher's pedagogy, the theorists remind us about the limited nature of a metaphoric conceptualisation of a phenomenon (Latoff, 1993; Stone, 1998). Metaphors "act as a lens, a screen, or a filter through which a subject is (re)viewed" (Saban, 2006, p.300), thus focusing on a limited set of the subject's characteristics and, in a way, "hindering our realization of the true dimensions of the phenomenon" (Stone, 1998, p.345).

It will be useful to further explore the suitability of the environment afforded by the IWB to the specific needs of children with ASD. There is a need to investigate the use of additional metaphor for the use of digital technologies with these students - the metaphor of digital technologies as a 'learning environment'. This metaphor implies a new milieu where the learners "[a]ctively engaged in building their own meanings as they work with digital technologies" and, "control their own trajectory through exploration, experiment and personal creativity in the new medium" (Stevenson, 2008, p. 849). Then, in Saban's words, "a realistic approach to studying some complex phenomena … must start from the premise that there is no single metaphor that can best capture all of the complexities of the phenomenon under investigation" (2006, p.311).

Conclusion

Whilst the use of IWB's as an educational tool for teachers of children with ASD has been identified as beneficial due to the emphasis on visual data, the tool metaphor allowed us to identify and discuss pedagogically sound criteria for successful use of digital

technologies in teaching children with ASD. It also highlighted the finding that sometimes the use of the digital tool such as IWB might not directly relate to a pedagogical goal but rather use the IWB as the focus of the lesson. Thus it is important to be aware that complex digital technologies (such as the IWB in our case) have the potential to distract from the pedagogical focus of the lesson.

The study demonstrated the usefulness of the tool metaphor for providing insights into what constitutes the effective use of the IWB in teaching children with ASD. Nevertheless, it also highlighted that the use of a single metaphor to describe a complex digital technologies might be somewhat limiting and further investigation is required in search for a composition of suitable metaphors. It was suggested that an expansion of the use of other metaphors to include the students perspective and emphasise the learning environment would be a worthwhile extension of this research.

The tool metaphor within the activity model has enabled us to go beyond the clinically-based research that has dominated the study of digital technologies in special education, and look at the day-to-day reality of how digital technologies are used by the teacher in a classroom context with students who have ASD. The tool metaphor allowed us to focus on the teachers and their pedagogy rather than on their adherence to digital technologies within the methodology of intervention. The focus on the pedagogical use of the IWB technology was justified by the authors' belief that if technology does not fit into teacher's everyday classroom pedagogical activity as a tool the teacher's effort might be wasted. Given that digital technologies hold so much promise for students with ASD we need to find more ways of integrating their use into sound pedagogical practices. To this end, metaphors can be rather instrumental as they "help to appreciate as yet unanticipated connections or consequences" (Stone, 1998, p. 344).

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