A Literature Review Exploring the Effectiveness of the Use of Interactive Whiteboards on Teaching Basic Science Concepts to Special Education Students

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This literature review explores the use of interactive whiteboards (IWBs) to enhance the teaching of science to special education students. The literature on using IWBs is reviewed to determine whether this new tool will help special education science students to learn and retain science concepts. IWBs, when used properly, are not simply a large computer monitor. The IWB, when used with a projector and a computer, becomes a system which enables a teacher to involve students in their learning in ways that cannot be accomplished by a computer alone. This requires special education teachers to learn new methods of teaching. The key idea behind the future success of the IWB in the special education classroom is the willingness of special educations teachers to learn and use these new methods, as opposed to using old methods with new technology.

Finding research regarding special education students and IWBs proved to be difficult, making it complicated to conclude about the possible advantages of using IWBs with special education science students. However, research does show that IWBs have many features that can assist the teacher of special education students. The interactivity of the IWB, combined with computers, animation and other features, make the boards ideal for use with visually-oriented students as well as easily distracted students.

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Abstract

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Dedicated to Dr. Ana K. Houseal, who encouraged me to finish this research,
And to my children, who served as an example for me

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Chapter One

Introduction

This literature review explores the use of interactive whiteboards (IWBs) to enhance the teaching of science to special education students. As a teacher of special education science, I am constantly searching for methods that will help students to remember and understand concepts that are presented to them. I reviewed the literature on teaching and learning using IWBs to determine whether they are a revolutionary new tool that will help my special education students, or just another short-term fad that will eventually fade away. What are the strengths, and what are the weaknesses or pitfalls to avoid?

What is an IWB?

The British Educational Communications and Technology Agency (BECTA) defines the IWB as "a large, touch-sensitive board which is connected to a digital projector and a computer. The projector displays the image from the computer screen on the board. The computer can then be controlled by touching the board, either directly or with a special pen" (http://www.becta.org.uk.). I propose that the combination of a touch-sensitive board, digital projector, and computer is a system, not just a board. To be able to use the IWB, the IWB system (IWBS) must work together and be interconnected. The technology is new enough that members of the general population who have not been either a teacher or a student in the last fifteen years may not be familiar with them.

Glover, Miller, Averis & Door (2005) note that "Interactive whiteboards are part of the toolkit of information and communications technology" (p. 156). Glover et al. (2005) also note that as teachers become more familiar with the operating system connected to the IWB and the software which enables it to work, they begin to add IWB use to their lessons. IWBs are very adaptable to classroom use, and as teachers become comfortable with the IWBS, they increase use of the devices.

Purpose

The purpose of this literature review is to explore the advantages and weaknesses that the IWBS may have in the teaching of science concepts in special education settings. Can the IWBS enhance and improve the teaching of science to special education students, and is it a viable tool for presenting material to these students? Secondly, I wanted to determine if special education teachers can adapt to learning and using this new technology, and whether or not they will use it advantageously to teach their students, as contrasted with continuing to use old teaching methods with these new tools.

I found that my ninth-grade special education general science students, many of whom were reading at the fourth to sixth grade level, lacked an understanding of basic science concepts, such as the effects of heating and cooling on density and convection. I wondered if my students simply forgot what they had previously been taught or if they simply were unable to read text-based materials. Could it be that they needed to have information presented to them in more visual or interactive ways, ones that would help them to associate information with concepts that they needed to understand? Could the IWBS help to fill the gap between text-based materials and understanding?

The following example from my experience illustrates how I became interested in this research. Some people need to see something twice before it "clicks," or before they understand it. Two summers ago, I took a basic introductory class in IWB presentations. The class seemed to go by quickly, and when it ended, I was not yet comfortable using the IWBS. As a result, I continued using my old practices and methods the next year. The class was repeated the following summer and I took it a second time. This time, it “clicked” for me. Because of that, I developed many IWBS presentations for basic science concepts. These presentations contained features that allowed students to interact with the lesson material via the touch screen. I found that when I used the IWBS, students not only seemed to pay attention better, they also seemed to understand the concepts more clearly than when I simply presented information to them from a text book, perhaps because the IWBS is so well adapted to a group setting. From this experience grew a desire to know if special education students, who appeared to me to be more attuned to visual, auditory, and kinesthetic stimulation, understood and retained more information when IWBS technology was used as the basic medium for science lessons. I wanted to know if the features of IWBs exceeded mere “entertainment value” for my students.

Special education students have a wide variety of disabilities, and each student has an individual set of challenges to meet. IWBs have the ability to yield more personal, individualized instruction suited to each student’s abilities (Glover & Miller, 2009). Moreover, these boards are interactive and capitalize on visual conceptualization (Tanner & Jones, 2007; Xin & Sutman, 2011). The IWBS is largely activity-based, as students who are directed by a teacher can participate and manipulate the board themselves, an advantage particularly for those with poor manual dexterity, for example. The features of IWBs enliven concept development far beyond the old chalkboard (Glover et al, 2005). Part of the students’ excitement might be due to the interactivity of IWBs, allowing students to become involved in their own learning to an extent never before possible (Blue & Tirotta, 2011; Smith, Higgins, Wall & Miller, 2005). “IWBs can be used in fully interactive ways that are able to bring together digital resources like text, images, audio, video, 'dragable' objects and, of course, a seemingly infinite collection of resources from the web" (Betcher & Lee, 2009, p. 8). Students become participants in a lesson rather than just passive listeners, and the end result is increased motivation to learn (Blue & Tirotta, 2011; Glover et al, 2005).

Much of the examined literature posited that IWBs enhance teaching by making lessons more interactive. Some of the literature notes weaknesses such as technological failures and questions if IWBs are just a fad. This research will attempt to sort out those advantages and weaknesses and apply them to special education science classrooms and students.

Research Questions

1. What does the literature say about how the IWB experience may enhance students' experiences in science classes?
2. What does the literature say about how the IWB can be used in special education?
3. What does the literature say about how IWBs can be used as a pedagogical tool to teach science concepts to special education students?
4. What does the literature say about how IWBs are used by teachers?

Limitations

One of the limitations I faced was the lack of literature available. IWBs are a relatively recent technological invention, and therefore, empirical studies regarding IWBs and the teaching of special education students are rare. Research literature on IWBs and science is more obscure yet. Finding literature on IWBs, science, and special education is currently nonexistent.

In the last ten years, IWBs have been installed in virtually every classroom in Great Britain. In fact, they were installed before they were adequately tested. Much of the newest literature, coming out of Great Britain, is retrospective. There was plenty of information available regarding the various visual tools made available by an IWB. However, even researchers in Great Britain have not fully considered the impact of IWBs in special education classrooms. It has therefore been necessary to draw conclusions extrapolating from the available literature. These conclusions have been combined with personal experience.

Chapter Two

Literature Review

History of IWBs: How Did We Get Here?

Electronic technology is revolutionizing classroom teaching and presentation. An affordance is a quality of an object which allows an individual to perform an action. The IWBS, for example, allows students and teachers to perform some actions in the classroom which could not be performed otherwise in the absence of an IWB. In the words of Kennewell and Beauchamp (2007),

> A consideration of 'traditional' classroom media—the ordinary black/whiteboard, the textbook, the worksheet, the blank piece of paper, even the analogue video recording—suggests that they are more limited in their affordances and much less flexible in their constraints than new digital media (p. 238).

IWBs are part of this "new digital media," descended from a series of tools invented for teaching that can be traced back thousands of years. The history leading up to the creation of IWBs sheds a great deal of light on the question of whether or not this technology is just a fad.

Perhaps the first question to ask is, "How did we get here?" From the earliest times, people have sought ways to improve written communication. Consider visual communication to students within the history of teaching. Teachers sought ways to present material to their students long before the blackboard, whiteboard, and IWB that we are all familiar with today. To answer the question, we need to go back thousands of years.

Ancient peoples drew pictures of their lives on cave walls. Ancient Europeans and Native Americans used materials such as tree bark to make drawings and inscriptions. Six thousand years ago, residents of the ancient Sumerian city of Uruk wrote on clay tablets. Four thousand years ago, the Sumerians were still writing on clay tablets, and shortly thereafter, the Egyptians invented a paper-like material made of papyrus stalks that grew on the banks of the Nile (McGaughey, 2011C). In addition, well over two thousand years ago, peoples of the Middle East used animal skins and cloth to make their records. The Hebrews wrote their history on scrolls made of animal skins, and later the Essenes wrote and stored the Dead Sea Scrolls, made of animal skins and papyrus, inside of caves near the northwest shore of the Dead Sea. The great Greek scholars, such as Archimedes (c. 287 B.C.), who developed and taught calculus, often wrote in ash and dust on the ground. More than a thousand years ago, the Chinese inscribed characters on bones, turtle shells, bronze, and slate (McGaughey, 2011A & 2011B). The desire of humans to find a better, more durable writing surface goes back thousands of years, to the dawn of modern humans.

In the early 1800's, a new means of visual display emerged. Chalkboards, later called "blackboards," were developed. These boards made it possible to teach and present material to larger numbers of students simultaneously. Chalkboards or blackboards, reusable writing surfaces that can be used to write text or to draw on, originally were composed of thin sheets of slate stone. James Pillans, headmaster of the Royal High School in Edinburgh, Scotland, invented the blackboard and colored chalk sometime between 1801 and 1823 in order to teach geography to his students (McGaughey, 2011C).

One of the advantages of chalkboards compared to older methods, such as Archimedes' writing on the ground, was that they could be displayed on a wall in the front of a classroom, enabling large numbers of students to view the desired material at once. They could be erased and material could be corrected or edited as students participated with the teacher.

Chalk and chalkboards are falling out of use in more industrialized countries today, though they are still heavily used in developing countries, which lag behind in adoption and use of technology (Miah & Omar, 2011). Part of the reason for this is that chalk and chalkboards are ten times cheaper than quality whiteboards and dry erase markers, which are in turn considerably cheaper than IWBs.

About 1990, whiteboards became the preferred tool of the teacher. Whiteboards, also called dry-erase boards, were invented by Martin Heit, a photographer and Korean War veteran. He discovered that he could use markers on film laminate for notes while on the phone or photographing, and that it could then later be wiped off. His early whiteboard was made out of film laminate. A crude version began to appear on the market in 1965, the year Sanford invented the dry-erase marker. Heit sold a prototype to Dri-Mark®. Dri-Mark® developed a version for educators that was made of melamine and was very expensive. They were hard to keep clean. They were refined and are now made of acrylic, glass, and other materials (McGaughey, 2011A). They are still common in schools, universities, businesses, and hospitals. The ability to use a marker that could be wiped off with little residual effect once again changed the face of education. Writing on a whiteboard is much simpler to read than chalk on a chalkboard. The markers come in many colors and also add a more attractive visual element.

IWBs were first designed for office use. They were created in 1990 to be used in group meetings and for office organization by Xerox Parc, inventor of the mouse, graphical user interface—GUI—and Ethernet (Hiltzik, 2000). SMART®, the current leader in IWBs used in education and industry, introduced their first SMART® board a year later, in 1991. Intel became interested and funded further research in 1992 (Hiltzik, 2000). Improvements and developments since then include an eraser, color markers, projection, screen capture, and a host of interactive features that make it useful to classroom teachers.

IWBs incorporate software that makes it easy to construct attractive presentations. This style had its' beginnings in the early 1980's. Harvard Graphics® 2.3 for DOS 3.0 on a 386 machine and AT&T RIO® had simple presentation software that predates Microsoft® or Word Perfect® (a Microsoft competitor), but it cannot be denied that IWB software owes credit to PowerPoint®, a Microsoft Office® product, for development of a commercial presentation program style that laid the groundwork not only for the SMART Notebook® style of presentation, but also for recent free products like Open Office® as well. PowerPoint uses linear slides that contain text, sound, graphics, movies, and objects that can be freely moved and arranged. That particular style has become the standard for presentation software. The original name for PowerPoint was "Presenter," a product designed for MacIntosh® computers by Dennis Austin and Thomas Rudkin for Forethought, Inc., which was bought out by Microsoft in 1987 for $14 million USD. PowerPoint was officially released on May 22, 1990, the same day that Microsoft released Windows® 3.0. The style of slide creation and presentation used in PowerPoint persists in SMART Notebook® presentations today, and SMART Notebook® presentations can be exported to PowerPoint (Hiltzik, 2000; Jackson, 2000).

Sales today make IWB technology a multi-billion dollar industry. Digital Tree Consulting estimated that by the end of 2007, an IWB would be in one out of every seven classrooms in the 66 countries it tracked (Davis, 2007). Close to 600,000 IWBs were sold worldwide last year, bringing in nearly one billion dollars in revenue (Milligan, 2012). Today, competition with SMART includes companies such as Touchboards®, Promethean®, and eInstruction®, developer of a fully mobile interactive system that can be used via wireless technology from anywhere in a classroom. It is certain that the technology will grow and expand over the coming decade (Betcher & Lee, 2009).

What Does the Literature Say About How the IWB Experience May Enhance Students' Experiences in Science Classes?

General use of IWBs in science education. Four points summarize general use of the IWBS in science education: First, teachers and students can use the IWBS to explore science together. Students understand scientific principles and concepts better when teachers and students use this cooperative exploratory process. Hennessey, Deaney, Ruthven, and Winterbottom (2007) note that, "In science, dialogic, interactive communication allows teacher and pupils to explore ideas together, pose questions and reconcile scientific and informal ideas" (p. 284). The IWBS enables teachers and students to be mutually involved in this kind of exploration.

Secondly, IWBs enable a teacher to present the material in a number of different ways which may benefit students with different learning styles (Gardner, 1999). Hennessey et al. (2007) relate IWB use to the idea of "exemplary science teaching," and note case studies by Alsop et al. (2004) that seem to indicate that IWBs "bring abstract concepts to life through diverse and creative approaches, acknowledging students' different learning modalities, and promoting high student engagement" (p. 292). Science tends to be very abstract at times due to the number of concepts which involve things which cannot be seen with the naked eye (such as microorganisms). The IWBS makes it possible to model and animate abstract concepts, making them easier to envision and understand.

Third, the IWBS enables teachers to organize concepts in a way that increases understanding and retention of facts. Bailey and Chambers (1996) conducted some of the earliest research concerning IWBs and science concepts. Glover, et al., (2005) commented that IWBs enable the teacher to use information in a more organized fashion that increases understanding and retention of facts. Kennewell and Beauchamp (2007) studied the effects of IWBs on student learning and retention of information. Kennewell and Beauchamp (2007) conducted a study which was four-phased. One phase was a teacher-led whole-class activity; one was scaffolded, meaning that supports are provided that promote learning when concepts and skills are being first introduced to students; one was a group or individual activity without IWBs; and the fourth group was instructed by revisiting key points. They found IWBs to be instrumental in helping students to retain important information (Glover et al., 2005). Because students pay more attention when an IWB is used, students tend to remember what they have been taught.

Fourth, IWBs can be used to show processes or concepts in action using animation and interactivity. Students benefit from illustrations that show science processes or concepts in action. Iding (2000) notes that “At the very simplest level, illustrations that depict a sequence, change, transformation, or process of some sort are of interest” (p. 405). Because many science concepts are not physically observable, being able to use the IWB tools to animate illustrations can help to make concepts more concrete (Aremu & Sangodoyin, 2010). For example, the IWBS can be used to animate the actions of the water cycle, showing how warm moist air rises and then condenses in the cooler upper atmosphere to form precipitation.

In summary, the use of IWBs and their brand of multimedia presentations may facilitate better models or mental representations of processes and concepts that are difficult to visualize in the everyday world (Iding, 2000). An example would be a presentation showing the movement of a virus into a cell, where it borrows DNA in order to replicate itself. This could be done by drawing illustrations on a whiteboard, but with an IWB you can combine illustrations, videos, and animation, showing the entire process. This is a benefit that would be hard to realize with a simple whiteboard.

What Does the Literature Say About How the IWB Can Be Used in Special Education?

Special education population. Special education students have a broad range of needs. Some have physical disabilities, while others may have learning disabilities. Still others may have emotional disabilities (Oliver & Reschly, 2010).

No matter what the disability, it appears that use of the IWBS can improve learning within a population which requires special techniques. For example, Special education students tend to have literacy problems and often read far below their current grade level (Oliver & Reschly, 2010; Stephenson & Carter, 2011). Bell (2000) and Glover, et al (2005) note that use of IWBs may help literacy problems by offering repetition, recall prompts, and other stimuli. Stephenson and Carter (2011) wrote of a similar effect noted from sensory experiences which appear to improve cognitive skills in children with disabilities. The IWBS offers sensory experiences because of its' interactive abilities.

Use of the IWBS reduces distraction. Many special education students are easily distracted and exhibit disruptive behaviors in class settings which may exacerbate existent deficits in academic achievement (Oliver & Reschly, 2010). Miller and Glover (2002), who studied the responses of 35 participants who were asked about the use of IWBs in an elementary setting, commented, "Distracted children pay attention for longer periods [using IWBs]…we can pick up on problems of learning at the point of occurrence rather than at a larger stage…so they don't lose interest and we keep them on task"(p. 13). Applying this to special education students, many of whom are easily distracted, IWBs may be able to keep students on task for a longer period of time by decreasing their distraction time. Perhaps because students are less distracted, there seems to be an increase in motivation as well as understanding of the concepts being taught (Blanton & Helms-Breazeale, 2000; Cooper & Brna, 2002; Glover et al., 2005; Glover & Miller, 2009). An interesting presentation using an IWBS has a strong motivational effect and thus decreases distraction and evidence points to specific gains from enhanced presentation and the increase of pupil motivation (Glover et al., 2005).

Visual learners. Glover et al. (2005) comment that since IWBs are a visual learning tool, there is a twofold gain- (a) retention and recall of information, and (b) "sequential explanations backed by movement such as 'drag and drop' and 'hide and reveal'" (p. 163). Many special education students are very visually-oriented (Xin & Sutman, 2011), meaning that they respond well to visual stimulation. Perhaps because of this visual orientation, the visual display of the IWBS may result in a higher level of student motivation. For example, Tanner and Jones (2007) note that "A bright, colourful, dynamic device at the focus of the classroom provides opportunities for greater attention levels and more sustained engagement" (p. 40). Tanner and Jones (2007), in other words, recognize that some students benefit from the visual stimulation afforded by IWB.

IWBs improve motivation and engagement. Improvement of motivation, student engagement and willingness to be involved in learning is one of the biggest advantages of IWBs. The connection to this aspect of student motivation has been noted by many researchers (Beeland, 2002; Blue & Tirotta, 2011; Burden, 2002; ;Clemens, Moore, & Nelson, 2001; Hall & Higgins, 2005; Hennessy, et al., 2007; Levy, 2002; Slay, Sieborger, & Hodgkinson-Williams, 2008; Thompson & Flecknoe, 2003). These researchers felt that students were more engaged and on-task in the classroom when IWBs were used. Further, Glover et al. (2005) and Clemens et al. (2001) connect motivation to the special education population: "Motivational gains also help pupils with learning problems as illustrated by Clemens et al. (2001), who describe a measurable learning enhancement for slower learners" (p. 162).

Students seem to be highly motivated by changes in technology and adjust to it quicker than their adult teachers. In this respect, when technology is involved, students seem to be more willing to explore. "Once students become comfortable with technology tools, exploring others becomes easier" (Blue, 2011, p. 32). In addition, when students are permitted to physically manipulate objects in a presentation themselves, there is an increase in learning and motivation (Hennessy et al., 2007). Special education students who cannot adequately manipulate a keyboard may be able to use an IWB because of its touch screen capabilities and thus find a way to be more involved in their learning (Xin and Sutman, 2011).

Miller & Glover (2002) believe that IWBs may improve motivation and thus actually cause students to enjoy school more, therefore resulting in less absenteeism and more seat time, which equals more learning time. Special education students tend to learn material at a slower pace as a result of their varied disabilities such as lower reading levels and comprehension problems, so this improvement in seat time may be an important tool for special education teachers (Sweller & Chandler, 1994).

Wall, Higgins, and Smith (2005) surveyed students, asking their impression about IWBs and their ability to learn and understand concepts. Students mentioned that they liked multimedia functions such as ease of internet connection, movement, sounds, and the ability to animate illustrations. These students noted that they were more highly motivated to be involved in their own learning process due to the ease of using these multimedia functions. They felt that they were more inclined to go beyond the requirements of an assignment.

A common physical science topic for general science students is the concept of momentum, which involves the force or speed of movement. Tanner and Jones (2007) asked if the momentum of [special education] students in a science class can be increased. Tanner and Jones (2007) defined momentum as the "mass of the class engaged in thinking times the pace of the lesson" (p. 37). With the addition of this tool, students who have learning disabilities are able to move with the speed of the rest of the class. Tanner and Jones (2007) informed us that IWBs can improve engagement of special education students in the science class by enabling more students to be involved in learning at similar levels of achievement. The IWBS may be particularly effective in the teaching of students with emotional or behavioral disorders (Oliver and Reschly, 2010). The additional of this tool may make it more likely that students with disabilities will be able to move with the speed of the rest of the class.

Color and animation improve motivation. Animation is simply defined as images in motion (Aremu & Sangodoyin, 2010). Improvements in motivation of highly visual special education students when using an IWBS partially arise from the quality of the presentation and the use of tools such as color and animation. The use of color and movement is seen as an important addition to presentations (Glover, 2005). Animations can be used to show special education students how concepts work in a way that is superior to inanimate pictures on a piece of paper, as animations stimulate several senses at the same time and therefore make information more memorable and attention-grabbing (Akpinar & Ergin, 2008; Aremu & Sangodoyin, 2010). Aremu & Sangodoyin (2010) argue that animations are more effective than static sequential images for teaching about concepts and dynamic events. For example, a static image of a bird is not as effective as an animation of a bird in flight.

Visual and verbal effects. The IWBS can combine visual, verbal and even auditory effects. The IWBS can be used, for example, to attach a video or sound clip to a presentation that will open on command to illustrate a concept. Iding (2000) and Mayer and Gallini (1990) explain that learners can process animations better when an auditory narrative accompanies the animation, as opposed to a student being forced to watch an animation and simultaneously read a text-based explanation.

Iding (2000) and Xin and Sutman (2011) note that learners most likely to benefit from this more visual approach are those with low prior knowledge about content. Many of the special education students I have taught seemed to have lower content knowledge, for various reasons. Some do not retain information easily, while others become distracted in class (Oliver & Reschly, 2010; Stephenson & Carter, 2011). For some, traditional methods have a detrimental effect on retention of information due to what Iding (2000) and Sweller and Chandler (1994) call the “split attention” and “redundancy” effects. Split attention effects occur when a learner is forced to try to integrate information that comes from separate sources. Text may be on one page, for example, and the illustration on another. The IWBS can solve this problem, enabling the teacher to put an illustration and applicable text on the same slide. This can be combined with auditory effects. There are advantages from a cognitive perspective because it does not overly tax short-term memory capacity of students (Iding, 2000). In other words, verbal and visual interconnect via an integration process; if the information is encoded pictorially and verbally, it is more memorable (Iding, 2000).

Interactivity. Research has shown that IWBs, when used as a tool in the classroom, make learning more fun for the students because of the ability to involve students interactively. When students have fun in the classroom, they want to learn more. Interactivity, therefore, may improve student motivation.

IWBs make it fairly easy to manipulate text and pictures. Iding (2000) tells us that IWBs make it easier to use "bits of information" or short "chunks" that help students to maintain ideas in short-term memory. "Information presented pictorially and verbally is more effective if words and pictures are presented in proximity rather than separated by pages or screens" (Iding, 2000, p. 405). The touch-sensitive screen also enables teachers and students to move the pictures and text around on the screen which is displayed in front of the entire class, involving the class as a whole in the learning process. This is a social interaction which is not possible when one student is using a computer individually, without the aid of the entire IWBS.

The redundancy effect. The redundancy effect refers to repetition of information from different sources, requiring students to "attend to individual bits of repeated information" that could be understood without using repetition (Iding, 2000). For example, information from the text is often repeated under a picture or diagram, adding no additional information. Textbook authors often make the assumption that repetition helps students to retain the conceptual facts, but special education students often become confused by this repetition. Sweller and Chandler (1994) refer to a similar idea, "extraneous cognitive load," where students must simultaneously engage elements of the learning materials that may not be solidly connected to the desired content, and this type of organization results in confusion for the special education student.

What Does the Literature Say About How IWBs Can Be Used as a Pedagogical Tool to Teach Science Concepts to Special Education Students?

Pedagogical tools are strategies or styles of teaching. Some of these tools and strategies work better than others for helping special education students to understand, grasp, and remember science concepts. Are IWBs an effective tool for special education students in the science classroom?

Teaching—scientific practices. Some practices are standard in science classrooms. For example, reasoning and testing a hypothesis are concepts of paramount importance to every field of science. Experiments are devised to test a hypothesis, and the hypothesis may have to be revised or changed if it is unsuccessful or if the results cannot be repeated. Hennessey et al. (2007) note that the "IWB provides collaborative opportunities for reasoning, hypothesis testing and interpretation that go well beyond those afforded by more established classroom devices" (p. 284). Students are offered new opportunities to express and share ideas verbally and graphically, and thus may more easily articulate scientific knowledge (Hennessey et al., 2007). Deeper levels of interaction are achieved as teachers and pupils work together in the learning process (Tanner & Jones, 2007). Glover et al. (2005) tell us that students can "move material, complete tasks or outline an argument for which associated software provides an immediate reaction of calculation, evaluation or the recall of earlier material" (p. 158). This kind of pedagogical tool makes teaching science easier and more enjoyable for the teacher as well as the student. Social interaction is encouraged by use of this tool, and this kind of interaction cannot be achieved with traditional pencil and paper methods.

Through the use of interactive features of IWBs, students can access electronic documents, activities, calculators, maps, and video files. Miller and Glover (2002) identified five advantages for IWBs: (a) tighter lesson structure, (b) improved presentation, (c) improved response to pupil needs, (d) multimedia use, and (e) printed lesson records. Miller and Glover (2002) found that teachers ranked improved presentation (use of the IWB as a teaching tool) as number one and response to pupil needs as second in advantages of IWBs. Hennessey et al. (2007) found that IWBs allowed teachers to teach with confidence, in a familiar, yet authoritative and media-rich way.

Glover et al. (2005) sum up studies that have been done on teaching with IWBs by telling us that

> an analysis of findings from a broad sweep of sources…confirm that enhanced interactivity requires an understanding of the way in which both teachers and pupils gain from the use of technology and demonstrates that there is a progression at all levels in learning to use the equipment and associated software to educational advantage" (p. 155).

They conclude that the early evidence shows that the technology is a strong support for learning. Evidence, they say, is still exploratory, but is encouraging. However, Glover et al. (2005) relate that there are still doubters who argue that IWBs result in no real improvement: "There is almost no evidence of measured gains in pupil progress and long-term achievement as a result of changed teaching and learning approaches" (p. 166). In other words, there is still not enough evidence at this point that IWBs result in significantly improved performance when compared to traditional teaching methods. Researchers note that increases in efficiency, versatility, multimodal presentation and interactivity seem to be emerging from data, though it is not proven yet if those results can be transformed into benefits for learning (Hall, et al., 2005;

Kennewell & Beauchamp, 2007; Smith, Higgins, Wall, & Miller, 2005). Much more research is still needed to verify the positive effects of IWBs in the classroom.

Furthermore, “the use of technology as an adjunct rather than as an integrated element in teaching minimizes interaction and fails to capitalize on the matching of teaching to the learning needs of student groups” (Glover et al., 2005, p. 158). When we rely more heavily on electronic technology, there is a risk that we may actually be reducing personal contact with our students and therefore may be less responsive to their individual needs unless we fully integrate the technology.

Students are not identical and each has his own set of strengths and weaknesses. This is particularly true of special education students. Depending on the disability, some special education students may be more inclined to become confused when information is repeated in alternate ways and uses different methods of presentation (Iding, 2000; Sweller & Chandler, 1994). It is also true that some special education students could benefit from repetition of material in various ways and it could reinforce the information. “It is possible that unnecessary redundancies or confusion may be created by presenting information in more than one mode, for example, or presentation in more than one mode might actually facilitate learning” (Iding, 2000, p. 404). It depends on the students in the class and the nature of their disabilities. Not enough research has been done to confirm or deny the possible benefits or detriments of IWB use with different student populations.

What Does the Literature Say About How IWBs Will be Used by Teachers?

A key question researchers ask is, “Are IWBs just a fad?” Whether IWBs will stand the test of time or prove to be short-lived is a particularly important question because of the cost of the boards and software, the time it takes to create presentations to use on the boards, and the question of teacher buy-in.

Do teachers tend to adapt to new technology slower than their students? As with all tools, IWBs are only as good as the teacher using them. Do teachers, especially special education teachers, adapt to new technology, or do they continue to use old ideas simply packaged with the new tools, old methods intact. Glover et al. (2005) noted that many teachers continue to use the IWB more as a large computer screen, merely a display, and ignore the interactive elements of the boards that have such great potential to involve students. Colley, Comber, and Hargreaves (1998), Damcott, Landato, and Marsh (2000) and Simpson, Payne, Munro, and Lynch (1998) demonstrated using interactive technology in specific subject areas, stressing the need for teachers to change their approach to teaching in order to fully utilize and optimize the effectiveness of technology in the classroom (Glover et al., 2005).

Ertmer (1999) provided the model for analyzing barriers to technology by classifying them into two categories, extrinsic and intrinsic. Extrinsic factors are factors external to the individual; examples might include the desire for money or good grades. Educational environmental factors such as resources and training might be considered extrinsic, since training is desirable to maintain one’s job and might result in higher pay. Intrinsic factors are internal desires to perform a particular task; for example, teachers do certain things because of desire for pleasure, to develop a skill, or because of morals, beliefs and conceptualizations, beliefs about technology or discomfort with change (Florida International University, 2012; Guerrero, 2005). Someone who is intrinsically motivated might want to do something because it is the right thing to do, while someone who is extrinsically motivated might want to do it if it will bring him money or power.

SMART® boards as well as other interactive whiteboards have a technological language that users must learn and adapt to (an intrinsic factor for those who want to learn because they want to be a better teacher, for example). They present distinct problems for those who are unfamiliar with them and have no desire to expend the extra time on something they consider to be unimportant to them (an extrinsic factor). There is a learning curve. Some teachers resist using the boards simply because they have not learned that language and feel that their time could be better spent elsewhere (Glover et al, 2005; Guerrero, 2010). Some feel overwhelmed with their duties and preparations and do not want to expend the time it takes to learn how to use IWBs (Guerrero, 2010). For some, new technology is frightening (this is intrinsic). Some teachers are afraid of failure and tend to fear those things that are unfamiliar. For these teachers, it is more comfortable and secure sticking to older methods they are familiar with (Guerrero, 2010). Some teachers are those that Blue and Tirotta (2011) call "digital natives" who are comfortable with technology tools, while others are "digital immigrants," having little knowledge about technology tools (p. 32). They propose that failure to use new technology is not tied so much to age or the population a teacher serves as it is to knowledge of and familiarity with the technological tools themselves. Teachers must become familiar with the IWBS, not just the IWB alone, which includes hardware, operating systems, and software (Glover et al., 2005). For some teachers, this is intimidating.

Weaknesses. We must acknowledge that while IWBs have many good qualities and advantages, there are also a few weaknesses. One of the common complaints by teachers and students alike is the limitations presented by technological malfunctions. Technological problems, when they occur, can be frustrating to both teacher and students. Many of these problems are with the software or with one element of the IWBS such as cables or connections, not a problem with the board alone. The board is only a board without the system it is connected to. Problems can include the projector, the computer, the internet, and cables. Even the board itself is not impervious to problems or breakage. Selena Fabricius, a Wyoming teacher, tells about using a SMART® board in her classroom. Using the IWB in her classroom has enabled her to reach a student who is homebound. This student is able to listen to and virtually attend her class using Skype®. However, when computer problems occur, she comments that she has to move on, regardless of the effect on the homebound student, because she cannot leave the rest of the class behind (S. Fabricious, personal communication, Jan. 2012). The choice is between keeping pace with the majority of the students and slowing the pace down for the sake of one student. This forced decision is difficult to make.

Guerrero (2010) notes that

> … very little change has occurred in teachers' instructional practices with each successive wave of reform. Teachers continue to teach in largely traditional ways, often adapting reform efforts to fit their current conceptions and style of teaching rather than making any significant changes to their instruction or thinking about teaching and learning" (p. 19).

If we are going to invest in expensive tools such as IWBs, we need to be willing to adapt to new ways of teaching, which their use requires. In other words, the problem is not with the IWB, but rather with teachers who are asked to use it.

Several researchers have sought student input and note their criticism of IWBs. Wall et al. (2005), for example, note that "Negative comments by students included technical issues such as need for recalibration in the middle of the lesson and problems with projectors (p. 863)." The recalibration problem has decreased somewhat since the advent of mounted projectors. Similarly, Blue and Tirotta (2011) note, "The greatest challenge to collaborative tools is Internet access interruption—through the server or through the global applications provided by companies like Google"(p. 35). This idea, that Internet reliability is a major obstacle, is espoused by several researchers (Blue & Tirotta, 2011; Holschuh & Caverly, 2010; Wall et al., 2005). This partly speaks to the nature of the Internet, the speed of one's connection, and the technical expertise of the teacher. However, technology is not always predictable and problems will occasionally occur. The job of the teacher is to be to be flexible enough to switch to another task so that disruptions will be minimal.

To summarize, some teachers are instantly converted to IWB use. Others have caveats, and some are totally resistant or "skills dormant" (Cooper, 2003; Glover et al*.,* 2005, p. 158). Cooper (2003) notes the "ripple effect" (p. 158). What happens in one classroom often eventually affects aspirations in another classroom and has a positive effect. So while teacher resistance is a negative, it is not totally insurmountable.

Whenever new technology is incorporated into the classroom, there is a learning curve for the teacher as well as for the students. While many teachers complain about the time involved in preparing presentations, for example, others acknowledge that there is a trade-off between that time and the learning effectiveness that results (Glover et al., 2005). There is also a reduction in preparation time over the course of ensuing years, as the same presentations can be repeated with a minimum of editing. Although IWBs initially require more time because of training and additional preparation, teachers who put time in to learn how to use them properly may find that they are worth the investment if proper pedagogical approaches are used.

Chapter Three

Conclusions

This literature review has explored the use of interactive whiteboards to enhance the teaching of science to special education students and the willingness of teachers to adapt to this new technology. Based on current literature, we can conclude that IWBs often help more visual learners remember, learn and understand science concepts better than with the use of simple textbooks and other traditional teaching methods used without the supplementation of an IWB. However, some note shortcomings such as technical issues and teachers' instructional practices. The largest shortcoming is the lack of research. I can now return to my original questions and determine if this literature review has answered them.

IWBs as enhancing the special education students' experiences. Special education students have different learning styles which a teacher must meet in the classroom. IWBs enable a teacher to present material in many different ways. The IWBS makes it easier to build and reinforce conceptual knowledge by using many different adaptable tools and interactivity which research shows can capture the attention of special education students. For example, illustrations, animations, and interactive elements of IWBs are part of the tools that can be used to illustrate difficult concepts. A presentation about plate tectonics may include an animated map of Earth's plates in motion, showing the slow motion of the plates from the breakup of Pangaea to the present; or a link to an internet site about tectonics can be inserted on one of the slides. None of us living today were on Earth when Pangaea began to breakup, but we can show students what it might have looked like. Students can manipulate the map, touch the screen and turn back time at will, and social interaction takes place as other students help and become involved in the activity which is basically student-led.

Concepts are not merely projected on the screen. The touch screen enables students to manipulate material themselves. One of my first experiences with the IWBS involved projecting a Windows 95®-based word search program onto the board. The program contained interactive features that I had been unaware of. I had always used the program just to print up word searches. Students could use their fingers to mark words, following which animated helicopters dropped each letter into place. Wild sounds were emitted each time a word was found. The students loved, and still love, this program. They seemed to be much more motivated to find vocabulary words when the IWBS was used as opposed to when I just printed the word searches out on a piece of paper. Social interaction occurs as students in the class share experiences.

There is an improvement in organization that makes concepts clearer and helps in retention of information. Bulleted facts can appear one fact at a time simply at the touch of a finger to the board, for example. Activities can be constructed so that the teacher becomes the observer. The interactivity of the IWBS helps both teacher and students. Teachers are freed from their desk computer, and students become participants instead of just observers. In particular, research shows that the IWBS helps the teacher to bring abstract concepts to life and make them more understandable. For example, an interactive manipulative activity showing the concept of evaporation and condensation of molecules of water as part of the water cycle can be inserted to show students how temperature affects these molecules.

What evidence is there that IWBs improve the presentation of material to special education students? This was one of the problems I faced in doing this research. No one has yet done any extensive research on the connection between IWBs and the improvement of teaching to special education students, so little evidence exists to show this relationship. However, while literature is scant on using IWBs with special education students, research does show a benefit to students who have literacy problems. Using repetition, recall, and other stimuli with the boards appears to improve cognitive abilities with this population.

Many special education students have a shorter-than-normal attention span. Problems with distraction are minimized (Miller, 2002). Students who are visually oriented, such as many special education students, may feel a greater motivation to pay attention in class and exhibit more on-task behavior. My students seem to become more involved in my lessons when they are able to manipulate the boards themselves during a lesson while I simply observe and provide guidance. They are able to take control of their learning. Students report they feel more highly motivated due to interactive elements and other features; this fact would seem to back up these assumptions and makes the IWB a perfect candidate for special education use. Some of the features that help with special education science instruction are color and animation, visual and verbal effects, and ease of manipulation of text and pictures in a presentation. The key, however, is the ability of the student to manipulate the board himself in the course of learning, using the IWB as a system rather than just a display.

IWBs can be used as pedagogical tools to teach science concepts to special education students. Literature indicates that IWBs excel as a visual learning tool. The IWB is versatile and has features such as "drag and drop." Basically, anything you can do on a computer you can do on an IWB. Teachers can use this tool to help with retention and recall of information. Furthermore, interactive features of the boards make learning fun for students, improving their desire to learn. My students have indicated to me that they try harder not to miss my class because they enjoy their work. It appears that when students enjoy class more, seat time improves. Greater seat time equates to more learning time, which helps with retention of information. This makes IWBs a desirable tool for the special education classroom.

IWBs as used by teachers. Very little information is available at this time on how and to what extent teachers, especially special education teachers, are now using IWBs due to a lack of research focusing specifically on the special education group. I can only conclude from the limited research that special education teachers can use IWBs to improve literacy and to improve cognitive skills. I can also conclude, based on research, that teachers in general are not fully utilizing IWBs at this time. Based on experience and the special education teachers I know, I propose that this is true in the special education teacher population as well.

Barriers to use include both extrinsic factors such as training and intrinsic factors such as teachers' own self-confidence in being able to utilize new technology. It will be some time before special education teachers leave the ranks of "digital immigrants" to become "digital natives," but that is not an impossible goal to achieve. I think that pressure from other teachers who master IWBs will eventually combine with training to give hesitant teachers the boost in confidence that they need to master these tools. There are advantages in the IWBS that one cannot realize with a blackboard or whiteboard alone, which have no interactive connections. Furthermore, merely using the IWB as a display ignores the capacity to use the board as part of an interactive system that has tremendous teaching potential in a whole-class setting which cannot be realized by using a computer alone. Even computers with a touch screen lack the capacity for students to interact in a group setting that is afforded with an IWB. The IWBS is a social learning experience unlike any other.

It is unclear whether or not IWBs are a tool that will endure over time, or whether they are a simple fad. Chalkboards have been in use for nearly 200 years. Whiteboards are still in use after 47 years (1965) and have become a well-accepted classroom tool. The IWB has existed only 22 years at this time (1990) and has not seen its' "peak" of performance yet, meaning that they are still not in use universally. Part of the reason for this is due to the cost. It can be upwards of $2000 to set up a single classroom, making it prohibitively expensive at this time for poorer school districts and developing nations. However, this is the technological era, and the students we teach have never lived in a world without computers. Students demand technology. We can assume that as costs decline, and as technology becomes ever more available, more IWBs will be installed in more classrooms. If we use the timeline of whiteboards, we can assume that this escalation of purchase and use will continue for at least the next twenty to forty years. This assumption can be backed up by the law of supply and demand. As the IWB becomes more available and more are manufactured, cost should be driven down by the natural inverse relationship of supply and demand versus cost. The IWBS may be supplemented by the increasing use of personal handheld devices, which could become more accepted for classroom use in the next decade; however, I predict that hand-helds will never replace whole-class instructional tools like the IWB.

In summary, while some researchers note that students are more motivated and learning appears to be enhanced by the use of the IWBS and technology, others are concerned that it could be "just another presentational gimmick". That concern would seem to support the "passing fad" idea. It may depend on the pedagogical approach of each individual teacher. This question must be answered by further research.

Implications

A key implication of this research is that as teachers eventually adapt to IWB use over the next twenty years, they will experience a little bit of a push at the outset. However, once a practice is used on a regular basis, a habit will become easier to use and more entrenched. This will probably result in a feeling of accomplishment that motivates teachers to continue to learn and grow. Those of us who teach know that in order for a student to learn a new concept, he must be exposed to it, and hopefully, each exposure builds upon and reinforces previous knowledge. In this respect, we are not unlike the students that we teach; we need to reinforce new knowledge by continuous use and further learning and practice. As teachers continue to use the IWBS, they will adapt to new ways of teaching that involve more interactivity and less reliance on textbooks, paper and pencil. Teachers will become partners and observers as students take control of their own learning in the classroom.

Recommendations

I recommend that further research is needed regarding the IWB and its use in the teaching of special education students, particularly the effect of the IWB on the teaching of individual subjects such as science. I was interested in conducting this kind of research but I encountered a major limitation that was directly connected to good research. It would be helpful to have a control group, a group of students who were not currently being taught using IWBs. This was not possible in my teaching position because the number of students I taught in any one class hour was not large enough to allow for this separate group. In addition to this, every classroom in my school building has an IWB. This would preclude any attempt to divide my students into comparison and treatment groups. Therefore, I had to be satisfied with having my questions answered by studying research formerly done by others, in an area that is in its' infancy. Some of the questions I have asked will need further research to answer.

Most of the research that has been done up to this point incorporated one or more surveys involving teachers and/or students and their opinion of the use of the IWB in the classroom. Many of the survey groups included small numbers of students. What is lacking is data connected to assessments and actual improvements that result from the use of the IWBS. The opinion of teachers and students, while helpful, cannot by itself replace data gleaned from assessments and observations involving students who use the boards. I recommend that future research go beyond opinion and set up empirical studies involving special education students who use the IWBS. Both quantitative and qualitative data is needed in order to conclude what the actual benefits to this group could be.

My recommendations for the special education teacher seeking to improve science teaching are to obtain training in IWB use and then try it out. To become comfortable using these tools, trial and error is a necessary element. Increased use brings familiarity and comfort. Technology will not go away. We will have to adapt to it or become dinosaurs in the teaching world.

Summary

I have gained important insight into the possibilities for teaching special education science students in my own classroom. In particular, I think that the IWBS allows a teacher to reverse the traditional approach to classroom instruction. A stereotypical teaching role is one in which the teacher stands in the front of the classroom, writing on a chalkboard or whiteboard, while students dutifully remain in their seats and take notes. The instruction is one way, teacher to student. The IWBS allows for two-way instruction, between teacher and student. Because the student can manipulate so many of the IWB features, the teacher can become a partner in learning as well as an observer, while the student takes control of his learning. The students become a social unit that is unique, interacting with each other as well as with the board. The lesson for me is that I need to step back more in my classroom and allow my students to take control as I moderate between students and board.

I am also more conscious now of the fact that my students cannot operate in the presence of an overload of cognitive information. Repetition of information can confuse special education students. My lesson planning will change in the future to address this problem, attempting to build on previous knowledge.

I also realize that I can encourage student participation by allowing my students to use features that are popular such as the on-screen keyboard, hide and reveal, and drop and drag. When students have fun, they want to learn. As a teacher, I need to remember to make learning fun. A love of learning is the pathway to lifelong satisfaction. As a teacher, I am helping my students find that pathway.

I have come to the conclusion that I could use IWBs in my classroom to assist my own students in the understanding of concepts, even though I could not conclude that my data would prove to be true for all or even most special education students. The fact that my classes are small would allow for some observations to be made that could not be attempted in a larger class. My classes are small enough for every student to use the IWBS in the course of one class period. The benefits for my own classes seem clear to me.

Finally, in ancient times, wine was sometimes stored in containers made of skins. New wine would expand as it fermented, and new wineskins would stretch to accommodate the expansion. However, new wine could not be stored in old wineskins that had already been stretched out because of the risk of bursting the skin. This is analogous to our question of whether or not teachers merely use IWBs using old techniques that do not quite fit the new technology. A new tool needs new methods in order to be effective. I can see that many new methods are currently being developed and are in use, but there is room for improvement. If we use IWBs merely using old methods, IWBs will not be successful and will fail as surely as the old wineskin that was used for new wine.

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