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Interactive whiteboards in education: A literature scoping survey

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Interactive whiteboards are increasing in popularity and prevalence in education. A scoping survey was performed to ascertain the types of documents available from academic databases on the use of interactive whiteboards with school-aged children. More than half of all the identified documents were grey literature: that is, comprised of non-refereed research, descriptive articles, product descriptions, and general opinion. The remaining research-based documents were predominantly descriptive and qualitative. A small number of documents contained quantitative data, and these were mainly survey-based. There were few experimental studies available. The limited number of research studies contrasts with the sizeable volume of grey literature available on these technological tools. There appears to be a need for more experimental research on the purported positive outcomes of interactive whiteboard use in schools such as higher academic achievement and engagement levels.

Introduction

Interactive whiteboards in education: A literature scoping survey

The prototypical interactive whiteboard was produced by SMART Technologies® in 1991 (Betcher & Lee, 2009; Futuresource Consulting, 2014). 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®, other producers of IWBs including Mimeo®, Promethean®, Hitachi®, Sony®, and TURNING Technologies® (previously known as InterWrite®) continue to produce IWBs.

IWBs are a growing presence in classrooms (Balta & Duran, 2015; Bennett & Lockyer, 2008; Kearney & Schuck, 2008; Futuresource Consulting, 2014). Many documents on IWBs were published between 2005 and 2010, coinciding with the increasing presence in schools from the early to mid-2000s (DiGregorio & Sobel-

Lojeski, 2010; Hockley, 2013). Some information on IWBs appears in the grey literature, that is, in materials that have not been peer reviewed or published through recognised academic outlets such as journals and scholarly books. Perhaps the wide uptake of IWBs may be attributed to the claims made in such documents that IWBs increase the interactivity of lessons, revolutionise teaching, increase the attention of students (Beeland Jr, 2002; Villano, 2006), and encourage engagement and/or interaction (Whitby, Leininger, & Grillo, 2012).

Literature reviews to date have provided summaries of the particular areas of current research, but authors of earlier literature reviews have noted the dearth of research evidence available and/or the need for a more concerted effort to expand upon our current knowledge (DiGregorio & Sobel-Lojeski, 2010; Glover, Miller, Averis, & Door, 2005; Higgins, Beauchamp, & Miller, 2007). Existing literature reviews have addressed: 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 et. al., 2005; Higgins et. al., 2007; Smith, Higgins, Wall, & Miller, 2005).

Smith, Higgins, Wall, and Miller (2005) reviewed the literature that focused on school-aged children and reported that the claims of positive effects originated mainly from research exploring the views of teachers and students, but that there was inadequate evidence to support the purported benefits of IWBs. Five years later, DiGregorio and Sobel-Lojeski (2010), who also reviewed the literature on school-aged students, reported similar findings but also noted that the efficacy of IWBs may be due to "contextual factors", such as the school, teachers, and content (pp. 256-258).

Although scoping surveys can be used for a range of purposes, in general terms, they involve the synthesis of a wide range of non-research and research documentation and focus on providing an overview of the breadth of evidence, rather than depth (Davis, Drey, & Gould, 2009). In the current context, a broad overview of documents indexed in academic databases has the potential to provide a synopsis of the type of information that is available on IWBs, including research approaches, and offer insight into areas requiring greater attention.

This scoping survey aimed to provide an overview of both the literature available on IWBs and in particular the research relating to this technology. The survey reported here complements previous reviews of specific areas by looking at a broader range of documents and extends to more recent research. The research questions were:

1. What types of documents exist (refereed or non-refereed journal article, thesis or dissertation, book, conference paper, or grey literature)?

2. Did the documents report on IWBs only or IWBs along with other technology?

3. What were the ages of the students considered (primary, secondary, both, or unknown)?

4. For documents describing research, what research methodology was used (quantitative, qualitative, small-*n* design, group, descriptive, survey)?

Method

Search and Article Screening

The series of database searches were carried out from March to June 2014. Materials 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". This search resulted in a total of 1401 hits (828 documents from Academic Search Premier, 287 from A+ Education, and 286 from ERIC Proquest). When duplicates were removed, 1150 documents remained.

In screening, the title and abstract of each document were examined, and documents that did not meet the inclusion criteria were excluded. There were three inclusion criteria. Documents had to be written in English, include information about interactive whiteboards, and include information related to school-age children: that is, students in grades K to 12. Documents were included regardless of their status as peer reviewed or non-peer reviewed to ensure that the material collected would comprise a complete picture of the documents about IWBs in schools.

Reliability for screening

The first author performed this screening process, and a research assistant independently screened 20% (230) of the documents, using the same criteria for reliability purposes. The documents were selected by dividing the list of documents into thirds and selecting 77 documents from each third. Documents were taken from the beginning, end, then from either side of the midway point of the list of all documents. Reliability was calculated by using the formula agreements divided by agreements + disagreements multiplied by 100. Intercoder reliability for document selection was 80% (range: 79-82%). After the first screening step, 739 documents, which included refereed and non-refereed documents, theses, and grey literature, were retained.

Data extraction

Following screening, documents were categorised, and relevant data were extracted. Documents were categorised using publication information, such as source/journal name, title, and abstracts. Where 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; the refereed status of articles (by examining journal/source website), 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, or survey where analysis included numerical data and descriptive statistics) or qualitative (teacher/student/pre-service teacher, including case studies or survey where responses to open ended questions were analysed qualitatively); and whether the article was a literature review, descriptive article, product description, or general opinion (see Table 1 for categories and criteria). For some of the data extracted, for example, age of students, participants in surveys, and research methods used, documents could be counted in more than one category.

Table 1

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	Interactive Whiteboard (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 (research-based), survey (teacher/student/preservice teacher)
Qualitative Research	Teacher, student, preservice teacher; includes surveys and case studies
Other documents	Literature reviews/surveys, descriptive (non-research based) articles (e.g., how IWB can be or was used), product description, general opinion

Reliability for data extraction

To determine the reliability of data extraction, a research assistant was provided with training on the coding. Training consisted of reviewing and discussing the criteria. The author and the research assistant then independently coded the first 25 documents of the included 739. Reliability was then calculated using the formula agreements divided by agreements + disagreements multiplied by 100. Intercoder reliability for the initial 25 documents was 97%. Given the high intercoder reliability, the remaining 714 documents were equally divided between the author and research assistant to complete coding. After the first author completed coding, the research assistant independently coded 25% (n = 185) of the documents coded by the author. Intercoder reliability was 94%.

Results

Documents were categorised according to the source (see Table 2). Grey literature comprised 55% of the documents, and the remainder consisted of peer reviewed journal articles (37.5%), theses or dissertations (2.4%), books (1.7%), and conference papers (4%). A total of 216 documents (29.2%) were peer reviewed. Almost two-thirds of all documents (61.2%) solely described IWBs, 32% described primary aged participants, and 17.5% described secondary aged participants. There were 56 documents (7.6%) reporting on quantitative research, of which only 23 described experimental studies, and 151 (20.4%) documents reporting on qualitative research.

Table 2

Results of literature survey

Document type	Number of documents (% of total documents)
Peer reviewed documents	216 (29.2%)
Journal (refereed and professional)	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 documents (% of total documents)**
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 documents (% of total documents)**
Small-n intervention	11 (1.5%)
Group intervention	12 (1.6%)
Descriptive research	12 (1.6%)
Teacher survey	19 (2.5%)
Student survey	14 (1.9%)
Preservice teacher survey	2 (0.3%)
Qualitative research	**Number of documents (% of total documents)**
Teacher	120 (16%)
Student	68 (9.1%)
Preservice teacher	9 (1.2%)
Non-research peer-reviewed documents and grey literature	**Number of documents (% of total documents)**
Literature review	6 (0.8%)
Descriptive article	243 (32.4%)
Product description	89 (11.9%)
General opinion	261 (34.8%)

Note. Results from Table 2 state total numbers for each type, however, many documents could be classified in more than one category: for the age of participants, research method, type of participants, etc.

Grey literature

More than half of all documents were classified as grey literature and were mainly descriptive or ‘how-to’ articles. The largest proportion of documents was general opinion papers (261 documents or 34.8%) closely followed by descriptive articles (243 documents or 32.4%). Product descriptions accounted for 89 documents (11.9%).

Quantitative Research

Fifty-six documents were identified as reporting quantitative research, 41 (73.2%) of which were peer reviewed (See Table 3). Five documents were grey literature, and 10 were theses or dissertations. There were 11 small-n intervention studies. Three small-n intervention studies also included quantitative surveys, one of which also included a qualitative survey. There were 12 research-based descriptive studies. One of the descriptive studies included a quantitative survey, and three others included qualitative surveys. There were 19 teacher surveys. Seven of these surveys also included student surveys. Thirty-four of the 56 documents concerned primary-aged participants. Seven also concerned secondary-aged participants.

Table 3

Quantitative Research Results

	Number of quantitative documents	Percentage of total quantitative documents (n=56)	Percentage of total documents (n=739)
Article Type			
Peer reviewed	41	73.2%	5.5%
Journal	37	66%	5%
Thesis or dissertation	10	2.4%	1.4%
Book	0	0%	0%
Conference paper	4	7.1%	0.5%
Grey literature	5	8.9%	0.7%
Total documents	56	100%	7.5%
General characteristics	43	76.8%	5.8%
IWB only			
Primary aged participants	34	60.7%	4.6%
Secondary aged participants	16	28.6%	2.2%
Participants age unknown	13	23.2%	1.8%

Experimental studies

Experimental studies accounted for 35 documents reporting quantitative research, but only 15 were peer reviewed. Three out of the 11 small-n studies were peer reviewed (M. L. Campbell & Mechling, 2009; Mechling, Gast, & Thompson, 2009; Yakubova & Taber-Doughty, 2012). The outcomes for all three studies showed student

achievement when IWBs were used but did not show advantages of the IWB over other modes of instruction. M. L. 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 to present sight words to be learned. Yakubova and Taber-Doughty (2012) studied the effects of IWBs as a medium for video modelling on skill acquisition. The researchers examined ways to integrate technology rather than the effectiveness of the tool itself. The remaining eight small-n studies consisted of three dissertations, two non-peer reviewed documents published as grey literature, and three documents 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). Although three showed either better outcomes for the use of IWBs or that the participants preferred the IWB conditions (Dhindsa & Dhindsa, 2011; Hwang et al., 2013; Özerbaş, 2012), one showed no difference (Schroeder et al., 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 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 et al., 2013; Lopez, 2010; Thompson & Flecknoe, 2003), the problems encountered when using the technology (Mostertand & Needham, 2004), the limitations of using the technology (Coyle et al.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 documents published as grey literature and one non-peer reviewed conference paper.

Qualitative Research

Of the total number of documents, 151 were identified as reporting qualitative research (see Table 4). Of these, 125 (82.8%) were peer reviewed. Nine documents were grey literature, and seven were theses or dissertations. Qualitative research was also categorised into documents that described a 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 examined both teachers and pre-service teachers. In addition, there were 15 student-focus only documents, and eight student and pre service teacher-focus documents. Ninety-four of the 151 qualitative documents concerned primary-aged participants, 45 documents concerned secondary students, and 19 concerned both primary and secondary-aged participants. Thirty documents concerned participants of unknown school age.

Table 4

Qualitative Research Results

	Number of qualitative documents	Percentage of total qualitative documents (n=151)	Percentage of total documents (n=739)
Article Type			
Peer reviewed	125	82.8%	16.9%
Journal	119	78.8%	16.1%
Thesis or dissertation	7	4.6%	0.9%
Book	1	0.7%	0.1%
Conference paper	15	9.9%	2%
Grey literature	9	6%	1.2%
Total documents	151	100%	29.2%
General characteristics			
IWB only	56	37%	7.6%
Primary aged participants	94	62.3%	12.7%
Secondary aged participants	45	29.8%	6.1%
Participants age unknown	30	19.9%	4.1%

Trends

While the intention of the scoping survey was to provide an overview of the documents types available, some trends were noted in relation to the implementation and perceptions of IWBs, and these are briefly addressed.

Implementation of IWBs

Many qualitative documents 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, there 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; C. 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 on teacher and student perception was qualitatively and 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 explored 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., T. L. 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 the literature (Beeland Jr, 2002; Villano, 2006; Whitby et al., 2012). The results of this scoping survey show that most of the documents on IWBs located in academic databases are not research-based. Non-research documents consisted of literature reviews, descriptive articles, product descriptions, and general opinion documents. It is possible that teacher or practitioner demand drives the production of grey literature and descriptive documents. This might be due to the demand for assistance in using this tool in classrooms after schools have already committed to the technology.

Many documents (56.3%) failed to clearly specify the age of students being considered, with 32% identifying primary-aged students and 17.5% secondary-aged students. From the information that was provided on student age, there seems to be almost double the number of documents on primary students compared to secondary students. This may be a result of the generic, general nature of grey literature or may, in fact, be due to an interest in primary-based research. Thus while this finding might indicate that more research is needed that has a focus on secondary students, it may merely reflect the lack of specificity in the grey literature.

Documents that focused on IWBs exclusively accounted for just over half of all documents (61.2%), with the remaining documents addressing a range of technology. It is possible that this reflects the perception of IWBs as an integrated part of a suite of technological tools at the disposal of educators and that, again, grey literature, in general, is more generic rather than providing an in-depth analysis.

There were a surprisingly limited number of documents reporting on research, and the majority of these presented qualitative research. Qualitative research can provide rich descriptive insights but is not well suited to addressing causal questions and to providing information on efficacy. Quantitative research accounted for a small proportion of documents. This finding is consistent with those of previous reviewers (e.g., DiGregorio & Sobel-Lojeski, 2010; Kennewell & Beauchamp, 2007). Only a small number of experimental studies were identified, and at least half of these were dissertations. There were only three small-n experimental studies that were peer reviewed, and each of these examined students with disability (M. L. Campbell & Mechling, 2009; Mechling et al., 2009; Yakubova & Taber-Doughty, 2012). The small number of group intervention studies included only five peer reviewed documents (Dhindsa & Dhindsa, 2011; Hwang et al., 2013; Mark & Kobsa, 2005; Özerbaş, 2012; Schroeder et al., 2011) and, of these, only three showed positive outcomes or preference for the use of IWBs (Dhindsa & Dhindsa, 2011; Hwang et al., 2013; Özerbaş, 2012).

It has been claimed that IWBs: increase learning achievements (e.g., Cheung & Slavin, 2011; DiGregorio & Sobel-Lojeski, 2010; Liles, 2005); provide a greater variety of and/or innovative affordances (e.g., Bruce et. al., 2011); and enhance learning, participation, and engagement (e.g., Harlow et. al., 2010). However, these claims typically rely on qualitative data, rather than experimental studies, or are anecdotal. Thus, it appears that there has been relatively limited quantitative exploration of IWBs and, in particular, limited experimental research examining efficacy. Experimental research is required to draw strong conclusions about causal inference (D. T. Campbell & Stanley, 1963), and there appears to be a need for further such studies in examining IWBs and their effect on engagement, student achievement, and other benefits, which have been claimed in the nonexperimental research and grey literature.

Still, some claims have been supported by experimental data, albeit limited in quantity. These include that: IWBs can assist with learning acquisition (M. L. Campbell & Mechling, 2009; Mechling et al., 2009); IWBs can be interactive, adaptable, and multifunctional (Yakubova & Taber-Doughty, 2012); they can enhance teaching approaches in order to promote academic gain (Dhindsa & Dhindsa, 2011); students are more positive towards IWBs rather than other instructional delivery methods (Hwang et al., 2013); and they can be used to increase academic gain in comparison to a control group (Özerbaş, 2012). Nevertheless, there appears to be a considerable gap between what is claimed and what has been demonstrated with regard to the benefits of IWBs to learning generally and in comparison with other methods of delivery.

It is possible that the lack of research evidence, in general, is due to the difficult nature of carrying out research of this kind, especially in non-clinical environments such as schools. Nonetheless, such research is clearly needed to evaluate the substantial investment in IWBs and assist in future policy decisions regarding educational resourcing.

Limitations

The limitations of the current review need to be acknowledged. The survey was restricted to documents 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. As it is a scoping survey, the review does not provide any detailed analysis of methodology and results. Consequently, the findings are broad and reflect the general nature of publication in the area. A final limitation of this work is that the search was restricted to three academic databases. Although they represent major education databases, use of additional databases may have identified more relevant documents. Considering the scoping survey nature of this review, more in-depth reviews could include a greater reflection of the current literature by including sources such as websites, blogs, and the like.

Recommendations for future research

The relatively limited amount of experimental research found through this scoping survey highlights the need for additional studies. Given the results of this survey, several recommendations can be made. First, there is still an obvious need for more research to be conducted (Smith et al., 2005) to investigate claims about the effects of using IWBs in education. A recurring theme in the documents was the examination of the perceptions of teachers and students regarding IWBs. Although research of this nature is both necessary and helpful to practitioners, it does not negate the need for more experimental studies to ascertain what objective effect an IWB has on a student, a teacher, and a classroom as a whole. This would provide evidence to support or negate the perceptions held by teachers and students. Second, there is a need for measurement of long-term gains in IWB research (Glover et al., 2005). Last, there is a need for research with larger groups of participants and with a wider range of participants, including those with disability (DiGregorio & Sobel-Lojeski, 2010).

Conclusion

In sum, the documents identified were predominantly grey literature and consisted mainly of practical guides for use, general opinion, and descriptive accounts of how IWBs have been used. Considering the breadth, type, and interest in research in relation to IWBs, it is interesting to note that there are so few research studies to date, particularly experimental studies. There would appear to be needed for further quantitative research before IWBs can be considered an evidence-based technology.

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