6-1-2017

Interactive Whiteboards in the Elementary Classroom: Efficacy and Funding

Audrey Hebing
Western Oregon University

Interactive Whiteboards in the Elementary Classroom: Efficacy and Funding

By
Audrey Hebing

An Honors Thesis Submitted in Partial Fulfillment of the
Requirements for Graduation from the
Western Oregon University Honors Program

Prof. Marcus Wenzel,
Thesis Advisor

Dr. Gavin Keulks,
Honors Program Director

June 2017

Table of Contents

Abstract

New and changing implementations of technology in educational facilities are providing further opportunities and tools for teachers. However, controversy exists over whether or not there are academic benefits to utilizing these tools, as well as the degree of those potential benefits or detriments. Additionally, not all facilities and educators have access to the same equipment, as not all schools receive the same amount of funding. My thesis topic will focus on a specific educational tool, the interactive whiteboard, in the elementary classroom. I will be working with preexisting research and studies to compare and contrast the current literature on this subject. The purpose will be to not only analyze the efficacy of interactive whiteboards as a teaching tool, but also to look at the disparity that could arise in the quality of education between financially disadvantaged schools and more financially prosperous schools if the interactive whiteboard is indeed truly beneficial in the classroom.

Introduction

With new and changing implementations of technology in educational facilities and the constant new resources becoming available, interactive whiteboards (IWBs) have stood out as one of the more prominent and sometimes controversial tools in schools. IWBs are touch-sensitive screens which can be controlled by and collaborate with computers and projectors. While educational and pedagogical theories regarding these devices are still developing, interactive whiteboards are most widely used in schools, and have been gaining prominence as a potential tool for enhancing learning since they first became widely known. In 2013, 45% of classrooms in the United States had implemented IWBs; although this pales in comparison to the United Kingdom, which doubles that percentage to 90% (Orbaugh, 2013). The data presented through these statistics shows a significant increase over the past decade and signifies the relevance of understanding and analyzing their use in the educational system due to their rising abundance. The following literature review will explore the research surrounding IWB uses, funding sources, technology efficacy, and the digital divide.

Technology in the classroom can actually mean many things. As a whole, classroom technology can include anything that is man-made and used in the classroom. This means that everything from IWBs, calculators, and pencils can be considered classroom technology. However, for the purpose of this paper, the word technology will be primarily used to refer to more modern, electronic tools such as IWBs that have only recently come into more widespread use in classrooms. While in decades past, classroom technology mainly consisted of relatively cheap and simple technologies such as pencils

and dry-erase whiteboards, the advancement into more electronic technologies has brought a massive amount of modern tool to the forefront of the classroom technology discussion. Additionally, due to the higher expenses of electronic technologies, these advancements have created higher likelihoods for lower income schools to potentially suffer due to the unavailability of funding for these modern technologies. Whereas in the past, higher income and lower income schools could be relatively close in terms of availability of classroom technologies, the high cost of new electronic technology has widened the technology gap between schools. This gap creates the possible problem that lower income schools could be missing out on the latest strategies and resources for improved teaching and instruction.

Because the connection between efficacy and school funding is one that has not received much exploration, the literature being examined here is meant to relate to this central issue in an effort to provide some connection amongst the research and studies that do exist. The research this thesis project aims to accomplish is intended to provide an answer to how the efficacy or lack thereof in IWB instruction can be compared to schools without IWBs, and how the potential barrier of the cost could affect low-income schools. The purpose will be to analyze the efficacy of interactive whiteboards as a teaching tool and to look at the potential disparity in the quality of education between schools that can and schools that cannot afford IWBs. The relevant literature being reviewed should provide background and inform relevance to this project, as well as contributing to any connections that may exist. The scope will briefly cover the general discussion of multimodal technology in education, touching more comprehensively on

various case studies and pros and cons of interactive whiteboards specifically. Lastly, research will be analyzed relating to the issues of school and technology funding and the implications for economically disadvantaged schools.

The purpose of this thesis project is to analyze the efficacy of interactive whiteboards as a teaching tool and to look at the potential disparity in the quality of education between schools that can and cannot afford Interactive White Boards (IWBs). For the purposes of this project, "efficacy" will refer to improvements in student learning and engagement. This paper aims to first gather and centralize the most relevant research and data on the subject of IWB and technology in the classroom, then compare and contrast both the efficacy and availability of these technologies between higher and lower income schools. Upon analysis of this existing research, I will devise potential methodologies and focuses for further research into the subject of IWBs and technology in the classroom. This paper will serve as an introduction for further research as a centralized source of information on history, funding, and efficacy of IWBs in classrooms, and the differences in availability between high income and low income schools.

Interactive Whiteboards are interactive display screens that can either be standalone computers themselves, or are devices that can connect to an existing computer to display full screen. As the name implies, IWBs have much more interactive capabilities than a simple whiteboard or projector, and can be used for a much wider variety of purposes than simply display – students and teachers can interact directly with the IWB screen through touch, and the accompanying software can be used to create

games, interactive equations, and more which can be used within a lesson. While many newer forms of technology are making their ways into the classroom (such as e-books, tablets, and Chromebooks), IWBs are perhaps the most relevant to studies strictly on usage in schools due to their rising implementation and the abundance of educational software designed specifically for IWB use (National Education Association, n.d.). While technologies such as tablets are widely used in many fields and personal life, IWBs and IWB software are most often designed specifically with education in mind.

One important area of research involving IWBs is availability, and how that differs between low and high income schools (Northcote, Mildenhall, Marshall, & Swan, 2010; Smith, Higgins, Wall, & Miller, 2005; Slay, Siebörger, & Hodgkinson-Williams, 2007; Songer, 2006). IWBs can be quite expensive, and installing them in even a few classrooms, let alone an entire school, can require significant resources. While resource-rich schools may be able to reap the benefits of successful technological implementation, low-income schools may not only struggle with the cost of the tool itself, but also with the resources to effectively train teachers in IWB use in order to use the IWB properly in the classroom (Songer, 2006). This expense may lead to lower income schools being unable to provide IWBs for their classrooms and students. I will further compare research into the availability of IWBs in both high income and low income schools to determine how large the discrepancy in availability and budget may be. In addition, I will also compare levels of efficacy. How much do IWBs truly benefit student learning? Is there a difference in efficacy between different schools? Finally, are teachers properly trained on use of these new technologies, and do they make proper use of them?

Recommendations from this paper could serve as a centralized resource from which to build research into IWBs in the classroom. The outcomes will focus on two areas. The first area of focus is the gathering and comparison of the existing research in the field. The second area of focus will be on devising new questions and methodologies for further delving into the field of technology in the classroom. Technology in schools isn't going anywhere, and will only continue to advance and spread, so further research into the field could help to improve the efficacy of the technology, impact availability in more schools, and improve the knowledge teachers have of technology so that they can use it more efficiently.

Literature Review

History – From Chalkboard to Interactive Whiteboard

The history of the IWB extends back to an early classroom technology that most people today are more likely to see on television than in a classroom: The chalkboard, or blackboard. The history and initial use of the chalkboard in classrooms is difficult to pinpoint, but goes as far back as usage in music classrooms in the 16th century (Owens, 1998.)

The chalkboard, however, had the distinct disadvantage of the calcium dust produced by writing with the chalk. Concerns over student health and allergies (imagine the student coughing and gagging through clouds of dust as they clean the erasers), along with the possibility of electronics being damaged by the dust led to the rise of whiteboards in classrooms in the 1990's (Wojenski, n.d.). Rather than using chalk which could produce this potentially harmful dust, whiteboards used dry-erase markers that could easily be erased time and time again. Aside from the materials used, however, the actual functional capabilities of whiteboards were identical to that of chalkboards.

While the first commercially accessible IWB was introduced in 1991 (National Education Association, n.d.), and classrooms began shifting from chalkboards to whiteboards, it took a while for them to catch on. Usage is also more common in the UK than the US. In 2008, roughly 70% of schools in the UK had access to IWBs, while only 16% in the US did (National Education Association, n.d.). Those numbers have still been growing, and in 2013, US schools had increased to 45% availability of IWBs, and the UK to 90% availability of IWBs (Orbaugh, 2013).

IWBs can function in different ways, but all involve increased interactivity with the materials displayed on the board. They can either be standalone computers, or hookup to existing computers to control and interact with them. The technology used for the IWB screen interaction typically takes three forms (resistive technology, electromagnetic technology, and laser scanner technology), which also vary with the cost of the IWB.

Perhaps the most well-known type of IWBs (including the SMART brand IWBs) uses resistive technology. This is simply a touch screen functionality using pressure applied to the screen to interact, so an operator could use any materials, including their own hands to control the IWB. These are also often the cheapest form of IWB. The second type of ISB uses electromagnetic technology for interaction. With these IWBs, a specific pen with a metal tip must be used to interact with the screen, but it is also more precise than simple touch technology. Finally, the most expensive type of IWB, are the laser scanner IWBs. These IWBs have infrared scanners in the corners of the board that detect the pens, or styluses, for interaction, and are very precise. These also typically have a harder surface, and can easily be used as a regular whiteboard with dry-erase markers (Watson, n.d).

Interactive Whiteboard Use and Funding

In the midst of this implementation, a multitude of research investigating various areas of implementations and uses exists and is in progress. Many opportunities for research exist because there are so many ways in which IWBs can be used within an educational context. "The use of IWBs has been reported as ranging from teacher

centered, or presentational, to methods which are more student-centered, interactive and collaborative" (Northcote et al., 2010, pg. 494). In other words, IWBs used in a primarily teacher-centered context are being used to present a lesson to the students with little student interaction, while IWBs used in a more student-centered context allow for greater interactivity and involve students further in the lesson. This description of the range from teacher-centered to student-centered uses outlines two of the most essential and broad aspects of this research, which are how it can benefit and enhance the educational experience for students, and for teachers. Many of the existing case studies examined student performance and how this may or may not be impacted by the use of interactive whiteboards as an instructional tool in the classroom (Özerbaş, 2012; Becta, 2003; Liang et al., 2011). Other scholars surveyed staff and teacher opinions and perceived results in the classroom (Türel, 2011; Türel, 2012; Alexander, 2011). Much of the available literature focuses on both the pros and cons of IWBs based on the findings from field research (Northcote et al., 2010; Smith et al., 2005; Schmid, 2008).

The amount of funding allotted to schools significantly impacts the resources available to staff and students. "Integrating technology into the classroom and the lack of sufficient funding to purchase up to date technology are two issues that many schools are facing today" (Greer, 2010, pg. 2). In other words, the fact is many of these new technological tools becoming popular in classrooms, especially IWBs, can be very expensive and many schools do not have the funding to acquire and distribute these resources or ensure that their teachers are properly trained in their use.

Along with the question of how effective these are as a teaching tool is whether or not they are worth it; these two aspects have been researched and analyzed each on their own – several case studies have collected data on efficacy and potential benefits (Glover & Miller, 2001; Ashfield & Wood, 2008; Moss, Jewitt, Levaãic, Armstrong, Cardini, & Castle, 2007; Lovell, 2014; Brun, 2008; Coyle, Yañez, & Verdú, 2010; Özerbaş, 2012; Becta, 2003; Liang et al., 2011), and other research discusses the cost of IWBs (Greer, 2010; Songer, 2006; Somekh, Haldane, Jones, Lewin, Steadman, Scrimshaw, Sing, Bird, Cummings, Downing, Stuart, Jarvis, Mavers, & Woodrow, 2007) – but few studies and articles take both into consideration when asking and answering questions. The Primary Schools Whiteboard Expansion Project and its subsequent evaluation (Somekh et al., 2007) touches on both of these factors in a single context, although much more room remains for further and more in-depth research into this area. While the combined factors of efficacy and funding will be discussed in greater detail later on, it is important to note that in the question of how effective IWBs are, it needs to be taken into consideration that some schools could be at a disadvantage if being deprived of these resources means a lower quality of education.

Perhaps the biggest question asked when bringing up the idea of introducing IWBs into schools is the cost (Greer, 2010). In actuality, the price range for IWBs is quite large, although the cheaper ones tend to lack many of the features and quality of the more "average" to high-priced IWBs. The cheapest of the cheap IWBs can cost around $470, while the most advanced and expensive IWBs can reach nearly $10,000.

That said, "mid-range" IWBs typically cost around $3,000 to $4,000 (Touchboards, 2017).

Clearly, unless a school wants to risk using very cheap or potentially inferior IWBs, the cost to acquire and integrate IWBs into a school can be great. Studies have shown that a school's budget can be the greatest barrier preventing schools from adapting new and expensive teaching technology (Mills, 2012). A survey of preK-12 teachers showed that 63% of teachers consider the school's budget to be a continuing barrier to integrating new technology. When isolated to teachers in low-income schools, 70% of them said that school budget was the main barrier restricting them. Additionally, while basic computers and computer resources are available to the vast majority of teachers, high income schools were over twice as likely to have access to newer classroom technologies like tablets and IWBs (Mills, 2012).

With budget concerns affecting many schools, particularly those in lower income areas, it becomes worth asking whether or not IWBs are even worth the purchase price. While it could be hard to put a price on the potential increases in student engagement and learning, opportunity cost is still a major factor to consider. "Opportunity cost" refers to potential benefits or gains that could be achieved through an alternative choice when one option is chosen. Opportunity cost does not just involve actual monetary costs, but also the cost of what could have been done if other actions were taken. In the case of IWBs, let us consider the following: If an "average" IWB costs $3,000, and a school has 10 classrooms to install them in, it would cost them approximately $30,000, as well as the time spent training teachers to use them properly and integrate them into the

classroom. Of course, there is the question of whether or not that would fit in the budget at all, but there is also the question of what else could the school have spent their time and money on? How many new textbooks, or desks, or other classroom materials could have been gained with that same money?

Technology Efficacy

For the purposes of this paper, efficacy refers to quantifiable improvements in student test scores and grades (as applicable, relevant to the specific content area or lesson in which the IWB is being used), as well as an increase in student interaction and engagement within the relevant lesson (Swan, Kratcoski, Schenker, & van 't Hooft, n.d.). "Benefits" refer to overall improvement in student performance and learning, as well as more effective teaching and greater possibilities for instruction. "Detriments" refer to high expense, opportunity cost, and any restrictions of teaching styles. The research that follows will discuss case studies and collected data which informs how effective IWBs have proven to be in the past, and in which contexts.

In general, there have been many positive reports from schools granted access to newer forms of technology in their instructional methods (Özerbaş, 2012; Liao, 2004; Becta, 2003; Liang et al., 2011). A study in Taiwan found computer-assisted instruction to be more effective than traditional instruction without the use of computerized tools to enhance student learning (Liao, 2004). Many positive outcomes in schools have resulted from technology based on solid research by teachers and administrators. According to Liao (2004), the essential take-away from this is that "improvement of students' academic achievement are possible" from the use of technology and computers in the classroom

and further research is needed to determine this based on varying factors for various specific teaching tools (pg. 229). Another analysis of thirty-two separate studies determined that "computer-based education has generally had positive effects on the achievement of elementary school pupils" in the United States in the earlier stages of technological innovations integrating into schools (Kulik, 1985, pg. 59). These results show that the advent of modern technological tools have had a quantifiably positive impact in student education. Since then, computerized instruction has become "the norm" in some format in all modern classrooms, allowing research to more selectively target specific types of computerized technology and their implications for education, such as interactive whiteboards.

Studies have been conducted regarding IWBs as teaching tools in a variety of content areas (Coyle, 2010; Schmid, 2008; Wood & Ashfield, 2008; Vita, Verschaffel, & Elen, 2014). Many of these are specific to a particular subject such as Math or Bilingual Studies, while some focus on specific grade levels or geographical areas. These studies typically either focus on student achievement or teacher perception. One unifying topic of discussion that occurs in many of these reports is the lack of efficacy when the teachers are not trained or enthusiastic and do not utilize the IWB to its fullest potential. One study investigated the widespread implementation of interactive whiteboards in one secondary school in an attempt to assess the consequent pedagogical impact (Glover & Millar, 2001). Glover and Miller (2001) found "despite good intentions by many staff it may well be currently underused" which can lead to less than satisfactory results of implementations in schools (pg. 270). In other words, teachers may perceive they are

using IWBs effectively in their classroom when in fact there is much more teachers can do with this tool. The authors concluded that there were no benefits to student learning or engagement when teachers do not use it properly, as it is most effective as a multimodal facilitator – a tool communicating in a variety of different ways and being utilized in a variety of different functions – rather than a glorified projector simply used for dual-screen purposes. They reported IWBs were also really only effective in classrooms where the students were well-managed and receptive to learning, as they would not devote their attention to this new and unfamiliar piece of technology otherwise. Essentially, although the entire staff reportedly showed enthusiasm for the new IWBs, those who were not properly trained or did not know how to use it properly were unable to maximize the efficiency and efficacy in the classroom. This finding was supported in another report on the London Challenge, which I analyze next.

A research study was conducted on large-scale IWB implementation across several schools in London to assess the resulting impact in a variety of areas (Moss et al., 2007). Like Glover & Miller (2001), this study focused on the pedagogical impacts over the technological. Moss et al. (2007) found if used effectively, the integration of IWBs allowed for an "increased pace of delivery, increased use of multimodal resources, [and] a more interactive style of whole class teaching" (pg. 6). In other words, IWBs used within a lesson facilitated a more engaging and involved lesson for both the teacher and the students. This information also tells us that teacher competency with IWB use was directly tied to an IWB efficacy and an increase in positive educational outcomes. This increase was only in the most optimal of cases, however, as many teachers ended up just

using them as projectors. Mostly due to issues such as this, scholars found IWBs to be ineffective for enhancing learning if technology is placed above pedagogy.

Lovell's (2014) report on IWB integration in primary grade reading instruction places a great deal of importance on pedagogical goals as well; when used effectively, the conglomeration of functions provided by the IWB can enhance already effective pedagogy to improve the overall quality of education in the classroom (Lovell, 2014). The presence of the IWB has the potential to change how education is delivered, but this potential change is dependent on the skills and training of the educators. When surveyed school-wide, the teachers were found to perceive the IWB as being effective only if teachers knew what they were doing and were capable in utilizing it in the classroom. The pedagogical focus is strengthened in studies like this where a particular subject matter is being considered. Wood and Ashfield's (2008) case study is another example of this.

In order to research the purported interactive aspects of the interactive whiteboard, Wood and Ashfield (2008) investigated the IWB as a creative tool for teaching and learning in the subject areas of literacy and mathematics. In the context of these particular subject matters, it was determined that the context – for example, grammatical structure or mathematical manipulatives – and the purpose or learning objectives are the most influential factors in learning. The authors asserted it is essential to create a learning outcome to guide all interactions with the IWB rather than letting the technology guide the teaching (Wood & Ashfield, 2008). Similarly to other studies, interview results from the staff at the school in question further reinforce the idea that

training is essential as efficacy of the IWB is entirely dependent upon the teacher. As Wood & Ashfield wrote,

> This research seems to indicate that it is the skill and the professional knowledge of the teacher who mediated the interaction, and facilitates the development of pupils' creative responses at the interface of technology, which is critical to the enhancement of the whole class teaching and learning processes (84).

In short, this means that teacher competency and ability to effectively use IWBs is the most important factor in student learning and engagement. This quotation collaborates with many of the key ideas in the research so far – rather than providing black and white answers, most of the findings show efficacy is dependent upon the quality and expertise of the instructor. Even teachers themselves understand this, agreeing IWBs can only be used to facilitate learning and instruction under the following conditions: "collaboration with colleagues, training in effective strategies, and more frequent use to improve competency" (Türel & Johnson, 2012, pg. 381). In short, effective IWB use requires time and training. However, studies within some specific disciplines have been able to provide more definitive results regarding IWB efficacy in schools.

One instance of these results is shown through a study on IWB use in ESL (English as a Second Language) immersion classrooms by Coyle et al (2010). This study's authors found the IWBs were actually extremely ineffective in instruction to ELL (English Language Learner) students; this was credited to a failure to promote verbal interactions within the classroom (Coyle et al. 2010). Like the above studies, this could be

due to teachers not utilizing it properly, but Coyle et al. indicated the English-speaking students had less problems whereas the ELL students were further alienated from a lack of verbal communication and effort for understanding because they were expected to just interact with the IWB as a learning tool which took away from interactions with the teacher and other students. According to the authors, teachers' interactional competence – or ability to involve and engage all students within the classroom, rather than specific sub-groups – should be developed alongside technological skills, and in doing so there is a potential for positive impacts on classroom interactions. In regards to ESL education, this potential for "supporting comprehension and promoting output" is even more important. In order to achieve this, the authors assert that more research is needed in relation to bilingual and multilingual applications of IWB before they can really be effective (Coyle at al. 2010).

Controversy does exist over whether or not there are truly academic benefits to utilizing these tools, as well as the degree of those potential benefits or even detriments. As we have seen, measurable academic benefits are tied to teacher competency, and differ based on subject matter and discipline. In addition to the multitude of case studies analyzing the impacts of implementation in specific schools, much of the existing literature on the subject presents an analysis of the pros and cons of interactive whiteboards (Northcote et al., 2010; Smith et al., 2005; Schmid, 2008; Slay et al., 2007; Chamblee, 2013).

The literature suggests that interactive whiteboards are educational tools that increase levels of interaction, communication, collaboration and engagement in both

learning and teaching situations (Özerbaş, 2012; Liang et al., 2011). According to Mildenhall, et al (2010), there are many possibilities to attain these benefits, as IWBs could be used for revision, review, and reinforcement purposes in student centered learning. IWBs certainly have the potential for increased class interactivity if utilized correctly – however, in order for the full potential of this tool to be realized, interactivity needs to be explicitly considered in terms of learning goals and outcomes (Mildenhall et al., 2010). This means that IWBs cannot be effective simply as another tool; they need to be integrated into lesson planning and their full capabilities taken into consideration as the teacher forms the lesson. IWBs in the classroom provide opportunities for student-centered understanding, active participation, and improved teacher presentations, as well as having a positive influence on learning and sharing information, and in many cases data has been collected to support positive effects on student achievement academically (Özerbaş, 2012). This data is largely gathered from pre-existing case studies from specific schools or classrooms (Glover & Miller, 2006; Wood & Ashfield, 2008; Moss, 2007; Lovell, 2014; Brun, 2008).

There are several factors within the classroom that impact efficacy, and provide opportunities for further research. IWBs have been shown to be most effective when used in lessons where their purpose is explicitly guided in terms of learning targets or objectives and desired lesson outcomes, as well as when integrated into lessons with the purpose of creativity and innovation (Mildenhall et al., 2010). Other important factors include teachers' methodological choices and teachers' pedagogical beliefs and implementation of those beliefs (Schmid, 2007). All of these factors are highly fluid and

subjective to the situation and environment, inviting many further opportunities for research and evaluation in specific areas.

This conditional nature of IWB efficacy and the lack of extensive quantifiable date creates further questions about the efficacy of IWBs, and whether they might actually be detrimental to fostering a positive learning environment in the classroom. McCrummen (2010) cites the possibility that IWBs could "lull teachers into not using what we consider good instructional strategies" in the process of planning lessons, and instead relying on the glamour and innovational appeal of an interactive tool instead of delving into solid pedagogy in lesson planning. This means that providing explicit instruction to teachers on effective IWB use and functionality is essential to effective IWB use in lessons.

With regards to efficacy and benefits to student learning, the most important factor is teacher competency. Glover and Miller (2006) discussed that teachers cannot use this tool to its maximum efficiency and efficacy without training and experience. Moss et al (2007) agreed that IWBs are ineffective when teachers are not trained and lack of familiarity with relevant design principles keeps them from being as effective as possible and from creating their own lessons using IWBs. Consequently, it is important it is for teachers to be properly trained in the use of the specific technological tools that are available to them within their classrooms, which can be an additional cost to schools and school districts based on the availability of professional development opportunities and teacher instructors within the district. Teachers themselves believe IWBs can be used to facilitate learning and instruction under the following conditions: collaboration with

colleagues, training in effective strategies, and more frequent use to improve competency (Türel, Y. K., & Johnson, T. E., 2012). These three factors are supportive of how much teachers need to be trained – they are just as aware of this as administration and researchers.

All of this research shows that whether or not IWBs are effective tools in the classroom cannot be answered as simply positive or negatives. There are a multitude of factors which determine the efficacy of IWBs in the classroom. However, the summation of this research does tell us that IWBs have the potential to be used as effective instructional tools in the classroom under the right conditions. Specific measurements and data regarding efficacy under the ideal classroom conditions would be an area requiring more in-depth research within this field.

Digital Divide

The term "digital divide" refers to the lack of equality between those who have access to modern technological tools and those who do not. The digital divide generally refers to economic and social inequality, but this paper is focusing on the economic side of the divide. In the context of this discussion, those affected are the larger entities of schools and school districts, encompassing the individual students and teachers involved as well.

Research conducted under the Primary Schools Whiteboard Project has found that having interactive whiteboards in the elementary school classroom can be very beneficial for both the teacher and the students. The same project also suggested that it is worthwhile to provide funding to schools for the purpose of acquiring this specific

technology (Somekh, 2007). Several case studies provide data and survey results that support these benefits. Brun (2008) found a measurable increase in student engagement over a six-week study in a contained classroom. Lovell (2014) reports that teacher perception of IWBs is positive and they are seen as effective classroom tools, if the teacher has been trained properly in how to implement the IWB into their regular instruction. (Özerbaş, 2012; Türel, 2011; Becta, 2003; Liang et al., 2011)

School funding varies based on several factors, such as level of education, various sources of funding, and individual state laws and policies. There are many different demands for this funding. As many schools struggle with funding for much more basic educational resources, like general school supplies, teacher salaries, and support staff, spending scarce dollars on IWBs can be a controversial decision. Underfunded schools might not place a very high priority on new technological tools, and many schools opt against pursuing funding for interactive whiteboards if they have decided the academic benefits will not outweigh the costs. Many educators turn to grant-writing in order to acquire tools such as IWBs, which can be a very time-consuming and lengthy endeavor (Greer, 2010). According to Greer (2010), lack of sufficient funding is a significant issue in the integration of technology into the classroom.

Insufficient funding carries many possible implications for financially disadvantaged schools. Not all facilities and educators have access to the same equipment, as not all schools receive the same amount of funding. If having interactive whiteboards in the early elementary classroom does indeed provide significant benefits to student learning, then children born into economically disadvantaged school districts will

be experiencing a lesser version of this education. Students who progress to levels of higher education and encounter these forms of technology later will be less prepared from the start. If using an interactive whiteboard to teach a class of third-graders greatly increases their learning and understanding, then a class of third-graders in a school without the necessary funds to afford one could be at a disadvantage.

The purpose of this thesis project is to analyze the efficacy of interactive whiteboards as a teaching tool and to look at the potential disparity in the quality of education between schools that can and schools that cannot afford IWBs. In my review of the literature, I consolidated existing research through a comparative analysis of relevant sources. In the following section, I will discuss potential methods and focuses for further research and studies into the subject of IWBs and technology in classrooms.

Discussion

Implications

The purpose of this thesis project is to analyze the efficacy of interactive whiteboards as a teaching tool and to look at the potential disparity in the quality of education between schools that can and cannot afford Interactive White Boards (IWBs). By observing the results of existing research into IWB's, there are significant implications we can draw. We know that IWBs can be very expensive, and difficult for lower income schools to afford. This problem contributes to the digital divide between lower income schools and higher income schools. We have also seen through existing research that IWBs, when implemented effectively, can increase both student learning and engagement. The key phrase here is "when implemented effectively;" if teachers using IWBs are not properly trained on their use, and how best to apply them as tools to improve student learning and engagement, the potential of the IWB can be nullified. The financial strain that implementation of IWBs can have on a school is only increased when taking into account the time and resources needed to train teachers on proper IWB use and implementation.

With the high financial cost of IWBs, along with the resources needed to properly train teachers on their use, the digital divide between low and high income schools could increase. We already live in a society where the divide between low income and high income families is growing increasingly large. With high income schools and students gaining access to improved teaching that low income schools and students do not have,

that divide only seems to have the potential to grow. Ensuring that all schools have access to the best possible forms of educational tools is crucial to decreasing the size of this divide.

Recommendations

Based on efficacy findings presented in this paper, the financial cost of the IWBs is only worthwhile if the school also has the resources available to properly train educators. While several of the studies discussed here have shown benefits to student learning and engagement, they are not consistent across all studies, and the efficacy of IWBs is highly dependent upon teacher competency. Because of this, the benefits might not be great enough to support low income schools diverting funds to the implementation of IWB technologies.

More research in a variety of areas is necessary if IWBs are going to be effectively implemented in a widespread context. A large portion of the existing research on IWBs in classrooms is based on perception and the views of teachers and students, with many fewer studies definitively assessing the impact on student learning. Far more research is needed in terms of efficacy – while there are several case studies in the existing literature, further data collection and analysis is necessary to really assess the efficacy of IWBs in the classroom (especially pertaining to specific grade levels or content areas) beyond the collection of school-specific or smaller-scale case studies that currently exist. In order to effectively collect further research, teachers involved in the study need to be explicitly trained regarding proper and effective use of IWBs, so that researchers can be more

certain that the benefits from IWBs are actually being taken advantage of. Further research following improved training practices could create clearer results for whether or not the benefits outweigh the financial cost of IWB integration.

Further research into IWB use within specific grade levels and content areas would provide a more comprehensive look at the topic in terms of efficacy. Teaching styles can differ drastically between elementary, middle, and high school. Are the capabilities offered by IWBs more easily integrated into certain levels of education, or more helpful to students of different levels of mental development? Teaching styles, demands, and needs can also be drastically different across varied content areas at the secondary level. How can IWB use be maximized in different areas of teaching?

With technology constantly steaming ahead, and schools struggling to keep up due to funding and other barriers, further research into IWBs and other new classroom technologies is crucial in helping educators keep up. The purpose of this thesis project was to analyze the efficacy of interactive whiteboards as a teaching tool and to look at the potential disparity in the quality of education between schools that can and schools that cannot afford IWBs. I hope to provide a centralized point of reference to build on further research based on the areas which have been discussed here.

Bibliography

n.a. (2017) Smartboard interactive whiteboards. *Touchboards*. Retrieved from http://www.touchboards.com/smartboard/interactive-screens-whiteboards/interactive-whiteboards/#/smartboard/interactive-screens-whiteboards/interactive-whiteboards/?pg=2&F_Sort=3.

Alexander, S. M. *Teacher perceptions on the effectiveness of interactive whiteboards in the classroom.* University of Nebraska, 2010.

Bey, Marie A.. *The Negative and Positive Characteristics of Teacher Technology Professional Development Programs in Relation to Effective Classroom Integration and Knowledge of Interactive Whiteboards*. Philadelphia: Saint Joseph's University, 2012. Print.

Bielefeldt, T. (2005). Computers and student learning: Interpreting the multivariate analysis of PISA 2000. Journal of Research on Technology in Education, 37(4), 339-347.

Blok, H., Oostdam, R., Otter, M. E., & Overmaat, M. (2002). Computer-assisted instruction in support of beginning reading instruction: A review. Review of Educational Research, 72(1), 101-130.

Brown, David G., et al. *Interactive Learning: Vignettes from America's Most Wired Campuses*. Bolton: Anker Publishing Company, Inc., 2000. Print.

Brun, E. F. *The effect of using a smartboard during instruction in a sixth-grade classroom*. Melrose Park: Gratz College, 2008.

Camnalbur, M., & Erdogan, Y. (2008). A meta-analysis on the effectiveness of computer assisted instruction: Turkey sample. Educational Sciences: Theory and Practice, 8(2), 497-505.

Coyle, Y., et al. "The impact of the interactive whiteboard on the teacher and children's language use in an ESL immersion classroom." *ScienceDirect*. Spain: Universidad de Murcia. (2010) pp. 614-625.

DeMonte, Tony. *Interactive Whiteboards in the Elementary Classroom*. Washington, D.C.: International Society for Technology in Education, 2013. Print.

Glover, Derek and David Miller. "Running with Technology: the Pedagogic Impact of the Large-Scale Introduction of Interactive Whiteboards in One Secondary School." *Journal of Information Technology for Teacher Education*. Routledge. Vol. 10. No. 3. 2001. Web.

Grabe, M. and Grab, C. *Integrating Technology for Meaningful Learning.* New York: Houghton Mifflin Company, 2004. Print.

Greer, L. E. *Diffusion of Innovation: SMART Boards*. University of West Georgia.

Kulik, J. A. (2003, May). *Effects of using instructional technology in elementary and secondary schools: What controlled evaluation studies say.* Arlington, VA: SRI International. Retrieved from http://www.sri.com/policy/csted/reports/sandt/it.

Lee, Mal and Arthur Winzenried. *The Use of Instructional Technology in Schools: Lessons to be Learned.* Victoria, ACER Press, 2009. Print.

Liao, Y-k. C. (2007). Effects of computer-assisted instruction on students' achievement in Taiwan: A meta-analysis. *Computers & Education, 48*(2), 216-233.

Lovell, M. A. (2014). *Interactive Whiteboard use: Changes in teacher pedagogy in reading instruction in the primary grades.* Alberta: University of Alberta.

McCrummen, S. (2010, June 11). "Some educators question if whiteboards, other high-tech tools raise achievement." *Washington Post.* Retrieved from http://www.washingtonpost.com/wp-dyn/content/article/2010/06/10/AR2010061005522.html.

Mildenhall, P., et al. (2010). Interactive whiteboards: interactive or just whiteboards? *Australian Journal of Educational Technology, 26*(4), 495-510.

Mills, M. (2012, January 22). "National PBS survey finds teachers want more access to classroom tech." *PBS*. Retrieved from http://www.pbs.org/about/blogs/news/national-pbs-survey-finds-teachers-want-more-access-to-classroom-tech.

Moss, G., et al. (2007). *The Interactive Whiteboards, pedagogy and pupil performance evaluation: An evaluation of the schools whiteboard expansion (SWE) project: London challenge.* Report No. RR816. London: University of London.

National Education Association. (n.d.) "Interactive whiteboards enhance classroom instruction and learning." Retrieved from https://www.neamb.com/professional-resources/benefits-of-interactive-whiteboards.htm.

Noland, Whitney Wright. *The Use of Manipulatives and Technology in Math Education: Slope and the Smartboard.* Cape Girardeau: Kent State University, 2008. Print.

Northcote, M., Mildenhall, P., Marshall, L., & Swan, P. (2010). Interactive whiteboards: Interactive or just whiteboards? *Australasian Journal of Educational Technology, 26*(4), 494-510.

Owens, J. A. (1998). "Composers at Work: The Craft of Musical Composition, 1450-1600." Oxford University Press.

Özerbaş, Mehmet Arif. "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.* Department of Primary Education, Gazi University, Gazi Faculty of Education. Vol. 4. No. 6. November, 2012. Web.

Orbaugh, J. (2013, October 22). *Lessons from the downfall of interactive whiteboards.* Retrieved from https://www.edsurge.com/news/2013-10-22-lessons-from-the-downfall-of-interactive-whiteboards.

Sadowski, Alyssa. *The Effects of the Use of the SMARTboard and technology on the grammar achievement of sixth-graders.* Atlanta: Mercer University, 2003. Print.

Schmid, E. C. *Potential pedagogical benefits and drawbacks of multimedia use in the English classroom equipped with interactive whiteboard technology*. ScienceDirect. Germany: University of Education, 2005. Web.

Simon, Fran and Karen Nemeth. *Digital Decisions: Choosing the Right Technology Tools for Early Childhood Education*. Lewisville: Gryphon House, 2012. Print.

Slay, H., et al. "Interactive whiteboards: Real beauty or just "lipstick"?" *ScienceDirect.* Rhodes University. Vol. 52. 2008, pp. 1321-1341. Web.

Smith, Fay, and Frank Hardman and Steve Higgins. "Gender Inequality in the Primary Classroom: Will Interactive Whiteboards Help?" *Gender and Education*. Newcastle University. Vol. 19. No. 4. July 2007, pp. 455-469. Web.

Somekh, B., et al. Center for ICT, Pedagogy and Learning. (2007). *Evaluation of the Primary Schools Whiteboard Expansion Project: Report to the Department for Children, Schools and Families*. Manchester: Manchester Metropolitan University.

Songer, N. B. (2006). Curriculum-focused professional development: Addressing the barriers to inquiry pedagogy in urban classrooms. In E. A. Ashburn and R. E. Floden (Eds.), *Meaningful Learning Using Technology* (70-86). New York: Teachers College Press. Print.

Swan, K., et al. (n.d.). Interactive whiteboards and student achievement: Practices that enhance efficacy. *ResearchGate*. Retrieved from https://www.researchgate.net/publication/241876192_Interactive_Whiteboards_and_Student_Achievement_Practices_that_Enhance_Efficacy.

Türel, Y. K., & Johnson, T. E. (2012). Teachers' Belief and Use of Interactive Whiteboards for Teaching and Learning. Educational Technology & Society, 15 (1), 381–394.

VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. Educational Psychologist, 46(4), 197-221.

Vita, M. D., et al. "Interactive whiteboards in mathematics teaching: A literature review." *Education Research International*. Belgium: Hindawi Publishing Corporation. 2014.

Watson, C. (n.d.) "Types of interactive whiteboards." *AZ Central*. Retrieved from http://yourbusiness.azcentral.com/types-interactive-whiteboards-16698.html.

Wojenski, J. (n.d.). *Erasing the past, typing the future: Timeline of the chalkboard*. Retrieved from http://people.ischool.illinois.edu/~chip/projects/timeline/1801wojenski.htm.

Wood, R. and Ashfield, J. "The use of the interactive whiteboard for creative teaching and learning in literacy and mathematics: A case study." *British Journal of Educational Technology*. Surrey: Kingston University. Vol. 39. No. 1. 2008, pp.84-96. Web.

Zucker, Andrew A. *Transforming Schools with Technology*. Cambridge: Harvard Education Press, 2008. Print.