Interactive Whiteboards in Education

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This thesis is presented for the degree of Master of Research.

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Requirements And Format Of A Thesis By Publication

A thesis must form a distinct contribution to knowledge either by the discovery of new facts or by the exercise of independent critical power. The thesis as a whole should be focused on a single project or set of related questions and should present an integrated body of work, reflecting a coherent program of research.

The Master of Research degree provides the standard mode of entry to Doctoral programs at Macquarie University and offers the opportunity to evaluate the capacity of candidates for doctoral study. Students achieving a Distinction grade or above in their Master of Research program may be offered admission to a Doctoral program.

The Macquarie University Special Education Centre (MUSEC) adopts the thesis by publication model. The basic structure of a thesis by publication for the Master of Research at MUSEC would normally be as follows:

- A brief introduction providing a coherent overview of the background of the thesis, the research questions and the structure and organisation of the remaining chapters. The distinct contribution of the thesis should be clearly identified.
- Two chapters, each written in the format of a self-contained submission ready journal article. The first chapter would normally consist of a literature review and the second a pilot study, with the potential to lead into doctoral research. Each chapter should be prefaced by a brief introduction outlining how the chapter fits into the program of research and, in the case of jointly authored chapters, the student's contribution should be clearly specified. If articles are published, they do not need to be reformatted for inclusion in the thesis.
- A brief final chapter providing an integrative conclusion, drawing together all the work described in the other parts of the thesis and relating this back to the issues raised in the Introduction.

The maximum length is 20,000 words.
For further details refer to the Higher Degree Research website.

Synopsis

Since the introduction of interactive whiteboards (IWBs) into schools and their widespread uptake, there has been much interest in the apparent efficacy of their use as a teaching tool. Among the purported benefits are increased academic achievement and increased engagement. This program of research includes a scoping overview of the nature of literature published on IWBs and a pilot project examining the effect of an IWB on student engagement. This thesis consists of four chapters. Chapter one is an introduction. Chapter two consists of a survey of the extant literature, including both academic and grey literature, on IWBs in school settings. Chapter three consists of a pilot study with students with disability comparing rates of engagement during a group activity conducted with and without an IWB. Chapter four is a concluding summary. The literature survey covered 739 articles that were then categorised in terms of source and type. Results of this survey indicated a dearth of empirical data, with 55 per cent of articles being grey literature, 151 articles (20%) reported qualitative research and 56 articles (8%) reported quantitative research of which only 23 were experimental studies. This lack of empirical research highlighted the need for investigation into this area. A pilot study was conducted with the research question: Do interactive whiteboards increase engagement in whole-group lessons for students with autism spectrum disorder and mild intellectual disability? The single-case alternating treatment research was conducted with two conditions, one using an IWB, and one using paper-based materials. All other variables were held constant. Data reported in the study included both active and passive on and off task behaviours of four participants, with a dual diagnosis of autism spectrum disorder and mild intellectual disability. Results showed an increase in on task behaviour during the non-IWB condition for two of the four participants. There was no marked difference for the remaining two participants. In this study, many additional features of the IWB were not used and further research could explore the effects of adding colour, animation and sound.

Statement Of Candidature

I certify this thesis entitled “Interactive Whiteboard in Education” is an original piece of research and my own work. All assistance from others in conducting the research and preparing this thesis has been appropriately acknowledged.

I also certify that the work in this thesis has not been submitted for a higher degree to any university or institution other than Macquarie University.

In addition, I certify that all sources of information and literature used are indicated in the thesis.

The research presented in this thesis was approved by the Macquarie University Faculty of Human Sciences and Humanities Human Research Ethics Committee, on 1st July 2013 (referenced no. 5201300450; see Appendix 1).

Statement Of Contribution

This is a statement of my contribution to this thesis and the papers included in it. The following is a list of papers written in conjunction with my Co-Supervisors Associate Professor Jennifer Stephenson and Associate Professor Mark Carter.

1. Interactive whiteboards and education: A literature scoping survey.

I wrote this scoping survey with advice and input from Associate Professor Jennifer Stephenson and Associate Professor Mark Carter.

2. Do interactive whiteboards increase engagement in whole-group lessons for students with autism spectrum disorder and mild intellectual disability? A pilot study.

I conducted this study and wrote this paper with advice and with input from Associate Professor Jennifer Stephenson and Associate Professor Mark Carter.

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Chapter 1: Introduction

Chapter Overview

This opening chapter is comprised of: the purpose, rationale, background, aims, structure, and methodological approach of the research contained in this thesis. This chapter is completed by a synopsis of each chapter of the thesis.

Purpose of the Research

The research described in this thesis was directed at addressing two issues. First, the thesis provides a scoping of the literature on interactive whiteboards with the aim of providing an overview of the type and nature of literature available. Second, the thesis provides an examination of the effect of interactive whiteboard technology on the engagement levels of students with autism spectrum disorder and mild intellectual disability in a whole group lesson.

Background to the Research

There has been increasing interest in interactive whiteboards in school settings. This program of research provides a scope and overview of the nature of literature published on interactive whiteboards with a focus on their use with school-aged children.

Interactive Whiteboards

Interactive whiteboards (IWBs) (sometimes labelled IAW) also known as electronic whiteboards (EWBs) are prevalent in many classrooms around the world, especially in nations such the USA, UK and Australia. IWBs are an electronic interactive screen attached to a wall or similar fixture that mirrors the images and content of its connected computer, laptop or in some cases, handheld electronic device such as an iPad®. This screen uses a combination of projector and cameras to replicate a touch-screen. The user is then able to interact with the screen as if they were using the

connecting device. This tool may be used in classrooms to deliver lessons, present information, and play games, as well as for a host of other activities.

This technology is lauded as a revolutionary tool that can transform learning and increase engagement and achievement in its users (Villano, 2006; Whitby, Leininger & Grillo, 2012). So popular is the IWB that in 2014, Futuresource Consulting reported that worldwide, more than 2.8 million SMART® Boards had been installed in schools (Futuresource Consulting, 2014). Numbers for all types of IWBs have not been reported.

Thus far, a comprehensive scoping review of the literature available has not been conducted. There are claims that IWBs increase engagement levels but there appears to be very little empirical research to support these claims. The justification for this thesis focuses on the need to address the gap in empirical research available on IWBs in consideration of the prevalence and sizeable uptake of this expensive technological tool (Futuresource Consulting, 2014).

Theoretical Perspective

A positivist perspective, employing a scientific approach to systematic enquiry drawn from applied behaviour analysis was used in this research (Alberto & Troutman, 2012). The understanding that outcomes would only be established and reported if they were directly and objectively observed underpinned both papers in this thesis. For the pilot study (Chapter 3), a single-case experimental design was used to methodically study the research questions posed and to allow conclusions about cause/effect relationships to be drawn. A replicable research design was used and data were collected from video recordings, focusing on ‘looking’ or ‘not looking’ and reported in numerical form. Both sets of data were subject to interrater reliability testing in order to confirm the objectivity of the selections and observations made.

Autism Spectrum Disorder And Engagement

It has been suggested that a significant number of students with autism spectrum disorder (ASD) find it difficult to maintain on task behaviour in the form of attention or looking (Beighley et al., 2013; Sussman, 2014). It has also been suggested that visual supports assist in increasing the ability of students with ASD to access instruction (Aliee, Reza Rezaei, & Alias, 2013; American Psychiatric Association, 2015; Nwokeafor, 2009; Sahin & Cimen, 2011). It is logical then to assume that any tool that can foster interest, and therefore enhance attentiveness, would assist in the delivery of instruction. Therefore this positive effect should be capitalised on (Mancil & Pearl, 2008). It has been proposed that students with ASD achieve more with visual supports, but current research in this area relates to screens such as handheld devices (e.g., Ganz, Boles, Goodwyn, & Flores, 2014). Studies on screen media have produced results that suggest there is increased attention to screens compared to other mediums of instruction (e.g., Aliee et al., 2013). Whether a visual format such as an IWB can increase engagement is not clear, but it is therefore proposed an IWB, a large screen, might produce similar results.

Aims of the Research

The aim of this thesis is to provide a scoping survey of the literature on interactive whiteboards, and to examine the effect of interactive whiteboards on the engagement of students with autism spectrum disorder.

The aims of this research are outlined as follows:

1. To ascertain the amount and type of literature available on interactive whiteboards related to school-aged children (see Chapter 2).

2. To compare the effect of interactive whiteboards with the effect of paper-based materials on the engagement of primary-aged students, with autism spectrum disorder, in whole-group lessons (see Chapter 3).

Structure of the Thesis

This thesis is comprised predominantly of two key chapters presented as submission-ready journal articles, in compliance with the style and format of a thesis by publication (outlined previously). These articles are preceded by an introductory chapter, and succeeded by a concluding chapter.

Methodological Approach

There were two methodological approaches used in this thesis.

Literature scoping survey. The purpose of a literature scoping survey (Chapter 2) is to provide an overview of the nature of the diverse literature available. This scoping survey of literature looks at available literature on interactive whiteboards and their use in relation to school-aged children. Once the literature was collected, the content was examined and coded into categories. The material was categorised by peer reviewed status, journal articles, theses and dissertations, conference papers, and books, and grey literature. Categorisation into age level (primary or secondary or unknown) was then completed. Material was then categorised by the nature of the research (quantitative or qualitative), or into descriptive articles, literature reviews, product descriptions, and general opinion.

By looking at the range and type of literature the data that are available and conversely the gaps in literature that are present are made apparent. Considering the diverse nature of the literature, this approach was considered suitable to provide a general overview.

Study. For the single-case study (Chapter 3), an alternating treatment design, drawn from applied behavior analysis, was employed to capture the engagement levels of four participants in a whole-group lesson. A single-case design was used in order to measure the precise behaviours exhibited by each of the participants. The single-case design allowed for participant comparisons, repeated measures, and allowed for examination of individual responses to interventions. This was particularly relevant as it is difficult to locate large groups of similar participants and also to employ an alternating treatment design with a baseline in particular (Alberto & Troutman, 2012).

The aim of this study was to ascertain and compare the effects of an interactive whiteboard and a non-interactive whiteboard presentation on student engagement. This included whether passive and active on task and off task behaviour increased or decreased under these conditions. Video recording was used to capture the students' face to detect whether the participant was looking at the presentation or other intended target.

A single case approach was used and four participants were included in order create within-subject comparisons. Repeated measures were taken in the alternating design in order to establish and track individual responses. Participants were exposed to two conditions, an interactive whiteboard condition and a non-interactive whiteboard condition using paper-based materials. This alternating approach was employed in order to provide a systematic comparison. Interval recording was used to provide a way to measure both continuous and discrete behaviours, that is, behaviours that were observed for the duration of an interval and the range of behaviours that occurred within the interval. The behaviours coded were active and passive on and off task behaviours. Observer reliability was established through inter-rater reliability.

Chapter Outline

Chapter 2. Chapter 2 provides a scoping survey on the types and features of literature available on interactive whiteboards in relation to their use with school-age children. Literature searches were carried out in three major databases (ERIC Proquest, A+ Education and Academic Search Premier) and items located were coded for article type, peer reviewed status, participant type, and research or non-research type. This type of literature review, a broad-based scoping survey, provides an overview of the current literature rather than an in-depth analysis.

Chapter 3. Chapter 3 is a research paper describing a quantitative single-case study conducted with school-age children with a dual diagnosis of autism spectrum disorder and mild intellectual disability. The study was conducted using an alternating treatment design with an interactive whiteboard condition and a paper-based or non-interactive whiteboard condition. Sessions were video-recorded then full-length videos were split into 15-second intervals to allow coding of student behaviour during each interval.

Chapter 4. This closing chapter provides a concise summary of the findings of the literature scoping survey and the research study undertaken. Suggestions for future research are also included. The contribution of this thesis to the field of research and education is also briefly discussed.

Summary

This chapter provided a brief outline of purpose, background, rationale, and aims of this thesis. It also provided an overview of the two papers that comprise this thesis.

References

Alberto, P. A. & Troutman, A. C. (2012). *Applied behavior analysis for teachers. (9th Ed.).* Upper Saddle River, NJ: Pearson Prentice Hall.

Aliee, Z. S., Reza Rezaei, N. J., & Alias, N. (2013). The effectiveness of managing split attention among autistic children using computer based intervention. *TOJET: The Turkish Online Journal of Educational Technology, 12*, 281-301.

American Psychiatric Association (2015). Autism spectrum disorders. Retrieved from http://www.psychiatry.org/mental-health/autism-spectrum-disorders

Beighley, J. S., Matson, J. L., Rieske, R. D., Jang, J., Cervantes, P. E., & Goldin, R. L. (2013). Comparing challenging behavior in children diagnosed with autism spectrum disorders according to the DSM-IV-TR and the proposed DSM-5. *Developmental Neurorehabilitation*, *16*, 375-381. doi:10.3109/17518423.2012.760119

Futuresource Consulting. (2014). *Quick facts and stats*. Retrieved from http://smarttech.com/us/About+SMART/About+SMART/Newsroom/Quick+facts+and+stats

Mancil, R. G., & Pearl, C. E. (2008). Restricted interests as motivators: Improving academic engagement and outcomes of children on the Autism Spectrum. *TEACHING Exceptional Children Plus, 4*(6), 15.

Nwokeafor, C. U. (2009). Conundrum of autism: A review of its causes and significant impact on the education of a school age child. *Forum of Public Policy, 2009,* 1-15.

Sahin, Y. G. & Cimen, F. M. (2011). An interactive attention board: Improving the attention of individuals with autism and mental retardation. *TOJET: The Turkish Online Journal of Educational Technology, 10*, 24-35.

Sussman, Z. W. (2014) *An evaluation of the impact of the DSM-IV-TR diagnostic group and cognitive ability on the presentation of Autism Spectrum Disorder symptoms.* (Unpublished doctoral thesis). University of Iowa, Iowa.

Villano, M. (2006). Picture this! *T.H.E. Journal, 33*, 16-20.

Whitby, P. J., Leininger, M. L., & Grillo, K. (2012). Tips for using interactive whiteboards to increase participation of students with disabilities. *TEACHING Exceptional Children, 44*, 50-57.

CHAPTER 2: Interactive Whiteboards In Education: A Literature Scoping Survey.

Chapter Overview

The aim of this chapter is to provide an account of the amount and type of literature available on interactive whiteboards. The literature scoping survey contained within this thesis assists in forming the foundational knowledge necessary for gauging the need for empirical evidence that supports the use of interactive whiteboards with school-age children. This chapter presents an introduction to interactive whiteboards, the method for gathering and categorising the literature, the results of this search, and finally a conclusion that provides a summary of the scope of the literature available on interactive whiteboards and school-aged children.

Interactive whiteboards in education: A literature scoping survey

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Abstract

Interactive whiteboards are increasing in popularity and prevalence but there appears to be little empirical evidence to support their efficacy. A scoping survey was performed in order to ascertain the types of literature available on interactive whiteboards with regards to their use with school-aged children. Results from the survey indicate that over half of all the available literature is grey literature and is comprised of descriptive articles, product descriptions and general opinion. The remaining research-based literature was predominantly descriptive and/or qualitative. A small number of articles contained quantitative data and these were mainly survey-based. There were few experimental studies available. The limited number of empirical studies is in contrast to the sizeable volume of grey literature available on these technological tools. It is recommended that further reviews should include a more in-depth analysis of the research and a broader search that includes pre-school and tertiary students.

Keywords: Interactive whiteboards, education, elementary, secondary, learning technology

The prototypical interactive whiteboard was produced by SMART Technologies® in 1991. An interactive whiteboard (IWB), also known as an electronic whiteboard (EWB), is an interactive technological tool consisting of a large flat screen or whiteboard that links with a computer or laptop. This screen mirrors the computer or laptop with which it is connected (Manny-Ikan, Tikochinski, Zorman, & Dagan, 2011). In addition to SMART®, the leading producer of IWBs, other companies such as Mimeo®, Promethean®, Hitachi®, Sony®, and TURNING Technologies® (previously known as InterWrite®), and others continue to produce IWBs.

IWBs are a growing presence in our classrooms (Balta & Duran, 2015; Bennett & Lockyer, 2008; Kearney & Schuck, 2008; Futuresource Consulting, 2014) but authors of earlier literature reviews have noted the dearth of empirical evidence available and/or the need for a more concerted effort to expand upon our current knowledge about this area (DiGregorio & Sobel-Lojeski, 2010; Glover, Miller, Averis, & Door, 2005; Higgins, Beauchamp & Miller, 2007). A great deal of the literature on IWBs was published between 2005 and 2010, about the time that IWBs starting becoming more common in schools, hence the immediate interest. Some literature on IWBs appears as grey literature, that is, materials that have not been peer reviewed and/or do not consist of any empirical research. Perhaps the wide uptake of IWBs can then be attributed to the claims made in these articles, articles that purport that IWBs increase the interactivity of lessons, revolutionise teaching and in general increase the attention of students (Beeland Jr, 2002; Villano, 2006), perhaps because it "forces" or encourages engagement and/or interaction (Whitby, Leininger & Grillo, 2012).

Literature reviews to date have provided summaries of the particular areas of current research. These areas have included: the integration and presence of IWBs in the classroom; the effect of IWBs in the classroom on students and teachers in teaching

and learning; and perceptions of this technology (DiGregorio & Sobel-Lojeski, 2010; Glover, Miller, Averis & Door, 2005; Higgins, Beauchamp & Miller, 2007; Smith, Higgins, Wall & Miller, 2005).

Smith, Higgins and Wall (2005) who reviewed the literature that focused on school-aged children, reported that the literature was positive and originated mainly from the views of teachers and students, but that there is inadequate evidence to support the purported benefits of IWBs. Five years later, DiGregorio and Sobel-Lojeski (2010) conducted a review of IWBs and school-aged students. Their findings were similar to Smith et al. but with the addition of literature that contained suggestions that the efficacy of IWBs was due to "contextual factors", that is, the school, teachers, and content (pp. 256-258). The one literature survey available conducted by Glover, Miller, Averis, and Door (2005) reported trends rather than reporting descriptive statistics as in the scoping carried out for this thesis. Glover et al. reported similar results as the review by Smith et al. with the addition of perspectives from promotional literature. This survey looked at early reports of IWB use and identified a change from descriptive literature to pedagogic literature. They also identified a gap in school-based literature. They acknowledged the greater trend of learning style and teacher effectiveness research as well as the literature on techniques to use and interactivity.

The approach in this scoping survey is to examine the range and nature of the literature available on IWBs and their use in relation to school-aged children. The search was broadened to include all school-aged children as there was insufficient literature specifically relating to the use of IWBs and students with disability. Previous reviews have focused more on particular areas instead of a broad-based investigation. However, this scoping survey is needed in order to complement previous reviews of specific areas by looking at a broader range of literature in order to gain a more

complete representation of the current literature, five years on from the last review and ten years on from the one declared literature survey which gave an overview of the subject matter of literature available (Glover et al., 2005).

The aim of this literature scoping survey is to provide an overview of both the research and grey literature available on IWBs and in particular the empirical research relating to this technology. The method used was to locate all relevant literature though a search of three large education databases and then use the titles, abstracts and where necessary the full text of articles located to answer the research questions outlined below. The research questions were: what types of literature exist (refereed or non-refereed journal article, thesis or dissertation, book, conference paper, or grey literature), aspects of the content (whether the article reported on IWBs only or with other technology), the age of the students, and where research was identified, and what form it took.

Method

Search and Article Screening

The search was carried out from March to June 2014. No article published after this date was included in the results. Articles were sourced from three academic databases: Academic Search Premier, A+ Education, and ERIC Proquest. The search terms employed were "interactive whiteboard" OR "interactive whiteboards" OR "promethean board" OR "electronic whiteboard" OR "smart board" OR "mimio" AND “school”. This search resulted in 1442 articles total and 1150 articles excluding duplicates. Data were examined in a two-stage process. The first step, a screening process, the title and abstract of each article was examined, and items that did not meet the criterion were excluded. There were three inclusion criteria; written in English language, included information about interactive whiteboards, and included information

related to school-age children, that is, students in grades K to 12. Articles were included regardless of their status as peer reviewed or non-peer reviewed to ensure that the material collected would form an extensive picture of the literature about IWBs in schools. The author performed this screening process and a research assistant independently screened 20 per cent of the literature for reliability purposes. The articles were taken from the first, middle and last third sections of all articles. This was calculated by 20 per cent of articles (=230) divided by three (=77), then 77 articles were taken from the beginning, end, then 25 articles from either side of the mid-way point. Reliability was calculated for all criteria coding, using the formula agreements divided by agreements + disagreements multiplied by 100. Intercoder reliability for the articles was 80 per cent (range: 79-82%). The first step left 739 articles, which included refereed and non-refereed articles, theses and grey literature. Table 1 provides details on the original number of articles from each database.

In the second step, to ensure reliability of data extraction, a description for each of the criteria was provided to a research assistant and discussed. The author and the research assistant independently coded the first twenty-five articles of the included 739. Reliability was then calculated for all criteria coding using the formula agreements divided by agreements + disagreements multiplied by 100. Intercoder reliability for the initial 25 articles was 97 per cent. Given the high intercoder reliability, the remaining 714 articles were equally divided between the author and research assistant to complete coding.

The articles were categorised using publication information, such as source/journal name, and title and abstracts. Where the information was not clearly available from the title, abstract and publication information, a copy of the complete article was obtained. Information was extracted about the nature of the publication,

refereed or non-refereed journal article, thesis or dissertation, book, conference paper or grey literature (magazine and newspaper articles, white paper); whether the article reported on IWBs only or with other technology; the age of the students (K-6, 7-12, both, or unknown age); whether the research was quantitative (small-n, group, descriptive, survey [survey analysis included numerical data and descriptive statistics]) or qualitative (teacher/student/preservice teacher, including case studies and surveys [open ended questions with the responses analysed qualitatively]); and whether the article was a literature review, descriptive article, product description or general opinion (see Table 2). For some of the data extracted, for example age of students, participants in surveys and research methods used, articles could be counted in more than one category. Following this step, 25 per cent of the articles were coded for reliability. Intercoder reliability was calculated using total number of agreements divided by total number of articles multiplied by one hundred. Intercoder reliability was 94 per cent.

Results

The literature search yielded 739 articles that were then categorised according to the source (see Table 3). Literature was sorted into five main categories. Article type consisted of the broad genre of article. In this category, 55 per cent of articles were grey literature and the remainder consisted of journal articles (37.5%), theses or dissertations (2.4%), books (1.7%), and conference papers (4%). Of the non-grey literature, the remaining 45 per cent of articles, 216 (29.2%) were peer reviewed.

There were 151 (20.4%) empirical articles that reported qualitative research and 56 articles (7.6%) that reported quantitative research of which only 23 described experimental studies. Non-empirical literature consisted of literature reviews (0.8%), descriptive articles (32.4%), product descriptions (11.9%), and general opinion articles

(34.8%). Almost two-thirds (61.2%) solely described IWBs, 32 per cent described primary aged participants and 17.5 per cent described secondary aged participants.

Quantitative Research

Fifty-six articles were identified as reporting quantitative research (see Table 4). Of these, 41 (73.2%) were peer reviewed (See Table 4). Six articles were grey literature. Ten were theses or dissertations. Of the 11 small-n intervention studies, three also included quantitative surveys, one of which also included a qualitative survey. Of the 12 descriptive studies, one included a quantitative survey and three others included qualitative surveys. Of the 19 teacher surveys, seven also included student surveys. Of these 56 articles, 34 concerned primary-aged participants. Of these 34, seven also concerned secondary-aged participants. Thirteen articles concerned participants of unknown school age.

Experimental studies. Experimental studies with quantitative analysis accounted for 35 articles but only 15 were peer reviewed Three out of the 11 small-n studies were peer reviewed (Campbell & Mechling, 2009; Mechling, Gast & Thompson, 2009; Yakubova & Taber-Doughty, 2012). The outcomes for all three studies showed achievement using IWBs but did not show advantages of the IWB over other modes of instruction. The remaining eight small-n studies consisted of three peer reviewed dissertations, two non-peer reviewed articles published as grey literature, and three articles published in non-peer reviewed journals.

Five of the 12 group intervention studies were peer reviewed (Dhindsa & Dhindsa, 2011; Hwang, Wu & Kuo, 2013; Mark & Kobsa, 2005; Özerbaş, 2012; Schroeder, Burns & Reicks, 2011). While three showed better outcomes or that the participants preferred the IWB conditions (Dhindsa & Dhindsa, 2011; Hwang, Wu & Kuo, 2013; Özerbaş, 2012), one showed no difference (Schroeder, Burns & Reicks,

2011), and the remaining study looked at a teaching method rather than the IWB as the medium (Mark & Kobsa, 2005). The remaining seven group intervention studies consisted of six peer reviewed dissertations, and one non-peer reviewed conference paper.

Seven of the 12 descriptive quantitative studies were peer reviewed (Alvarez, Salavati, Nussbaum, & Milrad, 2013; Coyle, Yañez & Verdú, 2010; Lerman & Zevenbergen, 2007; Lopez, 2010; Mostertand & Needham, 2004; Thompson & Flecknoe, 2003; Türel, 2011). The studies showed how IWBs could support learning (Alvarez, Salavati, Nussbaum, & Milrad, 2013; Lopez, 2010; Thompson & Flecknoe, 2003), the problems encountered when using the technology (Mostertand & Needham, 2004), the limitations of using the technology (Coyle, Yañez & Verdú, 2010), the limited way it was used (Lerman & Zevenbergen, 2007), and the development of an instrument that would provide accurate survey data on perceptions of IWBs (Türel, 2011). The remaining five descriptive studies consisted of four articles published as grey literature and one non-peer reviewed conference paper.

Qualitative Research

Of the total number of articles, 151 were identified as reporting qualitative research (see Table 5). Of these, 125 (82.8%) were peer reviewed. Nine articles were grey literature. Seven were theses or dissertations. Qualitative research was also categorised into literature that described teacher, student, or preservice teacher outcomes, or a combination of these populations. Seventy-four were teacher-focus studies, 45 were both teacher and student-focus studies, and one was on both teachers and preservice teachers. In addition, there were 15 student-focus only articles, and eight student and preservice teacher-focus articles. Of the 151 articles, 74 concerned primary-aged participants. Of these 74, 16 also concerned secondary-aged participants, and 23

others were solely concerned with secondary students. Twenty-two articles concerned participants of unknown school age.

Whilst the intention of the scoping survey is to provide an overview of the literature types available, some trends were noted in relation to the implementation and perceptions of IWBs and these will be briefly addressed.

Implementation of IWBs

Many qualitative articles on IWBs considered the implementation of this technology. Topics discussed included using IWBs to their full capacity and not simply as a substitute for a whiteboard or projector (e.g., Northcote, Mildenhall, Marshall, & Swan, 2010; Reedy, 2008), choosing quality electronic resources (e.g., Maher, 2012), using the IWB as a tool to enhance learning, participation and engagement (e.g., Harlow, Cowie & Heazlewood, 2010; Winzenried, Dalgarno & Tinkler, 2010), or as a means of fostering interactions, collaboration and communication (e.g., Fernandez-Cardenas & Silveyra-De La Garza, 2010; Kerawalla, Petrou & Scanlon, 2013; Kershner, Mercer, Warwick, & Kleine Staarman, 2010; Maher, Phelps, Urane & Lee, 2012; Mercer, Warwick, Kershner, & Kleine, 2010; Warwick & Kershner, 2008). In addition to this were studies that outlined how ill prepared many teachers were when faced with using these expensive tools that were at times more hindrance than help (e.g., Jang & Tsai, 2012; Serow & Callingham, 2011), and the issues that arose when using IWBs (Armstrong et al., 2005). Further qualitative studies described how and/or how often teachers and/or students used an IWB (e.g., Beauchamp, 2004; Campbell & Kent, 2010; Glover, Miller, Averis, & Door, 2007; Hodge & Anderson, 2007), and the affordances and revolutionary aspects of IWBs (e.g., Bruce, McPherson, Sabeti, & Flynn, 2011; Gillen, Kleine Staarman, Littleton, Mercer, & Twiner, 2007; Kennewell & Beauchamp, 2007; Teck, 2013; Wood & Ashfield, 2008). Descriptive articles, often

grey literature, describe the implementation of effective lessons (e.g., DeSantis, 2012; Glover & Miller, 2009; Lee, 2010; Linder, 2012).

Perceptions Of Teachers And Students

Research has been conducted in order to establish the perceptions of teachers and students. This research was qualitatively and/or quantitatively analysed. Qualitative studies addressed how effective participants thought IWBs were in teaching and learning (e.g., Brown-Wyatt, 2011; Hwang, Chen & Hsu, 2006; Shenton & Pagett, 2007) and the pros and cons of IWB use (e.g., Yáñez & Coyle, 2011). Studies also looked at the belief of participants that IWBs increased their learning achievements. This belief was explored in qualitative studies (e.g., DiGregorio & Sobel-Lojeski, 2010; Wall, Higgins & Smith, 2005), quantitative studies (e.g., Campbell, 2010; Cheung & Slavin, 2011), and also in the grey literature (e.g., Gray, Pilkington, Haggter-Vaughan, & Tomkins, 2007; Liles, 2005). Studies also looked at how participants believed IWBs increased engagement. For example, Godzicki, Godzicki, Krofel, and Michaels (2013) looked at engagement, analysing data from participants both quantitatively and qualitatively. They found that technology made students more motivated and engaged. Also included were quantitative studies on the acceptance and use of IWBs (e.g., Türel, 2011; Wong, Russo & McDowall, 2013).

Discussion

The benefits of IWBs and their use in classrooms are promoted in literature, both grey and research-based. Most of the literature on IWBs is not research-based. There are a great many descriptive articles both empirical and non-empirical, survey-based research, product descriptions, and opinion pieces. There are also a small number of dissertations, empirical studies, and conference papers. Two noticeable trends are present in IWB literature: the perceptions of teachers and students, and IWB

implementation. In general IWBs have been presented positively in research-based literature.

More than half of all articles were classified as grey literature. The number of descriptive or 'how-to' articles, both categorised as grey literature, accounted for most of this number. There were 243 descriptive articles (32.4% of all literature). Only general opinion papers (261 articles or 34.8%) matched this quantity. Product descriptions accounted for 89 articles (11.9%). It is possible that teacher or practitioner demand drives the production of the grey literature. This might be due to the demand for assistance in using this tool in classrooms after schools have already committed to the technology or IWB advocates promoting their use. It might also be that the time taken to conduct research and the difficulties of conducting research in schools may account for these statistics. The difficulty of conducting research in this area may be an ongoing problem and educators and educational leaders have little or no information based on sound research when making decisions about IWB use.

Empirical research accounts for a small proportion of literature. This finding is consistent with the conclusions of previous reviewers (e.g., DiGregorio & Sobel-Lojeski, 2010; Kennewell & Beauchamp, 2007). Quantitative evidence was provided in 23 articles or 3.1 per cent of all literature. Only a small number of experimental studies were identified and at least 50 per cent of these were dissertations. There were only three small-n experimental studies that were peer reviewed and each of these looked at students with disability (Campbell & Mechling, 2009; Mechling, Gast & Thompson, 2009; Yakubova & Taber-Doughty, 2012). Campbell and Mechling (2009) found that IWBs were effective in teaching sight words to students with disability. However, the intervention was not compared to other instruction. Mechling, Gast and Thompson (2009) found that IWBs were only more effective for observational learning, that is,

learning without being directly taught. But results were similar for direct instruction whether the teachers used an IWB or flash cards. Yakubova and Taber-Doughty (2012) studied the effects of IWBs on skill acquisition but as a medium for video modelling. The study looked at ways to integrate technology rather than the effectiveness of the tool itself. Descriptive quantitative studies were equal in number to group intervention studies (1.6%) and together these experimental studies were matched and only marginally overshadowed by the collective quantitative surveys. Quantitative research collectively accounted for 9.4 per cent of all literature. The implications of the lack of quantitative data are that there is little evidence for the efficacy of IWBs and there is a need for further evidence and more studies in this area that focus on students with disability.

Qualitative appears to dominate educational research, however, this type of research does not answer causal questions. Qualitative research cannot provide concrete evidence to support positive outcomes.

As previously noted, it might be suggested that the lack of empirical evidence in general is due to the difficult nature of carrying out research of this kind especially in non-clinical environments such as schools. This difficulty would be heightened when attempting quantitative research that involves experimental studies with interventions. The implication of relying on qualitative data is that evidence is limited and cannot be used to accurately suggest how dependent variables, such as the IWB, should be employed for greater outcomes. That is, qualitative research is not well suited to providing information on efficacy.

In more general terms, literature was predominantly on students of unknown age with 56.3 per cent of all literature in this category. This was followed by primary-aged students (32%) and secondary-aged students (17.5%). The implication of this is that

more research needs to be conducted on specific age groups with a focus on secondary students. Literature that focused on IWBs only accounted for just over half of all articles (61.2%). It might be suggested that this is due to the predominance of technology in general and the familiarity of schools with IWBs as one technological tool amongst many.

Recommendations For Future Research

Previous reviewers made a variety of recommendations. These included that more empirical evidence needs be conducted (Smith, Higgins, Wall, & Miller, 2005), that a measurement of long-term gains due to IWB use is needed (Glover, Miller, Averis, & Door, 2005), and that a greater range of participants in terms of diversity is needed (DiGregorio & Sobel-Lojeski, 2010). The relatively small amount of empirical research found through this scoping survey highlights the need for additional studies. Future research needs to focus on small-scale empirical studies of the common claims by manufacturers and practitioners alike, for example, that IWBs increase engagement and increase achievement.

Similar to these general claims, this scoping survey found a recurring theme in literature concerning the perceptions of teachers and students regarding IWBs. Whilst research of this nature is both necessary and helpful to practitioners, it does not negate the need for more experimental research. This evidence is needed in order to ascertain what effect an IWB has on a student, a teacher, and a classroom as a whole. In order to achieve this, future research should focus on determining the effect of having and using an IWB as a classroom tool. This would provide evidence to support or negate the accuracy of perceptions held by teachers and students. Considering the scoping survey nature of this review, further more in-depth reviews could include a greater reflection of the current literature by including sources such as websites, blogs and the like.

Limitations

The first limitation was that the survey was restricted to articles that related to school-aged children. Therefore the findings of this survey cannot be generalised to other educational groups such as pre-school aged children and tertiary students. The second limitation is that, as a scoping survey, the review does not provide analysis of methodology and results. Consequently, the findings are broad and reflect the general nature rather than the content of the articles. A final limitation of this work is that the search was limited to three academic databases. Although these databases were major education databases, use of more databases may have identified more articles. Literature such as webpages, blogs and the like were not included. The use of additional databases may have uncovered more relevant literature.

Conclusion

Considering the breadth, type and interest in research in relation to IWBs, speculation as to the reason(s) why there are so few empirical studies to date arises. Perhaps it is the difficulty in carrying out research of this type, considering the great ranges of: abilities of teachers and students, the range of resources and access available, and time-consuming nature of using a technological tool of this kind. These issues become compounded when factoring in the inclusion of students with disability.

In sum, the nature and scope of the literature to date on IWBs suggests that much more experimental research is needed. The literature, predominantly grey, consists mainly of practical guides for use, general opinion and descriptive accounts of how IWBs have been used.

References

Alvarez, C., Salavati, S., Nussbaum, M., & Milrad, M. (2013). Collboard: Fostering New media literacies in the classroom through collaborative problem solving supported by digital pens and interactive whiteboards. *Computers & Education, 63*, 368-379.

Armstrong, V., Barnes, S., Sutherland, R., Curran, S., Mills, S., & Thompson, I. (2005). Collaborative research methodology for investigating teaching and learning: the use of interactive whiteboard technology. *Educational Review, 57*, 457-469. doi: 10.1080/00131910500279551

Balta, N. & Duran, M. (2015). Attitudes of students and teachers towards the use of interactive whiteboards in elementary and secondary school classrooms. *TOJET: The Turkish Online Journal of Educational Technology, 14*, 15-21.

Beauchamp, G. (2004). Teacher use of the interactive whiteboard in primary schools: Towards an effective transition framework. *Technology, Pedagogy and Education, 13*, 327-348.

Beeland Jr., W. D. (2002). Student engagement, visual learning, and technology: Can interactive whiteboards help? *Action Research Exchange*, *1*, 1-7.

Bennett, S., & Lockyer, L. (2008). A study of teachers' integration of interactive whiteboards into four Australian primary school classrooms. *Learning, Media & Technology, 33*, 289-300. doi: 10.1080/17439880802497008

Brown-Wyatt, V. (2011). *Perceptions of the use of interactive whiteboards in teaching literacy to elementary school students* (Doctoral dissertation). Retrieved from ERIC ProQuest. (ED533812).

Bruce, C. D., McPherson, R., Sabeti, F. M., & Flynn, T. (2011). Revealing significant learning moments with interactive whiteboards in mathematics. *Journal of Educational Computing Research, 45*, 433-454.

Campbell, C., & Kent, P. (2010). Using interactive whiteboards in pre-service teacher education : Examples from two Australian universities. *Australasian Journal of Educational Technology, 26*, 447-463.

Campbell, M. L., & Mechling, L. C. (2009). Small group computer-assisted instruction with SMART Board technology: An investigation of observational and incidental learning of nontarget information. *Remedial and Special Education, 30*, 47-57. doi: 10.1177/0741932508315048

Campbell, T. L. (2010). *The effects of white boards on student achievement in fourth grade mathematics as Measures on the Palmetto Achievement Test (PACT) at selected schools in North Central South Carolina.* (Doctoral dissertation). Retrieved from ERIC Proquest. (ED522527).

Cheung, A. C., & Slavin, R. E. (2011). The effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms: A meta-analysis. *Educational Research Review, 9*, 88-113. doi:10.1016/j.edurev.2013.01.001

Coyle, Y., Yañez, L., & Verdú, M. (2010). The impact of the interactive whiteboard on the teacher and children's language use in an ESL immersion classroom. *System: An International Journal of Educational Technology and Applied Linguistics, 38*, 614-625.

DeSantis, J. (2012). Getting the most from your interactive whiteboard investment: Three guiding principles for designing effective professional development.

Clearing House: A Journal of Educational Strategies, Issues and Ideas, 85, 51-55.

DiGregorio, P., & Sobel-Lojeski, K. (2010). The effects of interactive whiteboards (IWBs) on student performance and learning: A literature review. *Journal of Educational Technology Systems, 38*, 255-312.

Dhindsa, H. S., & Dhindsa, H. (2011). Using interactive whiteboard technology-rich constructivist learning environment to minimize gender differences in chemistry achievement. *International Journal of Environmental and Science Education, 6*, 393-414.

Fernandez-Cardenas, J. M., & Silveyra-De La Garza, M. L. (2010). Disciplinary knowledge and gesturing in communicative events: A comparative study between lessons using interactive whiteboards and traditional whiteboards in Mexican schools. *Technology, Pedagogy and Education, 19*, 173-193.

Futuresource Consulting. (2014). *Quick facts and stats*. Retrieved from http://smarttech.com/us/About+SMART/About+SMART/Newsroom/Quick+facts+and+stats

Gillen, J., Littleton, K., Twiner, A., Staarman, J. K., & Mercer, N. (2008). Using the interactive whiteboard to resource continuity and support multimodal teaching in a primary science classroom. *Journal of Computer Assisted Learning, 24*, 348-358. doi: 10.1111/j.1365-2729.2007.00269.x

Glover, D., Miller, D., Averis, D., & Door, V. (2005). The interactive whiteboard: A literature survey. *Technology, Pedagogy and Education, 14*, 155-170.

Glover, D., Miller, D., Averis, D., & Door, V. (2007). The evolution of an effective pedagogy for teachers using the interactive whiteboard in mathematics and

modern languages: An empirical analysis from the secondary sector. *Learning, Media & Technology, 32*, 5-20. doi: 10.1080/17439880601141146

Glover, D., & Miller, D. (2009). Optimising the use of interactive whiteboards: An application of Developmental Work Research (DWR) in the United Kingdom. *Professional Development in Education, 35*, 469-483.

Godzicki, L., Godzicki, N., Krofel, M., & Michaels, R. (2013). Increasing motivation and engagement in Elementary and Middle School students through technology-supported learning environments. *Master of Arts Action Research Project, Saint Xavier University.*

Gray, C., Pilkington, R., Hagger-Vaughan, L., & Tomkins, S-A. (2007). Integrating ICT into classroom practice in modern foreign language teaching in England: Making room for teachers' voices. *European Journal of Teacher Education, 30*, 407-429. doi: 10.1080/02619760701664193

Harlow, A., Cowie, B., & Heazlewood, M. (2010). Keeping in touch with learning: The use of an interactive whiteboard in the junior school. *Technology, Pedagogy and Education, 19*, 237-243.

Higgins, S., Beauchamp, G., & Miller, D. (2007). Reviewing the literature on interactive whiteboards. *Learning, Media & Technology, 32*, 213-225. doi: 10.1080/17439880701511040

Hodge, S., & Anderson, B. (2007). Teaching and learning with an interactive whiteboard: A teacher's journey. *Learning, Media & Technology, 32*, 271-282. doi: 10.1080/17439880701511123

Hwang, G-J., Wu C-H., & Kuo, F-R. (2013). Effects of touch technology-based concept mapping on students' learning attitudes and perceptions. *Journal of Educational Technology & Society, 16*, 274-285.

Hwang, W.-Y., Chen, N.-S., & Hsu, R.-L. (2006). Development and evaluation of multimedia whiteboard system for improving mathematical problem solving. *Computers & Education, 46*, 105-121. doi: 10.1016/j.compedu.2004.05.005

Jang, S.-J., & Tsai, M.-F. (2012). Reasons for using or not using interactive whiteboards: Perspectives of Taiwanese elementary mathematics and science teachers. *Australasian Journal of Educational Technology, 28*, 1451-1465.

Kearney, M., & Schuck, S. (2008). Exploring pedagogy with interactive whiteboards in Australian schools. *Australian Educational Computing, 23*, 8-13.

Kennewell, S., & Beauchamp, G. (2007). The features of interactive whiteboards and their influence on learning. *Learning, Media & Technology, 32*, 227-241. doi: 10.1080/17439880701511073

Kerawalla, L., Petrou, M., & Scanlon, E. (2013). Talk factory: Supporting "Exploratory Talk" around an interactive whiteboard in primary school science plenaries. *Technology, Pedagogy and Education, 22*, 89-102.

Kershner, R., Mercer, N., Warwick, P., & Kleine Staarman, J. (2010). Can the interactive whiteboard support young children's collaborative communication and thinking in classroom science activities? *International Journal of Computer-Supported Collaborative Learning, 5*, 359-383. doi:10.1007/s11412-010-9096-2

Lee, M. (2010). Interactive whiteboards and schooling: The context. *Technology, Pedagogy and Education, 19*, 133-141. doi:10.1080/1475939X.2010.491215

Lerman, S. & Zevenbergen, R. (2007). Interactive whiteboards as mediating tools for teaching mathematics: Rhetoric or reality? In Woo, J-H., Lew, H-C., Park, K-S., & Seo, D-Y. (Ed.) *Proceedings of the Conference of the International Group for*

the Psychology of Mathematics Education. 3 (pp. 169-176) Cape Town, South Africa: International Group for the Psychology of Mathematics Education. Retrieved from http://igpme.org.

Liles, M. (2005). Interactive whiteboard system drives increased achievement at Texas school for the Deaf. *T H E Journal, 32*(10), 49-50.

Linder, S. M. (2012). Interactive whiteboards in early childhood mathematics: Strategies for effective implementation in pre-K-grade 3. *Young Children, 67*(3), 26-32.

Lopez, O. S. (2010). The digital learning classroom: improving English language learners' academic success in mathematics and reading using interactive whiteboard technology. *Computers & Education, 54*, 901-915.

Maher, D. (2012). Teaching literacy in primary schools using an interactive whole-class technology: Facilitating student-to-student whole-class dialogic interactions. *Technology, Pedagogy and Education, 21*, 137-152.

Maher, D., Phelps, R., Urane, N., & Lee, M. (2012). Primary school teachers' use of digital resources with interactive whiteboards: The Australian context. *Australasian Journal of Educational Technology, 28*, 138-158.

Manny-Ikan, E., Tikochinski, T. B., Zorman, R., & Dagan, O. (2011). Using the interactive white board in teaching and learning: An evaluation of the SMART CLASSROOM pilot project. *Interdisciplinary Journal of E-Learning & Learning Objects, 7*, 249-273.

Mark, G., & Kobsa, A. (2005). The effects of collaboration and system transparency on CIVE usage: An empirical study and model. *Presence: Teleoperators & Virtual Environments, 14*, 60-80. doi: 10.1162/1054746053890279

Mechling, L. C., Gast, D. L., & Thompson, K. L. (2009). Comparison of the effects of SMART Board technology and flash card instruction on sight word recognition and observational learning. *Journal of Special Education Technology, 23*, 2.

Mercer, N., Warwick, P., Kershner, R., & Staarman, J. K. (2010). Can the interactive whiteboard help to provide 'dialogic space' for children's collaborative activity? *Language & Education: An International Journal, 24*, 367-384. doi: 10.1080/09500781003642460

Mostertand, A., & Needham, R. (2004). Impact of ICT and PE on disaffected pupils: Interim report March 2004. *International Journal on School Disaffection, 2*(2), 49-52.

Northcote, M., Mildenhall, P., Marshall, L., & Swan, P. (2010). Interactive whiteboards: Interactive or just whiteboards? *Australasian Journal of Educational Technology, 26*(4), 17.

Özerbaş, M. A. (2012). The effect of using interactive whiteboards in the course of teaching technologies and material designing towards student achievement and retention. *International Journal of Academic Research, 4*, 151-157. doi: 10.7813/2075-4124.2012/4-6/B.23

Reedy, G. B. (2008). PowerPoint, interactive whiteboards, and the visual culture of technology in schools. *Technology, Pedagogy and Education, 17*, 143-162.

Schroeder, M. M., Burns, C. S., & Reicks, M. M. (2011). Interactive whiteboards: A new tool for extension education. *Journal of Extension, 49*(5), 1-3.

Serow, P., & Callingham, R. (2011). Levels of use of interactive whiteboard technology in the primary mathematics classroom. *Technology, Pedagogy and Education, 20*, 161-173.

Shenton, A., & Pagett, L. (2007). From "bored" to screen: The use of the interactive whiteboard for literacy in six primary classrooms in England. *Literacy, 41*, 129-136.

Smith, H. J., Higgins, S., Wall, K., & Miller, J. (2005). Interactive whiteboards: Boon or bandwagon? A critical review of the literature. *Journal of Computer Assisted Learning, 21*, 91-101

Teck, W. K. (2013). Affordances of interactive whiteboards and associated pedagogical practices: Perspectives of teachers of science with children aged five to six years. *Turkish Online Journal of Educational Technology - TOJET, 12*, 1-8.

Thompson, J., & Flecknoe, M. (2003). Raising attainment with an interactive whiteboard in Key Stage 2. *Management in Education, 17*(3), 29-33.

Türel, Y. K. (2011). An interactive whiteboard student survey: Development, validity and reliability. *Computers & Education, 57*, 2441-2450. doi: 10.1016/j.compedu.2011.07.005

Villano, M. (2006). Picture this! *T.H.E. Journal, 33*, 16-20.

Wall, K., Higgins, S., & Smith, H. (2005). 'The visual helps me understand the complicated things': Pupil views of teaching and learning with interactive whiteboards. *British Journal of Educational Technology, 36*, 851-867. doi: 10.1111/j.1467-8535.2005.00508.x

Warwick, P., & Kershner, R. (2008). Primary teachers' understanding of the interactive whiteboard as a tool for children's collaborative learning and knowledge-building. *Learning, Media & Technology, 33*, 269-287. doi: 10.1080/17439880802496935

Whitby, P. J., Leininger, M. L., & Grillo, K. (2012). Tips for using interactive

whiteboards to increase participation of students with disabilities. *TEACHING Exceptional Children, 44*(6), 50-57.

Winzenried, A., Dalgarno, B., & Tinkler, J. (2010). The interactive whiteboard: A transitional technology supporting diverse teaching practices. *Australasian Journal of Educational Technology, 26*, 534-552.

Wong, K.-T., Russo, S., & McDowall, J. (2013). Understanding early childhood student teachers' acceptance and use of interactive whiteboard. *Campus -- Wide Information Systems, 30*, 4-16. doi: 10.1108/10650741311288788

Wood, R., & Ashfield, J. (2008). The use of the interactive whiteboard for creative teaching and learning in literacy and mathematics: a case study. *British Journal of Educational Technology, 39*, 84-96. doi: 10.1111/j.1467-8535.2007.00703.x

Yakubova, G. & Taber-Doughty, T. (2012). Brief report: Learning via the electronic interactive whiteboard for two students with autism and a student with moderate intellectual disability. *Journal of Autism and Developmental Disorders, 43*, 1465-1472.

Yáñez, L., & Coyle, Y. (2011). Children's perceptions of learning with an interactive whiteboard. *ELT Journal: English Language Teachers Journal, 65*, 446-457.

Table 1

Database details: Databases, search terms and number of articles located

Database	Search Term 1	Search Term 2	Total number of articles	Total number of peer reviewed articles
Academic Search Premier[1]	"interactive whiteboard" OR "interactive whiteboards" OR "promethean board" OR "electronic whiteboard" OR "smart board" OR "mimio"	N/A	828	193
	"interactive whiteboard" OR "interactive whiteboards" OR "promethean board" OR "electronic whiteboard" OR "smart board" OR "mimio"	school	443	129
A+ Education [2]	"interactive whiteboard" OR "interactive whiteboards" OR "promethean board" OR "electronic whiteboard" OR "smart board" OR "mimio"	N/A	287	N/A
	"interactive whiteboard" OR "interactive whiteboards" OR "promethean board" OR "electronic whiteboard" OR "smart board" OR "mimio"	school	174	N/A
ERIC Proquest[3]	"interactive whiteboard" OR "interactive whiteboards" OR "promethean board" OR "electronic whiteboard" OR "smart board" OR "mimio"	N/A	286	212
	"interactive whiteboard" OR "interactive whiteboards" OR "promethean board" OR "electronic whiteboard" OR "smart board" OR "mimio"	school	185	137

[1] Academic Search Premier accessed through EBSCO Host https://www.informit.org/informit-education
[2] A+ Education accessed through Informit https://www.informit.org/informit-education
[3] Education Resource Information Center http://eric.ed.gov/ accessed though EBSCO Host https://www.ebscohost.com/eric

Table 2

Categories and examples

Category	Examples
Publication information	Refereed or non-refereed journal article, thesis or dissertation, book, conference paper or grey literature (magazine and newspaper articles, white paper
Article focus	IWB only or IWB and other technology
Age of students	Primary aged (Elementary/K-6), Secondary aged (High school/7-12), age is unknown
Quantitative Research	Small-n intervention, group intervention, descriptive, survey (teacher/student/preservice teacher)
Qualitative Research	Teacher, student, preservice teacher; includes surveys and case studies
Other publications	Literature reviews/surveys, descriptive articles (e.g., how IWB can be or was used), product description, general opinion

Table 3

Results of literature survey

Article type	Number of articles (% of total articles)
Peer reviewed	216 (29.2%)
Journal	281 (37.5%)
Thesis or dissertation	18 (2.4%)
Book	13 (1.7%)
Conference paper	30 (4%)
Grey literature	413 (55%)
General characteristics	**Number of articles (% of total articles)**
IWB only	459 (61.2%)
Primary aged participants	240 (32%)
Secondary aged participants	131 (17.5%)
Participants age unknown	422 (56.3%)
Quantitative research	**Number of articles (% of total articles)**
Small-n intervention	11 (1.5%)
Group intervention	12 (1.6%)
Descriptive	12 (1.6%)
Teacher survey	19 (2.5%)
Student survey	14 (1.9%)
Preservice teacher survey	2 (0.3%)
Qualitative research	**Number of articles (% of total articles)**
Teacher	120 (16%)
Student	68 (9.1%)
Preservice teacher	9 (1.2%)
Other literature	**Number of articles (% of total articles)**
Literature review	6 (0.8%)
Descriptive article	243 (32.4%)
Product description	89 (11.9%)
General opinion	261 (34.8%)

Note. Results from Table 3 state total numbers for each type, however, many articles could be classified in more than one category for age of participants, research method, type of participants, etc.

Table 4

Quantitative Research Results

Article Type	Percentage of quantitative articles	Number of articles (% of total articles)
Total number of quantitative articles	N/A	56 (7.5%)
Peer reviewed	73.2%	41 (5.5%)
Journal	66%	37 (5%)
Thesis or dissertation	2.4%	10 (1.4%)
Book	N/A	0 (0%)
Conference paper	7.1%	4 (0.5%)
Grey literature	8.9%	5 (0.7%)

General characteristics	Percentage of quantitative articles	Number of articles (% of total articles)
IWB only	76.8%	43 (5.8%)
Primary aged participants	28.6%	16 (2.2%)
Secondary aged participants	60.7%	34 (4.6%)
Participants age unknown	19.6%	11(1.5%)

Table 5

Qualitative Research Results

Article Type	Percentage of qualitative articles	Number of articles (% of total articles)
Total number of qualitative articles	N/A	151 (29.2%)
Peer reviewed	82.8%	125 (82.8%)
Journal	78.8%	119 (16.1%)
Thesis or dissertation	4.6%	7 (0.9%)
Book	0.7%	1 (0.1%)
Conference paper	9.9%	15 (2%)
Grey literature	6%	9 (1.2%)

General characteristics	Percentage of quantitative articles	Number of articles (% of total articles)
IWB only	37%	56 (7.6%)
Primary aged participants	27.2%	41 (5.5%)
Secondary aged participants	62.3%	94 (12.7%)
Participants age unknown	12.6%	19 (2.6%)

CHAPTER 3: Do Interactive Whiteboards Increase Engagement In Whole-Group Lessons For Students With Autism Spectrum Disorder And Mild Intellectual Disability? A Pilot Study.

Chapter Overview

This chapter describes a study conducted to ascertain whether interactive whiteboards (IWBs) increase the engagement levels of students with autism spectrum disorder and mild intellectual disability. The single-case study adds to the body of knowledge in this field by providing empirical data on the effects of IWBs on student engagement. This chapter is comprised of an introduction to IWBs, the method for the study conducted, the results of the study, and a conclusion that summarises how the study addresses a paucity of literature, especially in empirical evidence, the area of the efficacy of IWBs.

Do interactive whiteboards increase engagement in whole-group lessons for students with autism spectrum disorder and mild intellectual disability? A pilot study.

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Abstract

This study aimed to measure levels of engagement of students with autism spectrum disorder (ASD). It has been suggested that visual supports assist students with ASD to access instruction and also that they are more engaged when interacting with screen media in particular. Interactive whiteboards (IWBs) are large electronic screens that are used for instruction in many classrooms. An alternating treatment design was used to compare the engagement levels in a whole-group lesson focussing on four students with ASD and mild intellectual disability diagnoses in conditions using an IWB and conditions using paper-based materials. Results of this study were not consistent but an overall effect was seen and maintained for an increase in engagement levels in the non-whiteboard conditions for two of the four participants. It is suggested that when content and presentation is kept constant, IWBs do not necessarily increase student engagement. Future research should look at engagement levels when the affordances of IWBs are used.

Keywords: Interactive whiteboards, engagement, education, autism, attention

An interactive whiteboard (IWB) is a multimodal technology that consists of a large board or screen that interacts with a laptop or computer. This screen can be touch-sensitive or can work using cameras that detect objects such as fingers or pens. The screen delivers a projection of what is presented on the connected device (Manny-Ikan, Tikochinski, Zorman, & Dagan, 2011). The first IWB was created by SMART Technologies® in 1991 and they have since been used not only in education but also in business and government. By 2014, more than 2.8 million SMART® Boards had been installed in schools worldwide (Futuresource Consulting, 2014). In 2011, it was reported that 4300 IWBs would be installed in approximately 1000 classrooms, in New South Wales (NSW), Australia at a cost of $23 million (Banks, 2011). This indicates that there has been a serious and continued investment in IWB technology.

In consideration of its widespread uptake and significant investment, the lack of empirical evidence to demonstrate the efficacy of this technology is of concern (DiGregorio & Sobel-Lojeski, 2010; Glover, Miller, Averis, & Door, 2005; Higgins, Beauchamp & Miller, 2007). Although claims of increased engagement are made to promote the use of IWBs, there is a lack of research to indicate that IWBs affect student engagement. The majority of articles published reporting positive effects of IWBs in the classroom are opinion-based, descriptive and/or qualitative (e.g., Allsopp et al., 2012; O'Hanlon, 2007; Teck, 2013; Villis, 2010).

The limited amount of research addressing engagement focuses on the perceptions of teachers and/or typically developing students on the positive effect of IWBs on engagement (e.g., Phelps, 2012; Yang & Teng, 2014). For example, Phelps (2012) in their study of a school with both typically-developing students and students with disability, compared "teacher-researcher perceptions" (p. 36) (i.e., the level of engagement the teacher believed the student should be categorised as demonstrating)

with student perceptions. Phelps used a questionnaire to determine whether students thought they were engaged and what their perceptions of the IWB were. Phelps did report that personal bias and gauging engagement was challenging. The results from this study indicated high reported levels of engagement from perspectives of both the teachers and students. Similarly Yang and Teng's (2014) findings support the efficacy of the IWB in terms of engagement, but this was also based on perception rather than observable measures.

Some studies suggest that IWBs can support learning and can provide a substitute for traditional teaching methods for students with disabilities. In a search of literature on interactive whiteboards and school-aged children, only three small-n experimental studies that were peer reviewed were located and each of these included students with disability (Campbell & Mechling, 2009; Mechling, Gast & Thompson, 2009; Yakubova & Taber-Doughty, 2012). Mechling, Gast and Thompson (2009) found that IWBs were only more effective for observational learning, that is, they found that using an IWB increased learning of words that were not directly taught. However, Mechling et al. found that teaching sight words to students with an intellectual disability using an IWB in its simplest form (i.e., as a substitute whiteboard) achieved the same results as using flashcards.

Campbell and Mechling (2009) reported similar results from their study of teaching letter sounds to students with intellectual disability and Mechling, Gast and Krupa (2007) from their initial study of sight words teaching to students with intellectual disability. Campbell and Mechling (2009) found that IWBs were effective in teaching sight words to students with disability. However, the intervention was not compared to other instruction. Mechling et al. (2007) suggested that having a large screen may enhance the chance for students to see their lesson and hence enhances their

attention, however, in a later study of the effects of variable screen size on students with intellectual disability, Mechling and Youhouse (2012) found that screen size had little effect.

Yakubova and Taber-Doughty (2012) studied the effects of IWBs on skill acquisition but as a medium for video modelling. Although the results from this study were positive, the researchers examined ways to integrate technology rather than the effectiveness of the tool itself and therefore they did not report on the efficacy of the IWB.

There are few studies on IWBs in relation to students with disability and few studies specifically on students with autism spectrum disorder (ASD) (e.g., Whitby, Leininger & Grillo, 2012; Yakubova & Taber-Doughty. 2012). A significant number of students with ASD find it difficult to maintain appropriate functional behaviour or on task (American Psychiatric Association, 2015; Nwokeafor, 2009; Sahin & Cimen, 2011). It has been suggested that students with ASD benefit from visuals to assist with their learning. Hence the act of not looking, or inattention, would likely further reduce their chances of accessing learning.

The tool that can attract attention should be employed whenever possible. This is because using items that are of intense interest can increase engagement (Mancil & Pearl, 2008). Several studies suggest that students with ASD are more engaged when materials are presented on electronic devices (Adams Hill & Flores, 2014; Brennan, Watts, & Phelps, 2012; Draper Rodríguez, Strnadová & Cumming, 2013; Ganz, Boles, Goodwyn, & Flores, 2014; Godzicki, Godzicki, Krofel, & Michalels, 2013). Capitalising on the indication that students, especially those with ASD, attend more to screen media than to other mediums of instruction thus seems the logical step. Students with ASD have also shown a preference for screens that involve some level of

interaction (e.g., Mineo, Ziegler, Gill, & Salkin, 2008), i.e., IWBs. The large number of Australian school classrooms that have IWBs means this is a readily available and familiar teaching tool. This thereby creates potential for IWBs to increase engagement, as it is a large electronic screen that is accessible and with the added benefit of being interactive, adaptable and multifunctional (e.g., Servilio, 2009; Whitby, Leininger & Grillo, 2012; Yakubova & Taber-Doughty, 2012).

This study explores the effect of an IWB on the engagement levels of students with ASD and mild intellectual disability, during whole-class teaching. The research question addressed in this study therefore is: Does student engagement vary when similar content is presented on an IWB compared to paper-based materials?

Method

Setting

The participants attended a university-based demonstration program for students with special education needs, consisting of 45 primary-aged students, divided into four classes of between nine and thirteen students. Students are eligible for enrolment if they have mild or moderate intellectual disabilities, language disorders, autism, or attention deficit hyperactivity disorder, or a small range of other disorders and are likely to benefit from an academic program. The school's main focus is on enhancing literacy and numeracy skills. The participants were all in the same class, comprised of students with ages ranging from 8 years to 13 years. A classroom manager, a classroom teacher, and a classroom assistant staffed the classroom. All were qualified special educators.

Participants

The research was conducted at a school established as a research site. The University human ethics committee approved the research. Participants were eligible to participate if they had a mild or moderate intellectual disability and were diagnosed

with autism or Asperger's disorder by a pediatrician or psychologist, using one the following: Autism Diagnostic Observation Schedule (ADOS); Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM IV) or Text Revision (DSM IV-TR). Participants must also have had at least one term of schooling at the research site and school records providing details on and confirmation of their diagnoses and the measures used to ascertain these diagnoses had to be available.

The participants were three boys and one girl. The four participants were the only children who met the selection criteria out of the pool of potential participants in the nominated class. Information on the participants was sourced from school records. All four participants were assessed by the author using the *Childhood Autism Rating Scale (CARS), Second Edition* (Schopler, Bourgondien, Wellman, & Love, 2010), and *Vineland Adaptive Behavior Scales, Second Edition* (Sparrow, Cicchetti & Balla, 2005). Table 1 provides details on each student. All participants had been exposed to IWBs for their entire schooling at their current school and had Calendar sessions on the IWB for at least two years.

Research Design

An alternating treatment design was used during sessions for nine consecutive weeks. The first condition was the IWB condition, as described below. The alternate condition, the non-IWB condition, was the banner presentation, as described below. The alternating pattern consisted of alternating days rather than a longer treatment period (Barlow & Hayes, 1979). In an alternating treatment design there may be a final phase using the most efficient intervention if one is shown to be more effective. In the study reported here, neither treatment was clearly superior, so a final phase was not carried out.

Data collection. All sessions were video recorded using a wall-mounted wide-angle AXIS 212 PT2 camera preprogrammed to take daily recordings lasting fifteen minutes to capture the entire morning Calendar session. The camera was mounted slightly above the IWB screen. Video recordings of these sessions showed the entire class, with the chosen participants seated in the front row at tables. This meant that the camera captured the participants' behaviours.

Independent Variables. In order to examine the effect of IWB screen use alone, the more attractive affordances (i.e., screen colour, animation, sound) of the IWB were not used. Features of the IWB that could be recreated with the NIWB were included. This included movable objects, coloured objects and sizing. Mechling et al. (2007) suggested that the size of the display could confound attempts to evaluate the effects of IWBs. That is, observed effects could simply be a product of the size of the display rather than inherent characteristics of the IWB. However, in a further study of the variable of size, Mechling and Youhouse (2012) found that screen size had little effect. Nevertheless, given that size could be a confounding variable (Mechling et al, 2009) both the IWB and the paper-based display were the same size.

Baseline. The baseline condition was the standard for the IWB condition. That is, the baseline and IWB conditions were identical. The class, including all four participants, was used to having the IWB for Calendar and was accustomed to the format used. Only colours that could be replicated with the non-IWB (NIWB) condition were used in the IWB condition. All icons, numbers and layout features were the same size on the IWB and on the NIWB materials. Baseline was determined in order to ensure that confounding variables were eliminated. The use of the IWB condition in baseline was unusual as the IWB is usually the novel condition (e.g., Campbell et al., 2009; Mechling et al., 2007). In the study reported here, the participants were

accustomed to IWB presentation and any novelty effects therefore could only be applied to the NIWB conditions.

Dependent variables. Video recordings of each session were coded for the presence of on and off task behavior for each of the four participants as a measure of engagement. Behaviour was coded as passive on task, active on task, passive off task, or active off task. For the purposes of this study, behaviours of the students from the participants' classroom and from one other classroom in the school were observed and categorised drawing on the coding used in Kemp and Carter (2006) and Godzicki et al. (2013). Active on task behaviour was defined as appropriate behaviour and functional participation in the session. Passive on task behaviour was defined as appropriate behaviour and inactive participation in the session. Active off task behaviour was defined as inappropriate behaviour and deliberate non-participation in the session. Passive off task behaviour was defined as not attempting to participate in the lesson but not acting in an inappropriate manner. Table 2 presents definitions and sample behaviours. The focus for this study was measuring passive on task behaviour. All data is presented but only passive on task behaviour is analysed in detail. The reason for this selectivity is due to the nature of the group activity. Each of the activities was led by one student and there was very little opportunity for the other students to actively participate. Passive on task behaviour was most relevant so the primary analysis was of that behaviour. Other measures were viewed as secondary.

Data coding. Interval recording was used in the coding. Each video recording was split into 15-second clips using Time Splitter Video software (Gerber, 2004). Each of the four participants was observed in each 15-second second interval over the entire session. Each 15-second interval was coded in two ways. First, partial interval recording was used to indicate each behavior that occurred in each interval. If only one

behaviour was recorded, that is, the behaviour lasted for the duration of the interval, and then this was coded as the dominant behaviour. Second, for each interval where there was more than one behaviour coded (that is, where a single behavior was not the only behavior for the whole interval), the dominant behaviour (the behaviour that occurred most during the 15 seconds) was coded. This was determined by the total length of each of the behaviours. If the circumstance arose when two behaviours occurred for the same amount of time, the off-task behaviour and/or active behaviour was selected as the dominant. The data were plotted for visual analysis. To determine the total percentage of intervals where the dominant behavior was on-task, the number of predominantly on-task intervals was divided by the total number of intervals in that session and multiplied by 100. The number of intervals in each session varied depending on the length of the session.

Procedures

The data were collected during Term 3 of the school year (nine weeks total). All participants received interventions as a group (whole class) in the same context at the same time everyday. Interventions were implemented in an alternating pattern over the course of the week (5 days). This meant that weeks where the IWB treatment began the sequence alternated with weeks where the non-IWB condition began the sequence providing counterbalancing and controlled for carry-over effects. Baseline and intervention sessions took place during the morning and were overseen by the classroom teacher. The same teacher ran every session for the duration, and had been responsible for similar activities before the research commenced. The structure, wording, behaviour management and rules were kept the same for each session regardless of condition. Each session began with students seated in a specified seating arrangement, which remained constant throughout the study. The four participants sat at

tables in the front row set out in a ‘U’ shape with one non-participant in the front row and the remainder in a row behind without tables. Both the IWB and the NIWB material display were mounted on the wall approximately one to one and a half metres from the front row and approximately one metre from the ground. An additional traditional whiteboard was present, mounted on the wall to the left of the IWB. This was used briefly in each session, regardless of condition.

After being seated, the adults in the room greeted the students individually with “Good Morning _____” to which the students replied with “Good Morning” and with the adult’s name. Then the adults (other than the teacher running the session) withdrew from further involvement. A student, chosen to call the roll for the week, called out students’ names and marked them as present when they answered to their name. Participants were not chosen to call the roll for the weeks that the research took place. After roll call, the Calendar presentation began. Students were chosen to perform different tasks (for examples, see below). Students were selected if they were following the session rules, which were reviewed each session. The rules were that students must look at the board or the student performing a task and must be sitting quietly. These tasks were kept constant to ensure they did not affect the consequent data collection.

Data were taken from the point where the tasks started to the point where the tasks ended. The tasks and sessions in which each task would be performed by participants were pre-determined, in order to ensure this aspect of the activity was balanced across participants. One of the four participants was chosen to perform on one day of the week and other class members completed the other activities. This was implemented for each condition; for example, if Participant 1 was chosen once for an IWB session then he or she would complete the same activity in the alternate condition. On their chosen day, the participant was chosen for the first activity for which they

were following the session rules. If a selected student was absent, their replacement, a non-participant, was noted. Each Calendar session lasted approximately ten minutes.

During the NIWB session, the presentation materials consisted of two double-sided banners with objects attached with Velcro or Blu-tac. Students selected objects, by detaching them from their storage location on the banner and reattaching them to the appropriate place. During the IWB condition, students selected images displayed on the IWB pages and dragged them, using a single finger, to the appropriate area. The size of the NIWB presentation matched the size of the IWB and was overlaid on the IWB to ensure seating, height and familiarity of placement, including the video, was achieved.

The first activity/page displayed a large calendar showing the current month where the nominated student chose, by dragging (IWB) or selecting and fastening (NIWB) a star on the date of the current day, and two signs – one sign with the words "Yesterday was" to the appropriate location, and one sign with the words "Tomorrow will be" to the appropriate location. The student was encouraged to say aloud, "Today is_____, yesterday was _____ and tomorrow will be _____."

The second activity/page showed the days of the week, the dates of the month, and the months. The nominated student chose by dragging (IWB) or selecting and fastening (NIWB) the day of the week, the day of the month, and the month, and then wrote the date in the form dd/mm/yy. Again, the student was encouraged to say aloud each step. The teacher then wrote the short date on the regular classroom whiteboard and encouraged the class to repeat the date and reminded students why the short date was written as shown. The next activity/page showed the four seasons and an array of pictures of weather types. The nominated student chose by dragging (IWB) or selecting and fastening (NIWB) the season and the weather, again saying each choice aloud.

For the final activity/page showing the class rules and a label stating, “Today’s rule”, the nominated student stayed in their seat and orally chose a class rule for the day. The teacher dragged (IWB) or selected and fastened (NIWB) the selected rule. After this final activity, the students were directed to their first lesson (see Figure 5: images of Calendar session IWB).

Interobserver Reliability

Training. The research assistant was trained to code behaviours using footage of three sessions that were not used in the study but that followed the same presentational format as that in the study. Training was completed when inter-rater reliability of at least 80 per cent between the researcher and the research assistant was achieved for the practice footage. This was achieved after approximately three hours over four sessions. Further training was undertaken with the same research assistant for procedural reliability. The same footage was used and training was considered complete when inter-rater reliability of at least 80 per cent between the researcher and the research assistant was achieved.

Inter-rater reliability. Video recordings of 15 sessions (30% of all sessions) were selected at random (using a random number generator) and then independently coded by a trained research assistant to establish inter-rater reliability. Reliability was calculated for the dominant behaviour coding using the formula, agreements divided by agreements + disagreements multiplied by 100. Mean reliability for all sessions and across all participants was 86 per cent (range: 66%-99% mean). The mean range across the group was 80-93 per cent. The range for individual scores was 43-100 per cent. The low reliability score of 43 per cent for one participant was attributed to disagreement about whether the participant was looking at the presentation or other intended target

for a student with glasses. An overall average reliability score of 80 per cent was attained for this participant.

Procedural reliability. The 15 video recordings used for overall inter-rater reliability were consequently used for procedural reliability. The first three were used for training purposes and the remaining twelve were coded independently. To ensure procedural reliability, a checklist was marked for compliance for each video used in the results to ensure that the two conditions and each session were replicated in terms of structure, content, and classroom arrangement (see Appendix 2). The checklist consisted of order of events, controlled participation of participants in activities (one task per week per participant), and non-researcher interference. The researcher and a trained research assistant coded the recordings. Training was considered complete when 100 per cent reliability was achieved. Reliability was calculated using the formula, agreements divided by agreements + disagreements multiplied by 100. Procedural reliability was 98 per cent overall with 100 per cent inter-rater reliability (12 sessions, 26% of all sessions).

Results

Participants' Dominant Passive On Task Behaviour

Results for passive on task behaviour are presented in Figures 1-4. Results are presented as % of intervals spent on task in each session according to the dominant behaviour, that is, the behaviour that occurred for the longest duration of the 15s video clip.

As seen in Figure 1, Participant 1's results showed higher levels in passive on task behaviour in NIWB conditions. Engagement levels were variable. There was an initial spike in on task behaviour in the NIWB condition. There were seven changes where the IWB condition had higher levels of engagement. However, Participant 1's

engagement levels generally stayed at a low to mid-range. The range for the IWB condition was 10-44%. The range for the NIWB condition was 16-67%.

For Participant 2 (see Figure 2), passive on task behaviour in NIWB conditions was generally higher. However, there was little difference between conditions as his levels of passive on task behaviour were reasonably high across both settings with 100 per cent passive on task behaviour on one occasion for the NIWB condition and the lowest data point occurring under the IWB condition with 32% passive on task behaviour. The range for the IWB condition was 32-96%. The range for the NIWB condition was 41-100%.

For Participant 3 (see Figure 3), passive engagement was consistently low in both conditions. Whilst engagement levels were variable and there was an initial spike in on task behaviour in the NIWB condition, there were ten changes and both conditions showed that Participant 3 had a generally low range. The range for the IWB condition was 0-40%. The range for the NIWB condition was 0-54%.

As seen in Figure 4, Participant 4 performed consistently better in the NIWB conditions. In general there was little variability with only three changes. However, there was an initial spike in on task behaviour in the NIWB condition. At the final change towards the end of the study, there was a decreasing trend in engagement levels in IWB conditions and NIWB conditions but with higher engagement levels in the final four IWB conditions. This also marked the highest point of engagement for the entire study with 95% passive on task behaviour under the IWB condition. The range for the IWB condition was 31-95%. The range for the NIWB condition was 17-86%.

Two students were absent for several sessions. Participant 2 was absent for four IWB sessions and two NIWB sessions. Participant 4 was absent for four of each

condition. Data for these sessions was included for present students but there is no data point on these dates for absent students.

Total Percentage of Time Spent For Passive And Active On And Off Task Behaviour

Results from the total percentage of time spent for the categories of passive off task and of active on task and off task were also calculated and tabulated according to the dominant behaviour, that is, the behaviour that occurred for the longest duration of the 15s video clip (see Table 3). All four participants had a higher total percentage of time spent on task for the NIWB condition, this was more apparent in the passive on task behaviour, as the active on task behaviour remained the same. Conversely, all four participants had a lower total percentage of time spent off task for the NIWB condition. This was more marked in passive off task behaviour. However, there was a difference in the active off task behaviour for three participants. Participant 4 had higher total percentage of time spent active off task behaviour in the NIWB conditions with 3 per cent more than the IWB conditions.

Discussion

The nature of the lesson, a whole-group lesson, called for passive on task behaviour for the majority of the lesson, and for this reason measurement of this behavior was the primary gauge of the effect of the two conditions. There was no consistent or large effect of increased engagement with the IWB compared to the paper-based materials. The sessions with highest levels of engagement were with the paper-based materials, the NIWB. Three participants had an initial rise in engagement levels in the NIWB condition compared to baseline with the IWB. This initial difference may have been due to the novelty effect of having a new presentation style, the NIWB condition. This research was unusual in that the baseline condition involved the use of

the IWB and thus, any novelty effect would have applied to the NIWB. Thus, the better performance with the NIWB may have reflected a novelty effect. However, it would be unusual for such effects to last as long as the length of this study.

For Participant 1, higher levels of passive on task behaviour were seen over the course of the study. Although the levels were low to mid-range, the slight increase may indicate that she found the NIWB more engaging. Both Figure 1 and Table 3 show higher levels of on task behaviour and lower levels of off task behaviour in the NIWB conditions in comparison to the IWB condition. However, generally she was off task more than on task in both conditions. It is suggested that although the NIWB had some effect on engagement levels, Participant 1 was typically not engaged during this lesson.

For Participant 2, there was no clear difference between conditions and he had high levels of engagement. He was close to the ceiling of measurement in both conditions and this might have accounted for these results. There was some evidence for a general trend towards higher engagement with the NIWB condition with the majority of the highest points of on task behaviour falling under this condition. Participant 2 was also absent for several sessions. These absences were generally followed by low periods of engagement and then an upward trend in on task behaviour. It is suggested that although the NIWB had some effect on engagement levels, Participant 2 was typically engaged in this lesson. This finding is of particular interest when looking at his *CARS* rating of 'Minimum –to-No Symptoms of Autism' and his diagnosis of Asperger's Syndrome, in comparison to the other participants who were diagnosed with autism and tested as having at least mild symptoms on the CARS rating scale. Potentially, this result could be an indication that, in relation to attention and children with disability, large screens, even interactive screens, do not affect engagement.

Participant 3 was typically off task across both conditions. There was some evidence of higher levels of engagement with the NIWB condition but as he was typically off task this result was not as clear as with other participants. Participant 3 was generally inconsistent in behaviours but showed some suggestive findings as he was on average the most off task in both passive and active behaviours and across conditions and was the only participant shown as off task for an entire lesson in both conditions. This may be significant as he was also the only participant: with a 'borderline' intelligence diagnosis; to score 'Severe Symptoms of Autism' on the CARS rating scale; and also received the lowest rating of all participants on the Vineland II assessment. This might be suggestive of the difficulties of maintaining on task behaviour in whole-group lessons for students with more severe symptoms of autism.

Participant 4 had the most variable behaviour with almost equal on and off task behaviour across conditions. There was a slight difference in engagement levels suggesting that he was more engaged with the NIWB conditions and less engaged with the IWB conditions. Like Participant 2, he was absent for two periods of several days. The first return to school marked a spike in on task behaviour under the NIWB condition followed by a sharp decrease in the next NIWB session. The following return after an absence followed this trend. This was also succeeded by a downward trend in the NIWB condition. It is suggested that was a sustained pattern of higher levels of engagement under the NIWB conditions until the end of the treatment. It might be suggested that this is evidence of a 'wearing off' of the novelty effect of the NIWB. However, as the treatment lasted nine weeks this seems unlikely.

Total percentage of time spent on task for both the IWB and NIWB conditions were similar for each participant but still slightly favourable towards the NIWB condition with higher levels of on task behaviour and lower levels of off task behaviour

in comparison to the IWB condition. The implications of these results are that IWBs may not increase engagement in whole-group lessons for all students, especially those who already have higher levels of engagement. For two participants it appears they were more highly engaged in the NIWB condition, however, generally overall engagement levels as measured by on task behaviour were low.

Although data were collected on active on task behaviour, this behaviour occurred at low levels for all participants. This is because active on task behavior predominantly occurred as a result of the teacher/researcher requesting the participant engage in an activity on the board. Each participant had one opportunity per week (one opportunity per fortnight per condition) to interact with the IWB or the paper materials. Rarely did a participant ask a question or perform active on task behaviour that was not required. Total percentage of time spent for active on task behaviour for both the IWB and NIWB conditions varied very little across participants.

Results for passive off task behaviour were highly variable with two participants less engaged overall in both conditions and all relatively similar between conditions. These results were essentially the opposite of on task results. Contrary to the passive on task behaviour displayed, participants' passive off task behaviour was discouraged throughout the session but students did not receive firm reprimands for engaging in passive off task behaviour. This was due to two main reasons. First, this behaviour was not as noticeable as active off task behaviour and second, correcting this behaviour would have affected the results.

Active off task behaviour was rarely seen in either the IWB or NIWB conditions. This was most likely due to the highly controlled nature of the session. Participant 4 was slightly more likely to be display actively off task behaviour under the NIWB conditions. Anecdotally, Participant 4 in some instances, appeared to be more

actively off task when he was excited by the activities being presented. In addition, he called out repeatedly asking to have turns.

From as early as 1991 in Kozma's (1991) study of cognitive engagement, screens have shown to be a powerful tool in increasing visual attention. The study focused on the television screen but had implications for other technologies. Consequent studies on the effect of computer instruction (e.g., Goldsmith & LeBlanc, 2004) have also suggested that technology may be effective in increasing attention with students with autism. In more general terms Godzicki et al. (2013) found that technology increased engagement. There are also studies that provide evidence for the efficacy of handheld screens (e.g., Ganz, Boles, Goodwyn, & Flores, 2014). Results of this study are not consistent with these findings. This may be because some of the possible affordances of the IWB (e.g., sound and animation) were intentionally excluded in order to create a condition comparable to the paper-based condition, given the specific intent was to compare screen and paper-based presentation. It is possible that these features might have improved attending. The implications are that these functions might have been critical in previous studies in increasing outcomes such as attention with students with autism (Beeland Jr., 2002). Or more generally, it is the way the IWB is employed, e.g., interactively, that affects outcomes (Shenton & Pagett, 2007). Further research could replicate this study adding the additional features of sound and animation the IWB and counterbalancing these affordances with unique affordances of the NIWB such as manipulation of objects and texture.

However, findings of studies on ASD and screens have suggested that screens in general are motivating but conclusive evidence has not been found for their efficacy or effect on engagement (Adams Hill & Flores, 2014; Mineo, Ziegler & Gill, 2008). These results are mirrored in this study. The findings reported here are also comparable with

the findings of May (2014) in a comparison of instruction with and without an IWB in a university setting with typically-developing students. May found that were was not a significant difference in achievement between the control group and the intervention group. The findings are also somewhat consistent with the findings of studies on presentation of sight words to students with disability (Mechling, Gast & Krupa, 2007; Mechling, Gast & Thompson, 2009) in that there was not a significant difference in achievement of target or directly taught words between the IWB and NIWB conditions. Just as there was not a large difference between conditions in this study. Mechling et al. (2007) and (2009) did not directly measure engagement but the lack of impact on achievement suggests a lack of impact on engagement and on task behavior.

Limitations

The limitations of this study were threefold. The first limitation of the study was that behaviour was measured for only one kind of lesson that mostly required passive on task behaviour. Active off task behaviour was typically addressed quickly by the teacher so lengthy off task behaviour did not occur. Active on task behaviour was controlled and limited given the nature of the activity. It is impossible to determine if the behaviours would have occurred for lengthy periods without intervention. However, this behaviour management occurred in both conditions. The second limitation of the study was the video quality. The camera recording the lessons was fixed and for some clips, coding relied on the coders' judgement on whether the participant was looking at the presentation or other intended target or merely angled in the direction of the presentation but not looking. Despite this limitation, adequate interrater reliability was achieved. Finally, as for all single case designs, the results may not be generalisable to other students. Whilst single-case research allows for the evaluation of each participant, efficacy needs to be validated through replication to provide supplementary findings.

Recommendations

As a result of the findings of this study, there are three main recommendations for future research. Future research should focus on ascertaining the effects of IWBs on levels of engagement in other types of lessons that require more active on task behaviour. Second, future research should focus on the different affordances of IWBs in order to compare an IWB activity that uses basic functions to one that uses sound, colour and animation. Last, looking at the lesson material and teacher may be indicative of attention, but such attention is not a guarantee of learning (Jordan et al., 2013; Kidron & Lindsay, 2014). Future research should also investigate the effect of engagement or attention on learning outcomes.

Conclusion

IWBs are commonplace in classrooms but empirical research examining their efficacy is limited. The prevalent belief is that student engagement is enhanced by IWBs. The results of this study do not support the proposition that IWBs increase engagement. In previous studies it has been suggested that IWBs may improve attention for children with ASD, due in part to their purported visual learning style and their engagement with electronic devices. In this study of students with ASD there was no increase in student engagement as reflected in an increase in dominant passive on task behaviour when material was presented on the IWB compared to a paper-based condition. Indeed, for two of the four students an increase in engagement was seen in the NIWB, ‘paper-based’ condition.

References

Adams Hill, D. & Flores, M. M. (2014). Comparing the Picture Exchange Communication System and the iPad for communication of students with autism spectrum disorder and developmental delay. *TechTrends, 58* (3), 45-53.

Allsopp, D. H., Colucci, K., Doone, E., Perez, L., Bryant, E., & Holhfeld, T. N. (2012). Interactive whiteboard technology for students with disabilities: A year long exploratory study. *Journal of Special Education Technology*, *27*(4), 1-15.

American Psychiatric Association (2015). Autism spectrum disorders. Retrieved from http://www.psychiatry.org/mental-health/autism-spectrum-disorders

Banks, L. (2011) NSW Government rolls out 4300 interactive whiteboards. Retrieved from http://www.computerworld.com.au/article/print/384746/nsw_government_rolls_4300_interactive_whiteboards/

Barlow, D. H. & Hayes, S. C. (1979). Alternating treatments design: One strategy for comparing the effects of two treatments in a single subject. *Journal of Applied Behavior Analysis, 12*, 199-210.

Beeland Jr., W. D. (2002). Student engagement, visual learning, and technology: Can interactive whiteboards help? *Action Research Exchange, 1,* 1-7.

Brennan, S., Watts, L., & Phelps, R. (2012). iPads: Instant access and engagement for students with disabilities. *The Australian Educational Leader, 34* (2), 36-40.

Campbell, M. L., & Mechling, L. C. (2009). Small group computer-assisted instruction with SMART Board technology. An investigation of observational and incidental learning of nontarget information. *Remedial and Special Education, 30*, 47-57. doi: 10.1177/0741932508315048

DiGregorio, P., & Sobel-Lojeski, K. (2010). The effects of interactive whiteboards

(IWBs) on student performance and learning: A literature review. *Journal of Educational Technology Systems, 38*, 255-312.

Draper Rodríguez, C., Strnadová, I., Cumming, T. (2013). Using iPads with students with disabilities: Lessons learned from students, teachers, and parents. *Intervention in School and Clinic, 49*, 244-250. doi: 10.1177/1053451213509488

Futuresource Consulting. (2014). *Quick facts and stats*. Retrieved from http://smarttech.com/us/About+SMART/About+SMART/Newsroom/Quick+facts+and+stats

Ganz, J. B., Boles, M. B., Goodwyn, F. D., & Flores, M. M. (2014). Efficacy of handheld electronic visual supports to enhance vocabulary in children with ASD. *Focus on Autism and Other Developmental Disabilities, 29*, 3-12. doi: 10.1177/1088357613504991

Gerber, A. (2004). Coracle Ltd. Time Splitter Video. (Version 1.1.5) [Software]. Available from http://www.coracle.ltd.uk/

Glover, D., Miller, D., Averis, D., & Door, V. (2005). The interactive whiteboard: A literature survey. *Technology, Pedagogy and Education, 14*, 155-170.

Godzicki, L., Godzicki, N., Krofel, M., & Michaels, R. (2013). Increasing motivation and engagement in elementary and middle school students through technology-supported learning environments. (Master of Arts Action Research Project). Retrieved from *files.eric.ed.gov/fulltext/ED541343.pdf*

Goldsmith, T. R. & LeBlanc, L. A. (2004). Use of technology in interventions for children with autism. *Journal of Early and Intensive Behavior Intervention, 1*, 166-178.

Higgins, S., Beauchamp, G., & Miller, D. (2007). Reviewing the literature on

interactive whiteboards. *Learning, Media & Technology, 32*, 213-225. doi: 10.1080/17439880701511040

Jordan, N. C., Hansen, N., Fuchs, L. S., Siegler, R. S., Gersten, R., & Micklos, D. (2013). Developmental predictors of fraction concepts and procedures. *Journal of Experimental Child Psychology, 116,* 45-58. doi: 10.1016/j.jecp.2013.02.001

Kemp, C. & Carter, M. (2006). Active and passive task related behaviour, direction following and the inclusion of children with disabilities. *Education and Training in Developmental Disabilities, 41*, 14-27.

Kidron, Y., & Lindsay, J. (2014). *The effects of increased learning time on student academic and nonacademic outcomes: Findings from a meta-analytic review*. Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Appalachia. Retrieved from http://eric.ed.gov/?id=ED545233

Kozma, R. B. (1991). Learning with media. *Review of Educational Research, 61*, 179-211.

Mancil, R. G., & Pearl, C. E. (2008). Restricted interests as motivators: Improving academic engagement and outcomes of children on the Autism Spectrum. *TEACHING Exceptional Children Plus, 4*(6), 15.

Manny-Ikan, E., Tikochinski, T. B., Zorman, R., & Dagan, O. (2011). Using the interactive white board in teaching and learning: An evaluation of the SMART CLASSROOM pilot project. *Interdisciplinary Journal of E-Learning & Learning Objects, 7*, 249-273.

May, P. (2014). Effectiveness of SMART Board use in the teaching and learning of statistics. *Electronic Journal of Mathematics & Technology, 8*, 43-52.

Mechling, L. C., Gast, D. L., & Krupa, K. (2007). Impact of Smart Board technology: An investigation of sight word reading and observational learning. *Journal of Autism and Developmental Disorders, 37*, 1869-1882.

Mechling, L. C., Gast, D. L., & Thompson, K. L. (2009). Comparison of the effects of SMART Board technology and flash card instruction on sight word recognition and observational learning. *Journal of Special Education Technology, 23*, 34-46..

Mechling. L. C. & Youhouse, I. R. (2012). Comparison of task performance by students with autism and moderate intellectual disabilities when presenting video models on large and small screen sizes. *Journal of Special Education Technology, 27*, 1-14

Mineo, B. A., Ziegler, W., Gill, S., & Salkin, D. (2008). Engagement with electronic screen media among students with autism spectrum disorders. *Journal of Autism & Developmental Disorders, 39*, 172-187.

Nwokeafor, C. U. (2009). Conundrum of autism: A review of its causes and significant impact on the education of a school age child. *Forum of Public Policy,* 1-15.

O'Hanlon, C. (2007). Board Certified. *T.H.E. Journal, 34* (6), 30-34.

Phelps, R. (2012). Perceptions of the effectiveness of interactive whiteboards of student engagement. (n.p.) Retrieved from: http://search.proquest.com/docview/1237223689

Sahin, Y. G. & Cimen, F. M. (2011). An interactive attention board: Improving the attention of individuals with autism and mental retardation. *TOJET: The Turkish Online Journal of Educational Technology, 10*, 24-35.

Servilio, K. L. (2009). You get to choose! Motivating students to read through differentiated instruction. *TEACHING Exceptional Children Plus, 5*(5), 11-21.

Schopler, E., Van Bourgondien, M. E., Wellman, G. J. & Love, S. R. (2010) *Childhood Autism Rating Scale* (2nd ed.). Los Angeles, CA: Western Psychological Services.

Shenton, A., & Pagett, L. (2007). From 'bored' to screen: The use of the interactive whiteboard for literacy in six primary classrooms in England. *Literacy, 41*, 129-136. doi: 10.1111/j.1467-9345.2007.00475.x

Sparrow, S., Cicchetti, D., & Balla, D. (2005). *The Vineland Adaptive Behavior Scales-2*. San Antonio, TX: Pearson Assessments.

Teck, W. K. (2013). Affordances of interactive whiteboards and associated pedagogical practices: Perspectives of teachers of science with children aged five to six years. *TOJET: The Turkish Online Journal of Educational Technology, 12*, 1-8.

Villis, J. (2010). Interactive whiteboards: Revolutionise teaching practices and student learning. *Education Technology Solutions, 39*, 26-28.

Whitby, P. J., Leininger, M. L., & Grillo, K. (2012). Tips for using interactive whiteboards to increase participation of students with disabilities. *TEACHING Exceptional Children, 44*(6), 50-57.

Yakubova, G. & Taber-Doughty, T. (2013). Brief report: Learning via the electronic interactive whiteboard for two students with autism and a student with moderate intellectual disability. *Journal of Autism and Developmental Disorders, 43*, 1465-1472.

Yang, J. Y. & Teng, Y. W. (2014). Perceptions of Elementary School teachers and

students using interactive whiteboards in English teaching and learning. *Journal of Interactive Learning Research, 25*, 125-154. Chesapeake, VA: Association for the Advancement of Computing in education (AACE).

Table 1

Participant details

Participant	Age (months)	Grade Level	Gender	Level of Intellectual Disability	Diagnosis	Standard Used	CARS2[1] Rating	Vineland II[2] Adaptive Behavior Composite Score (Level)
1	116	3	F	Mild (Stanford-Binet Intelligence Scales)	Autistic disorder	DSM IV	Mild-to-Moderate Symptoms of ASD	79 (Moderately Low)
2	125	4	M	Mild (Woodcock-Johnson III Edition) FSIQ[3] Score 69-75	Asperger's Syndrome	ADOS	Minimum-to-No Symptoms of ASD	69 (Low, Mild Deficit)
3	132	4	M	Wechsler Intelligence Scale for Children - Third Edition FSIQ[1] Score 75[4]	Autistic disorder	ADOS	Severe Symptoms of ASD	58 (Low, Mild Deficit)
4	140	6	M	Mild (Stanford-Binet Intelligence Scales)	Autistic disorder	DSM IV-TR	Mild-to-Moderate Symptoms of ASD	68 (Low, Mild Deficit)

[1] *Childhood Autism Rating Scale (CARS), Second Edition*

[2] *Vineland Adaptive Behavior Scales, Second Edition*

[3] Full Scale Intelligence Quotient (FSIQ)

[4] Assessors opinion based on scores indicate participant has a 'borderline' intellectual disability due to discrepancies in scales.

Table 2

Response categories and examples

Passive On-Task	Active On-Task	Passive Off Task	Active Off Task
Looking at IWB/ teacher	Performing an on-task action, (e.g., moving materials to answer a task)	Looking away from IWB/ teacher	Calling out (off-topic)
Looking at peer who is performing an on-task action	Answering a question	Head on table	Out of seat
	Pointing at IWB		Looking at and moving/playing with objects
	Calling out (on-topic)		Looking at fingers/other body parts
	Hand up		Waving to non-greeter
	Calling roll		Talking to peer
	Responding to adult greeting, i.e. says "Good morning"		Distracting peers, (e.g. poking, grabbing, taking property, etc.)
	Responding to instruction, (e.g. "Hands up if…", "Sit down")		Refusing to follow instructions, (e.g. saying "No", not doing requested action)
			Lying on the floor

Table 3

Total Percentage of Time Spent (and Range) for Engagement Levels for all Participants

Total percentage of time spent passively on task

Participant	Baseline (%)	IWB (%)	NIWB (%)
1	19% (4-30%)	28% (10-44%)	44%(16-67%)
2	71% (47-89%)	70% (29-96%)	74% (41-100%)
3	17% (0-38%)	15% (0-40%)	24% (0-54%)
4	43% (24-59%)	50% (30-95%)	57% (17-86%)

Total percentage of time spent actively on task

Participant	Baseline (%)	IWB (%)	NIWB (%)
1	4% (0-22%)	5% (0-32%)	5% (0-32%)
2	9% (0-18%)	5% (0-24%)	5% (0-24%)
3	3% (0-13%)	5% (0-29%)	5% (0-33%)
4	7% (0-14%)	4% (0-13%)	4% (0-20%)

Total percentage of time spent passively off task

Participant	Baseline (%)	IWB (%)	NIWB (%)
1	70% (56-86%)	63% (27-89%)	50% (22-80%)
2	21% (4-43%)	24% (0-68%)	20% (0-59%)
3	79% (50-94%)	73% (24-100%)	70% (22-100%)
4	48% (35-62%)	44% (5-85%)	35% (14-63%)

Total percentage of time spent actively off task

Participant	Baseline (%)	IWB (%)	NIWB (%)
1	7% (0-21%)	4% (0-21%)	2% (0-24%)
2	0% (0%)	1% (0-10%)	1% (0-9%)
3	1% (0-6%)	6% (0-59%)	1% (0-10%)
4	2% (0-8%)	2% (0-7%)	5% (0-65%)

Total percentage of time spent on task

Participant	Baseline (%)	IWB (%)	NIWB (%)
1	23% (0-30%)	33% (0-44%)	49% (0-67%)
2	80% (0-89%)	75% (0-96%)	79% (0-100%)
3	20% (0-38%)	20% (0-40%)	29% (0-54%)
4	50% (0-59%)	54% (0-95%)	61% (0-86%)

Total percentage of time spent off task

Participant	Baseline (%)	IWB (%)	NIWB (%)
1	77% (0-86%)	67% (0-21%)	52% (0-80%)
2	21% (0-43%)	25% (0-68%)	21% (0-59%)
3	80% (0-94%)	79% (0-100%)	71% (0-100%)
4	50% (0-62%)	48% (0-85%)	40% (0-65%)

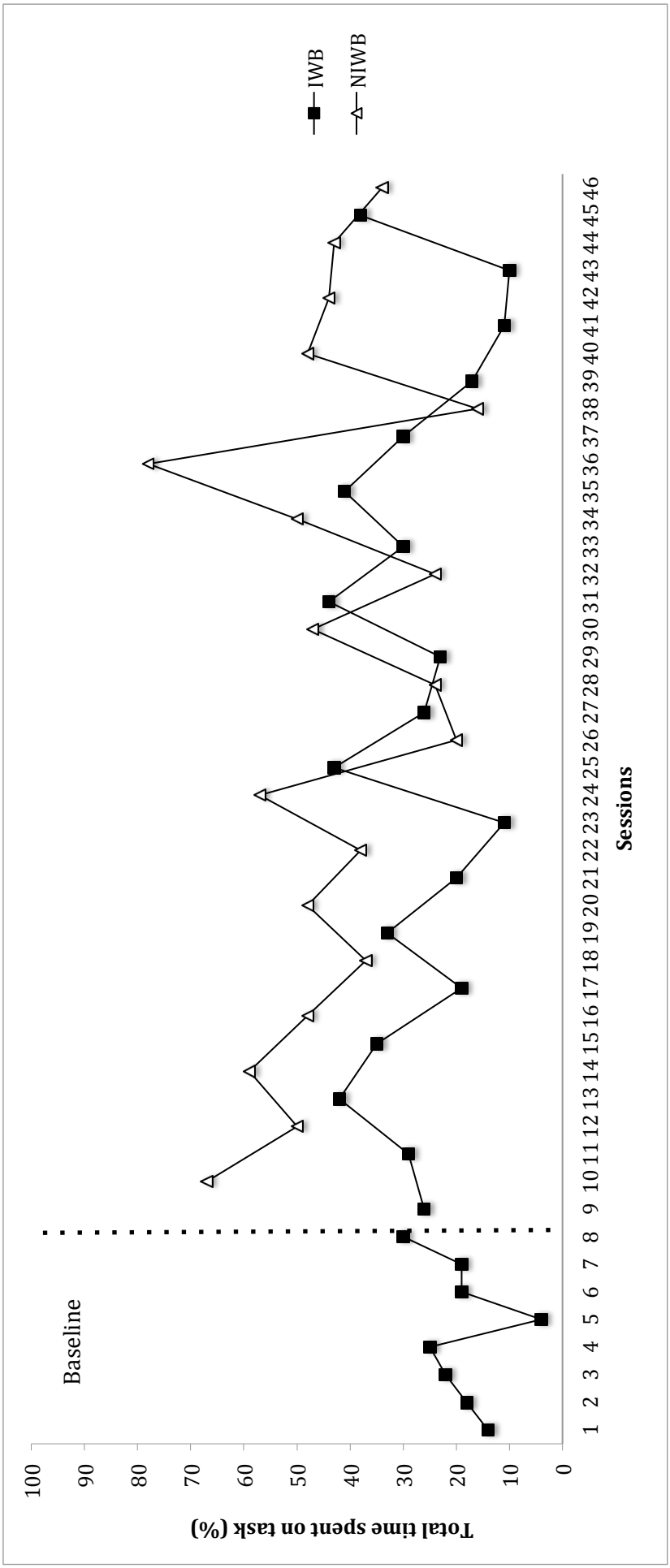


Figure 1 Dominant Passive Total Time On Task for Participant 1

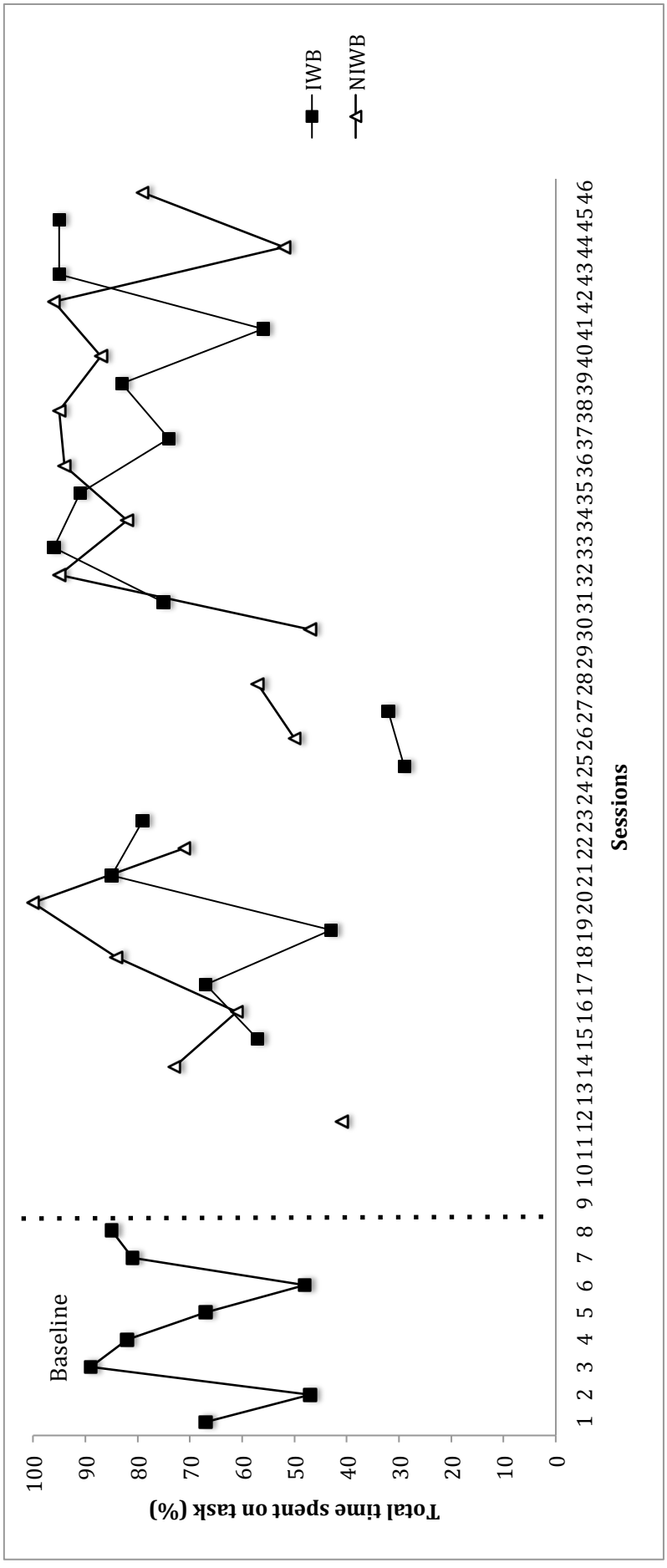


Figure 2 Dominant Passive Total Time On Task for Participant 2

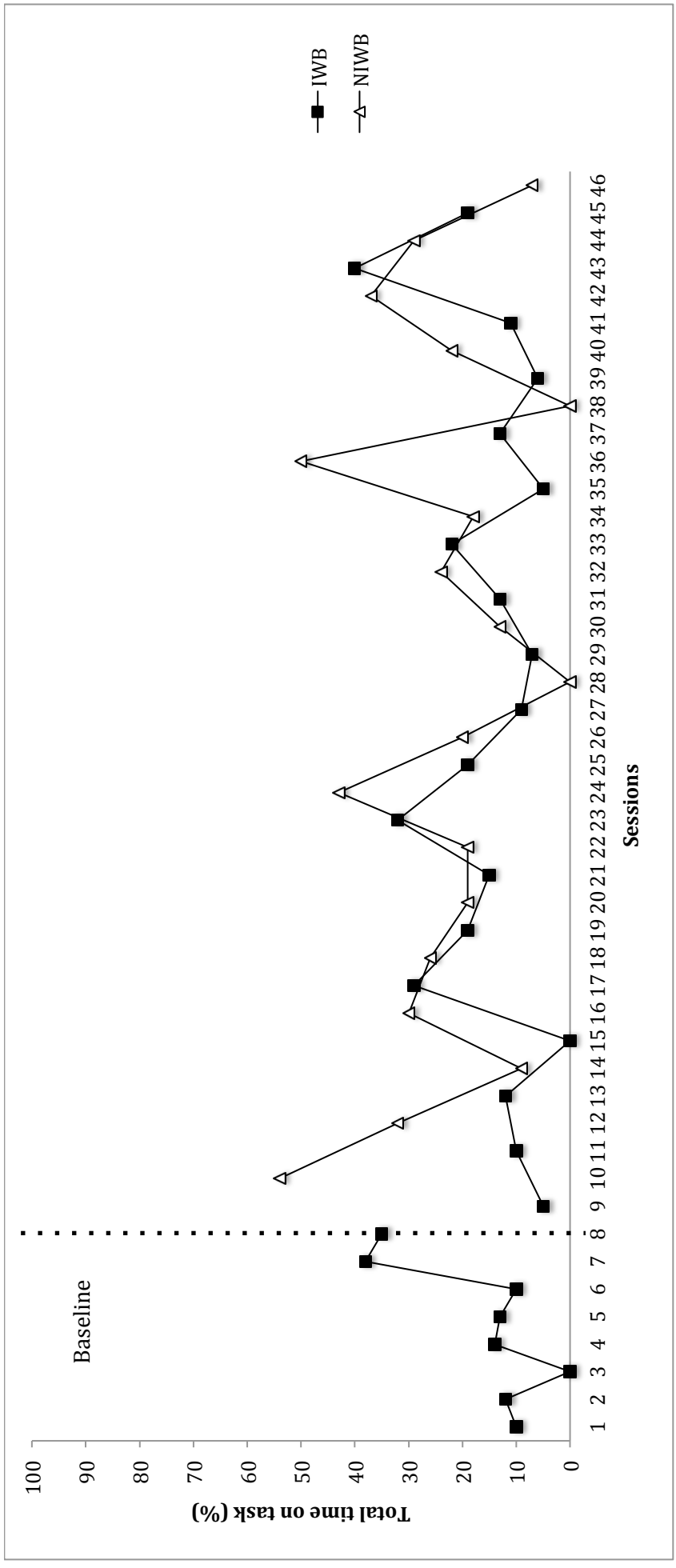


Figure 3 Dominant Passive Total Time On Task for Participant 3

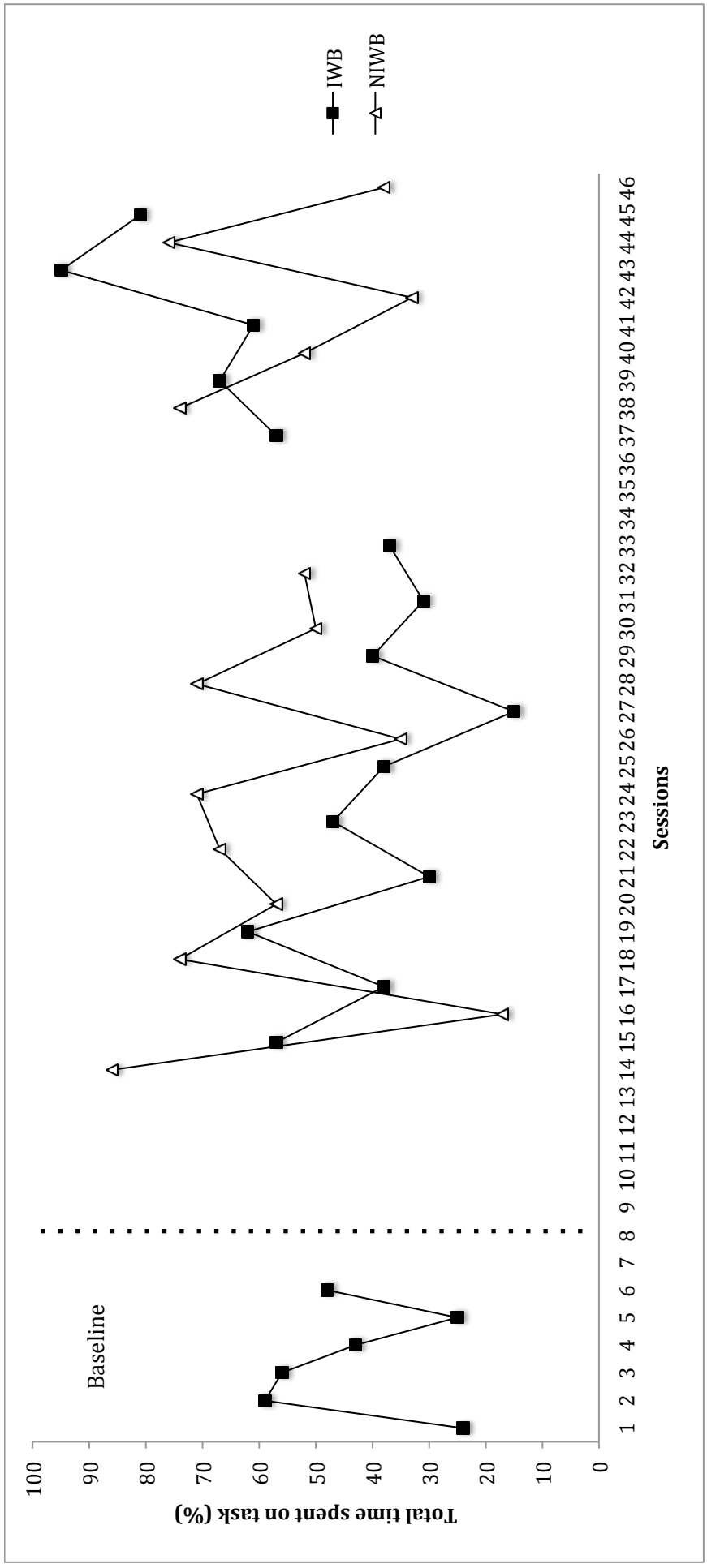
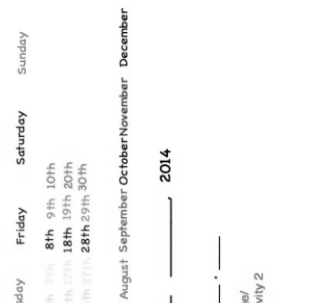
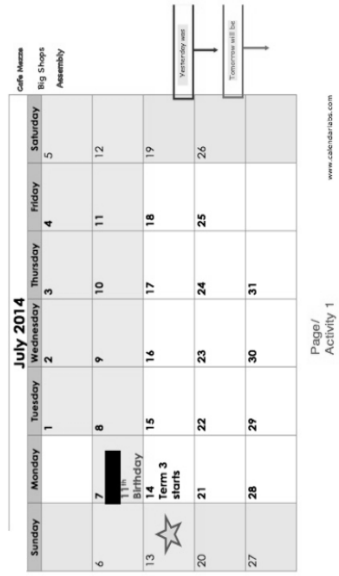


Figure 4 Dominant Passive Total Time On Task for Participant 4

Figure 5 Images of Calendar Session IWB





Chapter 4: Conclusion

Chapter Overview

This closing chapter presents a summary of the research comprised in this thesis. Succeeding this are the research questions addressed and the key conclusions suggested by this research. The key contribution of this research to the fields of education, interactive whiteboards and autism spectrum disorder is identified.

Summary

The core purpose of the research reported in this thesis was to provide a scoping review that examined the quantities and types of extant literature on interactive whiteboards and to establish further empirical data that added to the current body of evidence. The first chapter presented an introduction to the thesis. It included the purpose, rationale, and background literature to provide a context for the overview of the research being explored.

Chapter 2 presented a scoping survey of the quantity and categories of literature available on interactive whiteboards in relation to school-aged children. This was not an in depth analysis of the content but a broad overview of the nature of literature. The majority of literature was grey and the remaining 45 per cent consisted mainly of qualitative research. There was a lack of quantitative research, especially experimental studies that were peer reviewed (2%). The results of the scoping survey indicate that there is a lack of empirical research that supports the efficacy of IWBs.

Chapter 3 presented a quantitative study of four students with autism spectrum disorder and with an additional diagnosis of a mild intellectual disability. This study investigated student engagement levels during an interactive whiteboard presentation and compared this condition to one that presented the same content on paper-based materials using an alternating treatment design. Based on the results, it is suggested that IWBs do not increase the engagement levels of students with autism spectrum disorder

compared to equivalent presentation and content using paper-based materials. Further to this is the suggestion that the engagement levels of students were higher during the non-interactive whiteboard conditions for two students of the four included in the study.

Conclusions

Interactive whiteboards are used extensively in schools but there is little evidence for their efficacy. To date there appears to be little empirical research conducted with regards to IWBs and their use with school-aged children, especially those with disability.

There are four key conclusions that can be drawn from the research presented in this thesis. First, there is dearth of empirical evidence in the field of technology, specifically IWBs, with regards to their efficacy. Published materials consist mostly of grey literature and what research exists tends to be descriptive and/or subjective. The majority of grey literature is comprised of general opinion, product descriptions or descriptive accounts of IWB use. The majority of research consists of qualitative case studies or surveys. Few experimental studies exist.

Second, there is a further gap in field of technology, specifically interactive whiteboards, in relation to students with disability, especially in the context of group lessons. Considering this state, it is also interesting to note that the three single-case studies that were peer-reviewed included participants with disability. This may indicate the difficulty in carrying out studies of this kind within regular school settings. Segregated classes for students with disability are often smaller and sometimes have more staff, making single-case research a feasible option.

Third, in a study of four students with a dual diagnosis of autism spectrum disorder and mild intellectual disability, no advantage was found for using IWBs over paper-based materials in terms of engagement. A slight advantage was found for using

paper-based materials for two students, which may be due to novelty effects.

Last, in a study of four students with a dual diagnosis of autism spectrum disorder and mild intellectual disability, no unequivocal disadvantage was found for using IWBs over paper-based materials in terms of engagement. Two of the four participants were less engaged overall with the IWB condition.

Considering the two papers together, it is clear that more empirical research is needed in the area of interactive whiteboards and education, particularly for students with disability. The predominance of non-research articles and the continuing use in IWBs presents a renewed need for study in this area.

This thesis contributes to the field of research on IWBs, education and autism spectrum disorder through the scoping survey of literature on interactive whiteboards, and empirical study on IWBs and their effect on engagement levels.

Appendix 1

Ethics approval for students under the supervision of Dr Jennifer Stephenson and Dr Mark Carter of Macquarie University Special Education Centre (MUSEC) who conduct research on-site at MUSEC School.

From: "Ethics Secretariat" <ethics.secretariat@mq.edu.au>
Subject: Approved- Ethics application- Carter (Ref No: 5201300450)
Date: 1 July 2013 3:24:32 PM AEST
To: "Associate Professor Mark Carter" <mark.carter@mq.edu.au>

Dear Associate Professor Carter

Re: "Macquarie University Special Education Centre School" (Ethics Ref: 5201300450)

The above application was reviewed by the Human Research Ethics Committee (Human Sciences and Humanities) at its meeting on 28/06/2013. Approval of the above application is granted, effective 01/07/2013. This email constitutes ethical approval only.

This research meets the requirements of the National Statement on Ethical Conduct in Human Research (2007). The National Statement is available at the following web site:

http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/e72.pdf.

The following personnel are authorised to conduct this research:

A/Prof Jennifer Stephenson
Associate Professor Mark Carter
Dr Alison Madelaine

NB. STUDENTS: IT IS YOUR RESPONSIBILITY TO KEEP A COPY OF THIS APPROVAL EMAIL TO SUBMIT WITH YOUR THESIS.

Please note the following standard requirements of approval:

1. The approval of this project is conditional upon your continuing compliance with the National Statement on Ethical Conduct in Human Research (2007).

2. Approval will be for a period of five (5) years subject to the provision of annual reports.

Progress Report 1 Due: 01 July 2014
Progress Report 2 Due: 01 July 2015
Progress Report 3 Due: 01 July 2016
Progress Report 4 Due: 01 July 2017
Final Report Due: 01 July 2018

Appendix 2

Procedural Reliability Checklist For Study (Chapter 3)

Procedural Reliability Checklist

Observer: _____
Video date: _____ Video length: _____
Participants present: _____ /4

	Yes	No	Comment
Class seating arrangement maintained (all children in allocated seating)			
No adult/child enters the room during Calendar			
Adults say, "Good Morning"			
Teachers other than researcher have no further involvement			
Rules stated			
Roll Call conducted by non-participant			
Page 1 completed first (today, yesterday, tomorrow)			
Student chosen to complete activity: participant/non-participant			
Page 2 completed second (day, date, month, year)			
Student chosen to complete activity: participant/non-participant			
Page 3 completed third (season and weather)			
Student chosen to complete activity: participant/non-participant			
Page 4 completed fourth (rule)			
Student chosen to complete activity: participant/non-participant			
Students dismissed			
TOTAL SCORE ACHIEVED			
TOTAL SCORE POSSIBLE			
PER CENT RELIABILITY			