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SIMULATIONS IN INQUIRY-BASED LEARNING

By

Timothy E. Hall

**A Dissertation Submitted to the Graduate Faculty
Of Lynn University of Boca Raton in Partial Fulfillment**

**Of the
Requirement for the Degree**

**Of
Doctor of Education**

Boca Raton, Florida

2014

SIMULATIONS IN INQUIRY-BASED LEARNING

Abstract

One of the largest school districts in the southeastern United States is implementing a district-wide rollout of simulation software to supplement traditional direct instruction in the middle school science curriculum. Practically every area of human existence in the industrialized nations has been impacted significantly by technology in the last twenty years (Robinson, 2011). The United States Department of Education (USDOE) has challenged the nations school districts to transition to interactive digital textbooks to all students by 2015 (FCC, 2012). In general, students are far more comfortable using computers, smart phones, and texting devices than their parents or teachers (Doyle, 2006). Students are becoming more computer literate, but not necessarily knowledgeable about the content being offered in our schools (Adams, Reid, S., LeMaster, McKagan, Perkins, Dubson, & Wieman, 2008). It is important that educators assess the effectiveness of computer simulations in aiding teachers to raise student achievement (Adams et al., 2008).

DEDICATION

This work is dedicated to my dad and role model, Samuel E. Hall and the first school teacher I ever met, my mother, Josie M. Hall.

ACKNOWLEDGEMENTS

Thank you God for giving me the health and strength to complete this journey. I would be remiss if I did not thank the following people for their contribution to the development of this dissertation. Christine Recchi, whose leadership and encouragement will be with me always. Sophia Haynes, was my support in accessing data on the District warehouse. Kathy Ingels, you are outstanding at what you do and thank you for sorting the test data for me each time I asked. You made the difficult appear simple. Thank you to Dr. Howard Jones, Kathy Neville and Jeffrey Wenhold for your support in this endeavor. Thank you to every teacher who participated in this study. Your comments and observations contributed a great deal to this work. To Dr. William Leary, gratitude is all I have for you and the contributions you make to the field of education. To Dr. Suzanne King, thank for your encouragement, commitment and leadership. To Dr. Korynne Dunlop, thank you for your diligence, patience and leadership, for always instilling in others the will to forge ahead. To my editor and son, Timothy Brandon Hall, and my wife and classmate, Rose Hall, we did it! Thank you both. To my other children, Shina and Avery, thanks for always asking “But what about my dad?”. Thank you to Michael Gordon Mason and his wife Debbie for guiding and encouraging me always. To my siblings Acem Hall and Varlese Hall-Grady thank you for “man alert”! Thank you to every student that has ever entered one of my classes in the past, present or future for allowing me the privilege of learning and growing with you. Always remember, rule number four “Believe in yourself.”

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CHAPTER I

Introduction

Purpose of the Study

One of the largest school districts in the southeastern United States is implementing a district-wide rollout of simulation software to supplement traditional direct instruction in the middle school science curriculum. Practically every area of human existence in the industrialized nations has been impacted significantly by technology in the last twenty years (Robinson, 2011). The United States Department of Education (USDOE) has challenged the nations school districts to transition to interactive digital textbooks to all students by 2015 (FCC, 2012). In general, students are far more comfortable using computers, smart phones, and texting devices than their parents or teachers (Doyle, 2006). Students are becoming more computer literate, but not necessarily knowledgeable about the content being offered in our schools (Adams, Reid, S., LeMaster, McKagan, Perkins, Dubson, & Wieman, 2008). It is important that educators assess the effectiveness of computer simulations in aiding teachers to raise student achievement (Adams et al., 2008).

Problem Statement

Student achievement has been the primary or most popular justification for the use of simulations in science education (Mumba, Chabalengula, & Bassoppo-Moyo, 2006). According to researchers at Illinois State University, teachers have yet to learn how to properly explain why they chose and use instructional strategies (Mumba, Chabalengula, & Bassoppo-Moyo, 2006). Dr. Frackson Mumba and his colleagues'

indicate that in the last twenty years society has placed more emphasis on animal rights and environmental protections; therefore enhancing the call for the use of simulations in education (Wu, Chang, & Guo, 2008). Hence a reason to use simulations in addition to the researched theory that simulations help students leverage prior knowledge through interacting with simulations that students otherwise would not be able to experience in a classroom (NTSA, nd.). Simulations reduce the need to dissect living organisms like cats. Using simulations instead of experiments eliminates the need to add more toxic chemicals into the ecosystems on each experiment in education K-12 (Mumba, Chabalengula, & Bassoppo-Moyo, 2006). Some researchers believe the utilitarianism theory is the justification for using computer-based instructions like simulations to educate. Utilitarianism theory states students should be taught with the greater good in mind at all times. If more people benefit from the effects of a particular instructional strategy than an alternate strategy, the most utilitarian instructional strategy should be employed (Mumba, Chabalengula, & Bassoppo-Moyo, 2006). The primary objective of utilitarianism is to produce social utility or a benefit to society in general (Mumba, Chabalengula, & Bassoppo-Moyo, 2006).

Research Questions:

The following questions will guide the study:

1. What impact does implementing a Gizmos simulation program have on 8th grade science students' achievement on the Florida Comprehensive Assessment Test (FCAT) in science?
2. What are the teacher's attitudes toward the use of Gizmos branded simulations in the science curriculum?
3. How and at what point do teachers integrate Gizmos simulations into their lesson plans?

Hypothesis: Using Gizmos simulations as a supplemental tool to textbooks, audiovisuals, lectures and worksheets in a middle school science class will improve student scores on the Florida Comprehensive Assessment Test (FCAT) in science.

Operational Definitions:

Technology Enhanced Learning Environment (TELE) - classroom or place of study where students are interacting with personal computers, videos and instructor directed audiovisual presentations to increase student achievement and knowledge retention (Wang & Hannafin, 2005).

Computer simulation – a mathematical model of a real life phenomena presented by a computer program in a visual and audio display of a scientific event or process (Correiro, A constructivist approach to inquiry-based learning: A tunnel assay for the detection of apoptosis in cheek cells., 2008).

Inquiry-based learning – instruction that allows students to experience incongruities between prior knowledge and lessons' main ideas. It is a method of guided instruction that allows students to form conclusions through problem solving.

Technology - is the manner in which research is applied to solve practical problems. It provides a bridging function between research theoretical explorations provided by science on one side and the real-world problems faced by industry (Bell R. L.-N., 2008).

Educational Technology - the “application” of technological processes and tools which can be used to solve problems of instruction and learning (Seels & Richey, 1994, Bell, 2011).

Conceptual Rationale

This study were framed through the lens of constructivism. Constructivism learning theory is based on the belief that learners construct knowledge into and on a mental schema base of prior knowledge (Spector, 2012). Constructivist learning theory was used to guide the practice while using educational technology, specifically Gizmos (brand name) simulations in secondary science education lesson plans. The scores obtained on Florida Comprehensive Assessment Test (FCAT) 8th grade science test after the students are exposed to Gizmos we be analyzed for any positive or negative effects on the students involved. This study follows a Plan, Implement, and Evaluate (PIE) research design. The researcher will plan and implement a mixed methodology of research in a middle school. The researcher will evaluate the effectiveness of the plan formatively. The Researcher hypothesizes that student-centered cognitive learning theories support effective methods of delivering engaging instruction (Popkewitz, Tabachnick & Wehlage, 1982; Resnick, 1987). The literature on using simulations in instructional strategies indicates simulations create student-centered, collaborating learning opportunities for learners (Yin, 1999, Bell, 2008).

Significance of the Study

The teaching profession will benefit from informed research on simulations. Administrators, parents and students were able to purchase software capable of enhancing the learning experience while helping students achieve improved learning outcomes.

School districts, governments, schools and families are being solicited to purchase the newest, greatest technological breakthrough in daily life. The advertisements on phones, planes, games, and the media implore consumers to purchase technology products that promise to help them lose weight, gain muscle, live longer, and get better results in business and education. Ultimately, students in our schools will benefit if we weed out ineffective instructional strategies and increase the frequency of use of strategies that produce better learning outcomes. Pinpointing the reason a teacher chooses to use a particular instructional strategy can be a natural entry to improving teaching practice (Tanner, 2012). For example, simulations allow students to experience “cause and effect” relationships in scientific processes they may not have experience otherwise because of costs and risks associated with the process (NTSA, nd.).

Simulations have been effective tools in training the military, law enforcement and emergency response teams for decades (NTSA, nd.). Dewey espoused the importance of learners ‘experiencing’ a lesson. He also indicated learning increases with student active engagement (Apple, 2008). Active learning is promoted today through problem based learning, cooperative learning and simulations (Bell R. L.-N., 2008). Problem based learning is centered on students solving real life problems (Spector, 2012). Cooperative learning places the learner in groups to collaborate in solving problems (Marzano, 2003). “The key theoretical assumption of learning with simulations is that students construct understanding for themselves by interacting with information and materials, an orientation to learning that has acquired the name “Constructivism” (Savery, 2001).

Educational Technology

Educational technology is the use of technology to deliver and reinforce instruction. The literature lists many forms of educational technology. Educational technology is most often viewed as the use of computers in schools; such as online courses, webcasts, webinars, video gaming, podcasting, simulations, website creation and maintenance. This study reviewed simulations and their impact on the student achievement of 8th grade students exposed to them for a period of no less than 6 months. What has been discovered along the way is evidence that as Bell from the National Science Teachers Association NSTA indicates, “The technology itself is neutral—it is only when technology is combined with an appropriate strategy that it becomes effective” (Bell, 2008). Nevertheless, a recent Public Broadcasting System survey indicated that 93% and 81% of teachers believe interactive whiteboards and tablets respectively enhance learning in the classroom (PBS, 2012).

Learning Theory

Learning theories are the foundation of an instructional strategy. In order to instruct efficiently and consistently, an instructor needs to know how his/her students acquire new information or skills (Lehman, 2011). Constructivists believe that students construct their mental schemas based on personal experiences (Marzano, 2003). This school of thought is most often associated with John Dewey who believed learning had to be “experienced” by the learner. The other most cited constructivists include Piaget, Vygotsky and Brunner (Lehman, 2011). Engagement promotes learning. There is a body of research that emphasizes the importance of student engagement in a lesson. The research supports a constructivist view that children create their own knowledge. When

students are engaged they are actively connecting prior knowledge with the experience at hand.

Constructivist, project based learning (PBL), Peer team led (PTL) or learner-centered instruction has conclusively proven to be an effective instructional strategies (Correiro, Aconstructivist approach to inquiry-based learning: A tunnel assay for the detection of apoptosis in cheek cells., 2008). The whole point of instruction is to create situation scenarios and circumstances that induce students to connect prior knowledge or experiences to the lesson at hand (Lehman, 2011). Japanese education practitioners have incorporated lesson studies into their daily professional development. Lesson studies involve the observation of student reaction and engagement to a lesson plan or sequence of instructional activities. The premise is if a student is not engaged they are not learning. Under this premise the Japanese believe it is paramount to create instructional activities (Smith, 2008). The observations focused on collecting evidence that supports or refutes the use of the selected instructional strategies. It is based upon logic that the best place to begin to improve teaching is in a classroom context where student learning occupies the heart of the process (Lewis, 2002; Stigler & Hiebert, 1999, Smith, 2008).

Constructivism is a learning theory that is clearly student-centered. The word “construct” is used as it describes the process by which the learner receives the instruction (Savasci & Berlin, 2012, Brooks & Brooks, 1999). The theory of constructivism implies the students construct a mental image of the information being conveyed (Savasci & Berlin). Proponents of constructivism in learning theory imply students may create incorrect schemas of the information being taught. One may argue that is the risk involved in the transfer of all information. That being said, in student-centered learning the teacher remains the instructional expert in the same way a coach of a sports team does not play but directs the strategies of the team from the sidelines (Correiro, Aconstructivist approach to inquiry-based learning: A tunnel assay for the detection of apoptosis in cheek

cells., 2008). Constructivism is in contrast to the behaviorist learning theory, which emphasizes the learner's reactions to his/her environment (Skinnner, 1953). The instructional strategies of a constructivist allow learners to interact with a problem with limited assistance (Correio, Aconsructivist approach to inquiry-based learning: A tunel assay for the detection of apoptosis in cheek cells.). A behaviorist would be inclined to direct the learner in the exact way he should go (Skinnner). Constructivists do guide and direct the learners but only after they have a sense of what needs to be understood going forward (Weimer, 2002).

Tanner makes one last point to be considered. The call for more active learning has been heard, and many teachers are working diligently to get students active and engaged in class. Kudos to every teacher who is trying to give students the opportunity to learn by doing. However, as Tanner notes, students can be actively engaged in a hands-on activity, but still may not be doing much thinking.

Activity in and of itself does not promote learning. Activity must be accompanied by a metacognitive component, which requires students to process what they are doing, why they are doing it, and what they are learning from doing it (Tanner, 2012)

Educational Technology: True Value?

Schools are investing millions of dollars in the “nuts and bolts” of educational technology and allied technologies. But the influence of educational technology on K-12 education remains an open question. Are we getting a return on our investment? (Bell, 2008).

The billions of dollars already spent on wiring, hardware, and software have established the materials conditions for frequent and imaginative uses of technology to occur (Bell).

Many students and teachers have acquired skills and have engaged in serious use of these technologies. Nonetheless, overall, the quantities of money and time have yet to yield even modest returns or to approach what has been promised in academic achievement, creative classroom integration of technologies, and transformations in teaching and learning (Cuban, 2001).

Educational technology, explicitly computers and tablets, are being portrayed as the panacea for educational woes in our nation's school system. The United States Department of Education (USDOE) educational publications espouse the virtues of technology in education (USDOE, 2010). However, the research on educational technology clearly indicates no significant increase in overall student achievement based on the use of educational technology. Education suffers from the theory of slow adoption hypothesized by Cuban in 2001. The problem is technology moves too fast for the education's bureaucratic processes (Spector, 2012). School boards and governments are not setup to transform as quickly as the business sector (USDOE, 2010). Someone has to realize corporations are artificial entities. Better stated the corporations have the rights of individuals but none of the possible pitfalls of emotional scars of being mistreated, abused, neglected or violated. These pitfalls are all possibilities for each and every student in the educational realm. Therefore, we cannot just rollout Internet access to all students every time there is a technological breakthrough. The new technology comes with unintended consequences. The wiring of our homes to the World Wide Web has exposed children to pornographic materials and child predators which is only one example of an unintended consequences of technological advancement (Spector, 2012).

In order to create effective learning outcomes, teachers must know how student achievement were accessed. The purpose of instruction is learning therefore an effective instructional strategy has an explicit objective (Gagne, Briggs, 1987). Results in research were interpreted differently depending on what is being measured at the conclusion of the

treatment being researched. For example, educational objectives in motor skills, problem solving and verbal skills, which differ greatly and could not be accessed using identical criteria (Driscoll, 1999). Adapting instructional strategies to meet learning goals may prove to be a more important than increasing exposure to instruction (Cronbach, Learning and Individual Differences, 1967).

CHAPTER II

Literature Review

Over the last two decades, educational technology has been defined as the use of electronic tools: radio television, computers, tablets and the Internet. Prior to the personal computer and social media, educational technology was synonymous with instructional strategy or instructional technology. Gagne (Bell, 2012) has been dubbed the father of instructional technology based on his work with objectives being the starting point of an instructional activity albeit “to know” or “to do” something that demonstrates learning has taken place. Citizens’ protesting educational policies and strategies is often the catalyst school reform. Since the invention of the printing press in the late 1400’s, reformers have protested the introduction of a new technology into classrooms (Bell, 2012).

Standardized testing and NCLB

Standardized testing has become an indicator of school and teaching effectiveness (Coil, 2009). The United States has implemented a standard that 95% of all students in each designated sub-group must be tested. In addition to being tested, each sub-group must show adequate yearly progress (AYP). Schools receiving public funding that do not demonstrate or meet AYP are penalized. Schools that make or achieve AYP in all their sub-groups are rewarded. Schools that fail to make AYP five years in a row can be closed. Steps prior to closing schools included replacing the principal or replacing the principal and the entire staff. This policy was precipitated by the “Nation at Risk” report that concomitantly was the impetus for NCLB of 2001 (Coil).

Technology

Technology is being used by a larger percentage of people in the world.

According to the Pew Institute, 95% of all teenagers in the United States have access to the Internet. Seventy-eight percent of all U. S. teenagers have cell phones and over 90% of them use the smartphone as the primary way to access the World Wide Web (www.pewinternet.org, 2013). Nearly one in four teens in the United States owns an electronic tablet. iPad and iPhone sales have propelled Apple Computers into the most valued brand in the world (Bandenhausen, 2013). Nielsen reports over 57% of all U.S. teenagers own a smartphone (Nielsen, 2012). Teenagers are the fastest growing segment of the industry. The market leader for operating systems for smartphones is Android, a brand owned by technology giant Google (Taube, 2013). Android technology is valued at over 93 billion dollars (Taube). The largest users of technology in the world are children. Internet usage is up all over the world Web (www.pewinternet.org, 2013).

Disruptive Inventions

The pros and cons of new technologies have always been a topic in education. It has been said the invention of the printing press has weakened our students' minds. Today education reformers might easily proclaim the computer has stolen our souls. It is safe to say the printing press did not weaken our minds to any crippling degree. The computer along with the Internet and their effects on the cognitive development of the modern world would not be as an easy argument to defend (Robinson, 2011). Teachers worry students may lose their ability to spell as well as their ancestors because of the proliferation of word processing and spellchecking software and secondly, Google has become a verb in the dictionary (Technology). This chapter contains references to six major studies within the literature on educational technology. This review is comprehensive however, finite. The possibilities and situations being created by the rapid development of new technologies in computers, communication and science have

reduced educational researchers to heuristic servants of society (Spector, 2012). It took decades for the use of air travel to surpass railway passenger travel (Robinson). History has proven that the impacts of new technologies disruptive or otherwise are not apparently predictable (Cuban, 2007).

Technology Companies

The five most valued company brands in the world are Apple, Google, Coca Cola, IBM and Microsoft (Bandenhausen, 2013). Four of the five companies are core technology companies. The four technological giants Apple, Google, IBM and Microsoft are all valued at over a billion dollars and have three things in common. Each of the technological giants are worth over 59 Billion dollars and have amassed that wealth on technology developed within in the last 40 years (www.Business Insider, 2013). Seven of the top 10 most valued brand companies in the world are technologically based (Bandenhausen). Only Coca Cola, McDonald's and Toyota were able to keep up with the growth of the technology companies this year (Bandenhausen). Worth noting, Coca Cola had been the number one branded company in the world for the last 13 years in a row (Bandenhausen).

Constructivism

Vygotsky was a constructivist was the first to pioneer the hypothesis that a learner does not construct knowledge in a vacuum. The implications are learning invariably takes place within a learner's social sphere. Dewey also espoused the belief that as knowledge is "experienced" but within a social (Dewey, 1907). That is not to say learning must take place with others. Social context involves interpersonal as well as intrapersonal communication. Therefore it is in that lens that we study educational

technologies and their use in a social as well as theoretical context. Several motivation and cognition theorist equate intrinsic and extrinsic motivation with the learner's self-concept (Bell, 2012).

The rapid revenues generated by the technological behemoths are derived by the dramatic fixation with hand held electronics that interface with the Internet (Bandhenhausen). Consumers of all ages are using smartphones and tablets. Facebook is the world's leading social media website with over 1 billion users. Twitter is the world's most popular micro blogging service with more than 500 million active users (Pew Institute, 2012). WordPress is a free blogging service and content management service with over 64 million registered blogs worldwide (U. S. Department of Education, 2013). Amazon is another technology company worth over 23 billion dollars (Bandhenhausen). Amazon markets and sells goods and services via the Internet. Amazon is conducting research on disruptive technology to deliver packages via drones. Google which owns video website YouTube (over Billion visitors with 4 billion videos watched per month) is the third most valued brand in the world (Bandhausen).

Companies with large profits have invested in lobbying campaigns to influence politics, society and education. Bill Gates, whom some consider the richest man in the world, runs the Bill and Melinda Gates Foundation valued at \$36 billion US dollars and has donated \$454 billion dollars to 185 higher education institutions since 2006 (Chronicles, 2013).

21st Century Students

A prominent thought among educational practitioners on all levels is students of today are over stimulated by the multitude and of handheld gadgets and electronic games they play (www.pewinternet.org, 2013). Adolescents have grown up using interactive

games, operating consoles like PS4 and Xbox, iPods, personal computers, tablets and most recently touch screen technology. Most educational reformers and educators agree that the latest technology (tablets, touch screens, smartphones) should be included in the pedagogy of modern education (U. S. Department of Education, 2013). The United States Department of Education (USDOE) has initiated a technology plan for all our Nation's schools that involves outfitting all our schools with wireless Internet connectivity (Porter, 2013). A recent Pew Institute data survey indicates that African American students are overrepresented in the amount of electronic gadgets they own per person. Increased use of technology has not translated into higher academic achievement for African Americans. African Americans have consistently performed lower academically than their white counterparts (U. S. Department of Education, 2013).

Experts Calling for Technological Integration into Classrooms

There is no shortage of experts stating the role of teachers and education must change to deliver all that the Internet has to offer learners (Robinson, 2011). One dynamic change on the Internet is the development of Massive Open Online Course (MOOC) offered by the most prestigious institutions of higher learning in the world. Last fall, Harvard and MIT formed a partnership with Google to create the edX initiative to produce a catalog of MOOCs. Google also announce the creation of www.MOOC.org, which allows Internet users the ability to create MOOCs from scratch. MOOCs have become game changers for several University professors who are now internationally known like Harvard Professor, Michael Sandel through MOOCs they have taught. Professor Sandel can fill a 14,000-seat arena with students clamoring to experience his lectures on China studies and other studies live (Basulto, 2013).

The Open Education Alliance and companies like Udacity are forging ahead creating open access to education. It is taking place all over the world. Companies like Coursea are offering certificates of completion and college degrees for students who complete their programs. Georgia Tech is partnered with AT&T and launched a Master of Science in Computer Science Degree (Basulto). The online program is marketed at \$6,600 total price tag. The tuition for the entire program is cheaper than one semester at a traditional college including Georgia Technological Institute (Basulto).

Social Media in Education Today

Websites like Khan Academy are educating people all over the world for no cost. Khan Academy is a free website that instructs Internet users on hundreds of topics in math and science. A typical Khan Academy lesson lasts 5- 10 minutes and usually features the site founder Salman Khan. The website is a nonprofit and heavily funded through educational grants. Khan Academy is at the forefront of the concept of “Flipping Classrooms”. This is a concept where teachers videotape their lessons or lectures for students to view at home. Upon the student's return to class they complete problems that exercise the use of knowledge discussed in the video lessons.

Facebook has over a billion users and many of them are school age children (Pew Institute.org). Edmodo.com is a social media interface that allows teachers and students to post messages, pictures and videos in the same way students are accustomed to doing on Facebook. In colleges, students are accustomed to using Blackboard to communicate with their professors. Most education practitioners take it on face value that using technology in education equates to more effective delivery of instruction (Cuban, 2007).

Many of the technologies in use in classrooms today do engage students more effectively than textbooks and direct instruction (Cuban, 2007). However, the most

recent National Report Card on Education or NAEP standardized test scores for 3rd, 8th and 10th grade American students do not show favorable gains in the overall performance of American students in Reading, Science and Mathematics (Willingham, 2012). American students are ranked 24th, 28th, and 36th in academic performance in Reading, Science and Math respectively as compared to developed nations in the world (OECD, 2012). Some educational researchers point out that America should not be compared to developed countries dissimilar to their size and demographics (Ravitch, 2008). Several states like Florida and Massachusetts have elected to have their students compared internationally (as if their states were their own country) on the Program for International Student Assessment (PISA). The PISA is a series of assessments (reading, math and science) administered every three years to 15-year-old students in OECD member countries. As a result both Florida and Massachusetts standardized test scores are higher than the national averages in America (NCES, 2012).

Educational Technology and Constructivism

Educational technology is important in that technology tends to be engaging. Theorists like Wehlage (1989) indicate that engagement is the doorway to learning for most learners. If you can engage a student you can teach them. Ted Sizer (1984) hypothesized that he could teach students in a factory as long as they were hungry for knowledge. The literature emphasizes the constructivist approach to teaching is effective. Technology allows lesson plans to become student centered, which is a major attribute in constructivist teaching practices (Bell, 2012). Teachers' attitudes toward technology have been studied to see if it affects learning outcomes and whether or not teachers will integrate technology into their lessons. Studies have also been done to see how technology is used. Technology has been found to be used to a large degree to

enhance what is already being done in the classroom (Cuban, 2008). There are five major categories of computer usage in educational technology:

- Teaching machines: games, simulations, test prep modules
- Productivity tools: PowerPoint presentations, word processing
- Internet portal: access to information, web quests
- Test giver: computer based testing quick return of results
- Data processor: teachers using data to drive curriculum and administrative decisions (Pflaum, 2004).

Pflaum writes “. . . too much time is spent on the mechanics of computer-based tools and too little time is spent on the content being studied” (2004).

Pedagogy and Content Knowledge

Shulman (1987) theorized that pedagogy and content knowledge are two separate areas of knowledge that an effective teacher must have. Pedagogy is the knowledge of how to make content knowledge comprehensible to learners. Content knowledge is knowledge of the specific activity or subject area that is being taught. Mishra (2005) established that because of the increase of technology in education, more thought must go into the aspect of technological integration. Mishra’s data research highlights the importance of teachers possessing pedagogical and content knowledge, along with technological knowledge. In addition to operational knowledge, a teacher would need to know how to effectively integrate technology into a lesson to raise student achievement (Koehler, Mishra, 2005). Cuban’s research has highlighted ineffective uses of technology in our schools. Technology has not done an effective job of raising student achievement based on standardized test scores (Cuban, 2008). Constructivist teachers have used technology effectively in some research. Students tend to be more engaged

and motivated through constructivist teaching practices (Bell, 2008). Several studies show at risk students are motivated by the hands-on practices that are present in the constructivist teaching strategies espoused by Dewey and Vygotsky (Marzano, 2003). There are many studies that support the integration of simulations into math and science lessons. It is evident that technology creates engagement in math and science classrooms (Bell, 2008).

Shulman PCK

Teacher education initially involved teaching teachers content knowledge or pedagogical knowledge exclusively. Content knowledge was favored at the expense of pedagogical knowledge more often than not. In 1986 Shulman, theorized that this was the wrong approach. He created a framework that is often cited in the literature called Pedagogical Content Knowledge (PCK figure 1) that emphasizes the intersection of pedagogical and content knowledge in teaching (Bowles, 2004). He indicated effective teachers have adept knowledge of both pedagogical (ways students learn) and content (subject being taught). PCK is a framework that highlights the intersection of pedagogical and content knowledge which is the area that contains the most taught topics in a content area and the most effective uses of analogies, illustrations, and explanations, for teaching those topics (Mishra, 2009).

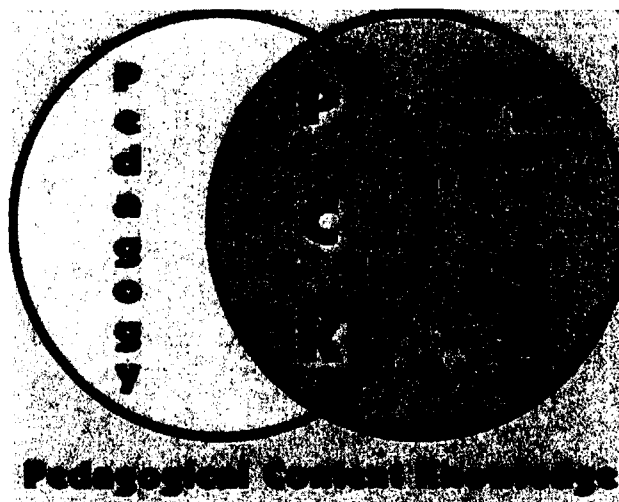


Figure 1: Pedagogical Content Knowledge (PCK)

Technology

Prior to 1985, technology was in the foreground in teacher education. Overhead projectors, textbooks, blackboards, charts of the periodic table, typewriters and pens were not considered technology in education (Mishra, 2009). Today, computers, simulations, software, hand held devices, tablets, interactive clickers, smartphones, educational games and interactive whiteboards are considered technology (Mishra, 2009). The new technology has the potential to change the way content is introduced, presented and reinforced into the mental schema of students (Spector, 2012). Not all teachers are enthusiastically using the new technologies nor are they required to. Researchers indicate that may change in the future.

The body of literature, as recently as 2009 has called for more research on effective strategies in implementing technology. The theoretical framework of Technology, Pedagogical and Content Knowledge (TPACK) was created by Mishra (2006) to address ways technology could be integrated into education producing positive learning outcomes. Mishra believes that teachers must be taught the close relationships that technology, pedagogy, and knowledge content possess (Mishra, Koehler, 2006). The

relationship is displayed in the theoretical framework depicted in figure 2. Mishra believes that technology activities should be viewed as subject specific (Mishra, Koehler, 2006). She calls for more research on exactly what activities are conducive to the transfer of knowledge in specific subjects (2009). Mishra relates that a technological activity may be better suited for social studies than math instruction. Mishra also believes technology used in the classroom should be used in the professional development course of the students' teachers (Mishra, Koehler, 2006). The theoretical framework of TPACK emphasizes that connection between technology used in teacher professional development and teacher classroom instruction (Mishra, Koehler, 2006). The body of literature indicates technology has been introduced with very little concern for evaluating its true value in improving student achievement (Willingham, 2012).

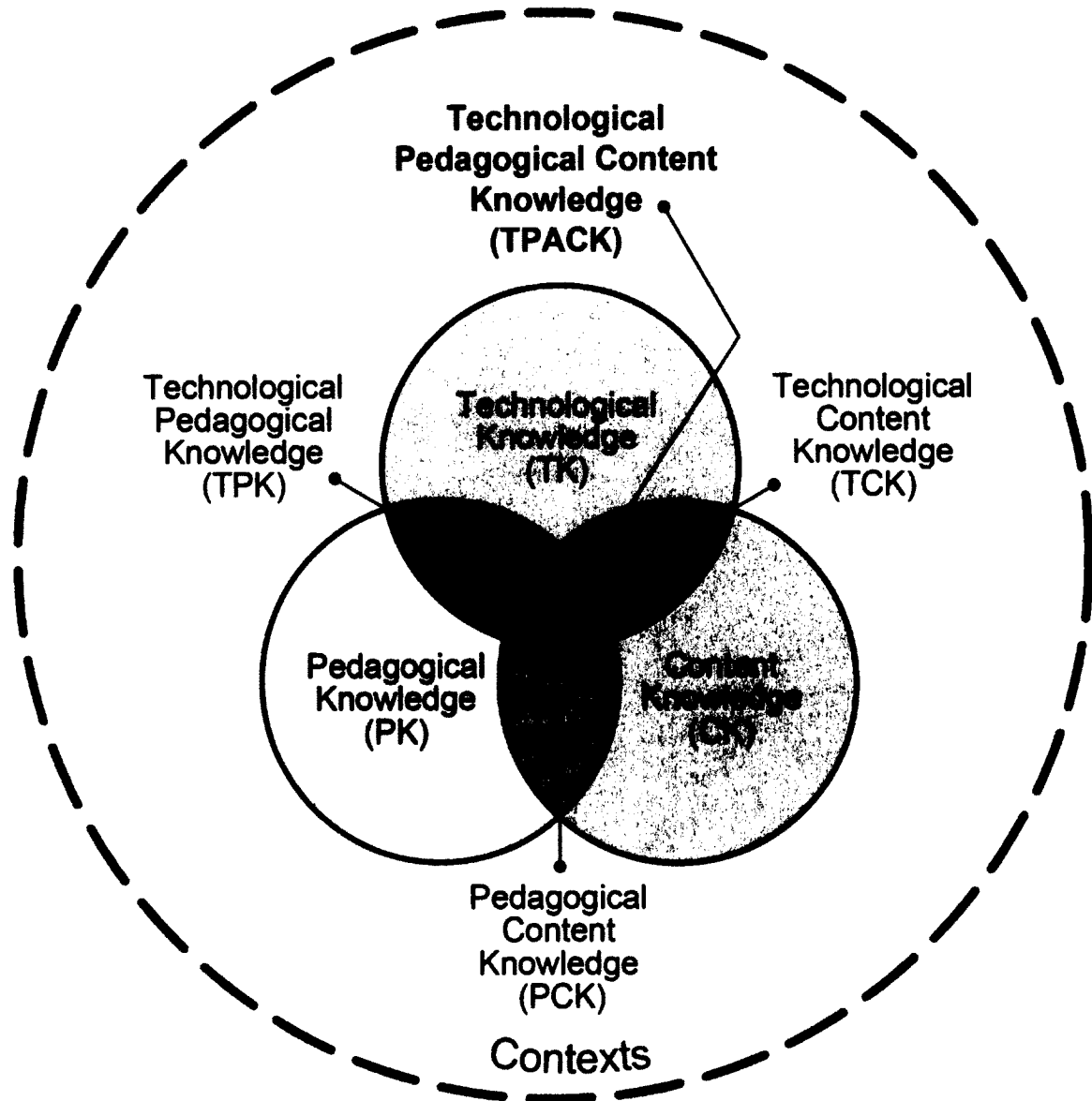


Figure 2: Technological Pedagogical Content Knowledge

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TPACK allows a framework for looking at the four new areas of knowledge that are created by the intersections of

- Technological pedagogical knowledge (TPK)
- Technological content knowledge (TCK)

- Pedagogical content knowledge (PCK)
- Technological pedagogical content knowledge (TPACK)

The TPACK framework has three pairs and one triad of knowledge intersections.

Research indicates the justification for the new framework and technology is now in the foreground of showing learners the examples, analogies, simulations and concepts of content Shulman highlighted in the PCK theoretical framework (Shulman, 1986).

Computer use in education indicate: “. . . raised pupil motivation, interest and enjoyment of the subject and raised the status of the subject in the students’ eyes” (Selinger, 2006).

Research on Information Communications Technology (ICT) done in the United Kingdom in the 1990’s on over 2000 students indicates the following overall use of simulations in science instruction had a positive effect on student understanding of basic science ideas. “The critical feature of simulations, for learning, is the student’s ability to experiment and experience ‘cause and effect’ activities firsthand (Winn, 2012).

Simulations could involve performing a hip transplant or a chemical titration. Students obtained deep understanding of concepts in science with the use of simulations. The teacher enhanced the positive effects of the simulations treatment when students were supported with scaffolding (Winn, 2012).

Technology and Constructivism

Mishra indicates that a teacher integrating technology into his or her instructional strategies needs more than PCK to effectively involve the learner in the process of knowing (Shulman, 1987, Driscoll, 1999). The teacher needs to also have technological knowledge on how to operate the technology. Understanding the learning theory that he or she wishes to employ in the lesson is important (Mishra, 2006). For example, simulations use in science promotes constructivist or student centered, social cognitive

learning experiences where the learner creates what Piaget hypothesized as mental schema (Newby, 2010; Vygotsky, 1978; Piaget, 1929). Simulations place the learner in a “what if” learning environment without the dangers associated with the real life event. For example, open-heart surgery can be simulated without endangering a human patient. Students can learn to fly jets via flight simulators without risking passengers’ lives. Constructivist learning theory promotes this type student engagement. Therefore a teacher utilizing this theory would employ technology that he or she could operate to engage students in science inquiry (NSTA, 2001).

Simulations in Science Instruction

According to the National Science Teachers Association (NSTA), research shows the use of simulations in science instructions shows measurable achievement gains. The use of simulations is as effective, if not more effective, than traditional instructional strategies in science teaching involving textbooks and other two dimensional educational artifacts like charts and videos. Other cited benefits of computer simulations in science instruction are time and cost efficiencies and issues related to simulating experiments and phenomenon behind the budget of most schools (Spector, 2012, Bell, 2012).

Gizmos simulations have won several awards in educational technology and are featured in the NSTA literature on best practices for use of simulations in instructional strategies (Bell, 2008). Gizmos are based on constructivist theory of learning that involves the learner in experiencing the content of the simulation (Dewey, 1897, Newby, 2011). Learners are allowed to problem solve in collaboration with the software and or learners in their cohort.

Gizmos simulations are delivered via www.explorelarning.com to learners. The course instructor assigns Gizmos to a class he or she has set up on the class Gizmos page.

Each Gizmos or simulation has accompanied assessment questions and a student activity worksheet. Prior knowledge questions are asked prior to the learner running the Gizmos simulation. After asking the prior knowledge question the student is instructed to setup initial parameters then run the simulation. A student activity sheet walks the learner through a series of simulations and corresponding questions. The student activity is student-centered, problem-based and can also perform via whole class instruction or in groups. Gizmos simulations employ the constructivist learning characteristics of collaborative, student-centered, teacher as a facilitator-learning model (Newby, 2010; Bell, 2008). After completing the student activity sheet students answer five online, multiple choice assessment questions. The students are given immediate feedback on their answers for self-regulation. The Gizmos software evaluates each self-assessment question and informs the learner(s) as to why an answer is either incorrect or correct. Gizmos simulations utilize visual and sound effects to help learners construct associations with prior knowledge. For example, the Gizmos digestion simulations takes advantage of sound effects (gas being release from the large intestine) that occur during digestion learners are familiar with. Researchers hypothesizes that student-centered cognitive learning theories support effective methods of delivering engaging instruction (Popkewitz, Tabachnick & Wehlage, 1982; Resnick, 1987). The belief that the use of simulations in science lessons creates more student engagement is well documented in the research.

Simulations offer a fun and effective way to enable students to learn by doing. By using computer-based simulations, we can vastly broaden the range of things students can learn by doing (Schank, 1995).

Studies show teachers who use simulation technology report increases in student engagement in science (Spector, 2012). Teachers' use of simulation technology to raise student achievement as measured by standardized test scores in science needs additional

research (Newby, 2010, Bell, 2008). The simulation software, when used in personalized learning at the school level, provides a clear look at the efficacy of technological innovation in the classroom (Spector, 2012). Using Gizmos in this capacity would also allow teacher and student attitudes on the innovative technology to be surveyed. Figure 1 is a visual depiction of Mishra and Koehler's TPACK theoretical framework of the interrelationships between technical, pedagogical and content knowledge.

Summary

The Nation at Risk report has spurred on an era of accountability and standardized testing (Kumar, 2013). Technology has a major influence on today's learner in the form of media that did not exist when this era of standardization and testing began (Mishra, Khoeler 2006). In response to the increased presence of technology in our society, school districts are mandating digital initiatives all over the country with an emphasis on closing achievement gaps in education, both within the United States and between the US and other leading developed countries (Marcoux, & Loertscher, 2009). Due to its focus on the student and a strong inquiry based pedagogy, Constructivism has emerged as a best practice in education (Marzano, 2003). For example, simulations use in science promotes constructivist or student centered, social cognitive learning experiences where the learner creates what Piaget hypothesized as mental schema (Newby, 2010; Vygotsky, 1978; Piaget, 1929)). Simulations place the learner in a "what if" learning environment without the dangers associated with the real life event (Foti, Ring, 2008). For example, open-heart surgery can be simulated without endangering a human patient. Students can learn to fly jets via flight simulators without risking passengers' lives. Constructivist learning theory promotes student engagement therefore, a teacher utilizing this theory would employ

technology that he or she could operate to engage students in science inquiry (NSTA, 2001).

Constructivist theory supports the inclusion of simulations in instructional strategies because they have been proven effective at engaging and creating collaborations among learners (Bell, 2012 Spector, 2012). The literature indicates simulations are not effective instructional strategies onto themselves, but instead should be used as supplemental tools (Bell, Newby, 2012). Explorelearning.com features simulations specifically engineered for science education. This program provides an opportunity to do research on a topic that has yet to be studied in depth: the effective use of simulation technology to raise student achievement.

CHAPTER III

Methodology

Methodology: Action-based research were employed to take advantage of a variety of different parameters both quantitatively and qualitatively to reinforce the renouncing of bias in the study. Mixed methodology were employed to ensure the validity, reliability and objectivity of the study (Wang & Hannafin, 2005). Design-based framework will employ survey, comparative analysis of post and pretest scores of 8th grade student's achievement on the FCAT. Expert review of practitioners were used to assist the researcher in building context for the practice.

Research Questions

1. What impact does implementing a Gizmos simulation program have on 8th grade science students' achievement on the Florida Comprehensive Assessment Test (FCAT) in science?
2. What are the teacher's attitudes toward the use of Gizmos branded simulations in the science curriculum?
3. How and at what point do teachers integrate Gizmos simulations into their lesson plans?

Setting

The study took place in an urban suburban Title I (51% or more free and reduced lunch) middle school in the southeastern United States. The school has been rated as an “A” school by the State of Florida for ten years in a row. The average years of teaching experience per teacher are 16.4. The current principal will have been at the school for 10 years. The researcher selected the group from of advanced and regular placement in science students. Students are placed in advanced or regular science classes based on their FCAT test scores in math and reading. Florida uses coded intervals to analyze student test scores. There are 5 levels or intervals in which data is categorized. Level 1 is the lowest and level five is the highest interval of test scores. Level 3 is considered the level of proficiency for student test scores. If a student’s scores meet level 3 criteria, the student is categorized as proficient in the subject area for their grade level (FDOE.org, n.d.). At least 80% of the students in advanced science classes this year are level 3 or above in Reading and Math scores on the FCAT. In contrast at least 80% of the students in regular science classes are level 2 or lower in either Math or Reading scores on the FCAT.

From this group, a sample of scores from students randomly assigned to two specific middle school science teachers over a two-year period were recorded and compared. The sample consisted of students who have had teacher A for 7th grade-advanced science and then teacher B for 8th grade advanced science. The first cohort of teacher A/teacher B advanced science students will take the 8th grade science FCAT without experiencing Gizmos simulation software. The second cohort of teacher A/teacher B students will have experience the same two teachers with the addition of using Gizmos simulation software for at least three grading periods with each grading period lasting approximately 9 weeks.

There was no attempt to manipulate or influence who was placed or not placed in both teachers' classes. A random process that allowed students to be distributed to each prospective teachers' classes was adhered to as in years past at the school. It should be noted that a student with a FCAT score of less than 3 (non proficient) could be placed in an advanced-science class at the request of a student's parent/guardian. In addition, a teacher or guidance counselor can recommend students categorized as "non proficient" for advanced placement. The staff member must document why he or she feels the student would benefit from advanced placement. The student's grade administrator determines the final acceptance or denial of advanced-science placement. The grade administrator is the assistant principal assigned to the student's grade. On average, students with less than a level 3 score in either math or reading on the FCAT account for less than 5 % of all students in advanced-science in EMS. Less than 1% of students in advanced science are less than level 3 in both math and reading for the FCAT. The makeup of the students assigned to advanced-science is reflective of the school wide demographics stated above. Ninety percent of the students in the cohorts are between the ages of 11-13 during the course of this study.

Subjects

Data was gathered on a cohort of students that had been instructed in the 7th grade by the lead researcher utilizing audiovisual presentations, textbooks, direct instruction and weekly hands on scientific inquiry labs. In the following year, an 8th grade instructor utilized a brand Promethean interactive whiteboard (IWB) supplemented by simulation software, direct instruction and textbooks to instruct the cohort. The cohort consisted of students taught in the 7th grade by teacher A in 2011-2012, who were also taught by teacher B in the 8th grade using Gizmos training simulations software in the

2012-2013 school year. Since assignment of students to both teachers is a random event that neither teachers nor the researcher have the ability to influence, the samplings that form the final cohort were random. By utilizing a group that would be randomly assigned to another set of teachers, the researcher able to eliminate selection bias in the sampling process. The demographics were 7th grade science students in a middle class neighborhood in 27.2% Black and 29.1 Hispanic 3.61 % Asian, .22% Native American and 36.9% White. There is an enrollment of 1357 students in grades 6-8. There are 709 males and 648 females enrolled in the Middle School.

Data Collection Techniques

Surveys were done online for parents to give their input about the school the students in the study attended. Surveys were used to assess the attitudes of parents of the students in the study concerning technology used in the school. The survey instrument were used to probe the effects of simulations in school on student motivation and achievement. The survey is designed to capture teacher and parent attitudes toward technology because not all the students in the study will have experienced Gizmos. Data from a reliable survey on technology in RMS is administered yearly by the school district. Data on the parental attitudes during the study were added to the study to help analyze the impact of Gizmos simulations on the parents of students involved in the study. The study will review the data from the parents whose children experience both teacher A's and teacher B's classes.

The method for administering the survey to parents will involve emailing a link to parents to access the survey. Online surveys were used. Students will not given extra credit or rewards for parents completing the survey in order to prevent the Hawthorne effect from taking place during the study (Fraenkel, Wallen, 2009). The teachers

involved with the study will also be surveyed for their opinions on the effectiveness or ineffectiveness of the Gizmos software in increasing student scores on the science FCAT. The type of data gathered were both qualitative and quantitative. Students in the study exposed to Gizmos in the 8th year of science saw an average of 3 Gizmos per month during a 180-day instructional calendar. Data were analyzed to verify its validity and reliability (Anderson & Shattuck, 2012).

The school curriculum specialist and the researcher will gather the data for this study. The FCAT scores were obtained from the district data warehouse on the district website. All students will remain anonymous. Only the test scores from the students that encompassed the subset of students that have taken both teacher A and teacher B's advanced-science were analyzed for the outcomes influenced by the Gizmo simulation software.

Table 3.0: Depiction of the student demographics of the school where the study was conducted.

Black or African American	370 - 27.2%
Hispanic or Latino(a)	396 - 29.1%
White or Caucasian	502 - 36.9%
Asian-American	49 - 3.61%

Native American or Native Indian	3 - 0.22%
Native Hawaiian or Pacific Islander	0 - 0 %
Total Boys	709
Total Girls	648
Total Count	1357

The researcher documented that students were exposed to the online simulation software an average of three times a month as mandated by the study. Second, researcher ensured that the amount of exposure the students have to the software was accurately documented. Third, the amount (i.e. one semester, one day) and type (online, workshop, college course) of training the administering teachers have with implementing with Gizmos simulations within lesson plans were documented. Fourth, the qualifications of the teachers to deliver the content and instructional strategies afforded by Gizmos online simulation software were documented. The amount of Gizmos modules was an average of three Gizmos lessons per month over a 180-day instructional period from August of 2012 to April 2013. All the teachers in this study were licensed and certified Florida educators. All the educators mentioned in this study completed an in house Gizmos administration course successfully before the software was introduced in the classroom.

The researcher will conduct a survey among the teachers involved in the study (Appendix A). The survey were used to capture attitudes of the teachers instructing the students in this study toward Gizmos software. Finally, test results from the 8th grade science FCAT for the subjects in the study along with parent customer service survey (appendix B) were collected and sorted from the district data warehouse.

Pilot Study

The teacher survey was piloted among (6) Middle School science teachers at for readability, validity and reliability. The six science teachers were asked to complete the survey over a five-day period. Each respondent were given an electronic copy of the survey. Hard copies of the survey were made available to respondents upon request.

Ethical Considerations

Researchers must ensure that the validity and reliability of their studies are not devalued via intentional or unintentional bias. The possibility of the Hawthorne effect is eminent in a design-based action research study. The relationship between the respondents in the study and the researcher were documented to maintain the context of the data being gathered, analyzed and interpreted (Anderson & Shattuck, 2012). International Review Board standards of scientific testing must be upheld throughout the study. The individual test scores of students were kept anonymous to maintain confidentiality. No student's access to quality information and instruction was impeded or delayed throughout the study for any reason or by anyone involved with this study.

Data Analysis

Statistical significance in test scores were used to indicate if exposure to the Gizmos simulation software for the school year prior to taking the 8th grade FCAT in science results in higher student achievement on the test. A statistically significant improvement in the targeted cohort's FCAT scores within the standard deviation of the tested population would indicate that there is a place for simulations in K-12 scientific instruction.

FCAT test scores were obtained from district in a form subdivided by benchmarks. The researcher will attempted to pinpoint benchmark S.C.7.N.1.3, whose purpose is to “distinguish between an experiment (which must involve the identification and control of variables) and other forms of scientific investigation and explain that not all scientific knowledge is derived from experimentation” (cplams.org). The researcher looked at the benchmarks that the Gizmos by www.explorelarning.com “Growing Plants” correlates to and evaluating FCAT results of student who have use the Gizmos versus the students who have not. Benchmark S.C.7.N.1.3 is assessed at up to a possible 11 points on the 8th grade FCAT. Points scored on the target benchmark were collected and graphed to compare the two cohorts in the study. The cohort not exposed to Gizmos simulations were compared to the cohort that has been instructed using Gizmos. Using the results from both the FCAT benchmark scores and the teacher, parent survey results, the researcher probed for answers to the research questions.

Summary

The researcher compared two cohorts of middle school students who have experienced the same two science instructors and curriculum over a two-year sequence. The school, curriculum and instructors were the same among the cohorts' instruction in science. The difference between the two cohorts was the introduction of

explorelarning.com Gizmos simulations to one group as part of the instructional strategy. The researcher analyzed how well the individual students score on the FCAT and specifically Life Science and Physical Science portions of the science FCAT. The teachers' and parents' attitudes towards Gizmos simulations and their effects on student achievement were collected via survey (appendix A) (appendix B). The researcher used quantitative data from the district warehouse along with qualitative data from teacher and parent survey results to answer the research questions of the study.

1. What impact does implementing a Gizmos simulation program have on 8th grade science students' achievement on the Florida Comprehensive Assessment Test (FCAT) in science?
2. What are the teacher's attitudes toward the use of Gizmos branded simulations in the science curriculum?
3. How and at what point do teachers integrate Gizmos simulations into their lesson plans?

CHAPTER IV

Findings

This study was conducted to see if Gizmos simulations impacted the standardized test scores of 8th grade science students in a southeastern middle school. The researcher looked at the science FCAT test scores of two cohorts of students. The two cohorts consisted of students who had two science teachers in common over a two year period at the same middle school. The study involved the surveying of teachers in the school that used Gizmos in their lessons at school. The researcher also surveyed the parents of the students in the study to gauge the impact of using educational technology beyond the classroom. In addition to the parent survey used in this study the researcher acquired data from the district's data warehouse on parental attitudes towards the school and the use of technology in the classroom. This chapter will use the gathered data to answer the following research questions:

5. What impact does implementing a Gizmos simulation program have on 8th grade science students' achievement on the Florida Comprehensive Assessment Test (FCAT) in science?
6. What are the teacher's attitudes toward the use of Gizmos branded simulations in the science curriculum?
7. How and at what point do teachers integrate Gizmos simulations into their lesson plans?

Purpose of the Study

One of the largest school districts in the southeastern United States implemented a district-wide rollout of simulation software to supplement traditional direct instruction in the middle school science curriculum. Practically every area of human existence in the industrialized nations has been impacted significantly by technology in the last twenty years (Robinson, 2011). The United States Department of Education (USDOE) has challenged the nations school districts to transition to interactive digital textbooks to all students by 2015 (FCC, 2012).

In general, students are far more comfortable using computers, smart phones, and texting devices than their parents or teachers (Doyle, 2006). Students are becoming more computer literate, but not necessarily knowledgeable about the content being offered in our schools (Adams, Reid, S., LeMaster, McKagan, Perkins, Dubson, & Wieman, 2008). It is important that educators assess the effectiveness of computer simulations in aiding teachers to raise student achievement (Adams et al., 2008).

School Parent Survey Description

Each year, district conducts a survey of its teachers, parents and student population to receive feedback on the standards, conditions and general sentiment each school has cultivated. The parent responses to the survey for the study school were used to establish a baseline for eliminating other variables that might affect student performance. The study results established that the majority of parents felt that the school was a safe environment where students received adequate to exemplary instruction. 84 percent of parents perceived the study school as an 'A' or 'B' school and

a full 99 percent of parents surveyed identified the study school as a 'C' school or better based on the Florida Department of Education's school rating system.

Parents surveyed also 'agreed' or 'strongly agreed' with statements that the learning environment that produced the analyzed test scores used educational technology in its instructional strategies.

The district's annual parent survey indicated parents believe their children acquired adequate access to computers and educational technology at study school. For the statement, "My child's current teachers have taught him/her how to use technology (computers and internet) to do his/her schoolwork." 70 percent of parents answering the survey 'agreed' or 'strongly agreed' with this statement. 78 percent of parents surveyed also 'agreed' or 'strongly agreed' with the statement, "My child has sufficient access to computers and technology at school to do schoolwork." Three quarters of all respondents also 'agree' or 'strongly agree' that their child has adequate access to computers and Internet at school. The survey results continue in this pattern with the majority of parents expressing faith in the amount of time, energy and resources that the school invests in technology and the technological instruction.

The teachers do not express the same level of confidence. Only 32 percent of teachers felt students had adequate access to computers and the Internet during school. 70 percent of teachers surveyed either 'agreed' or 'STRONGLY AGREED' that they give adequate instruction and help with regards to technology. Through their responses, the teachers paint a picture that technology and its instruction are given to students in sufficient quantities when they are available. Availability of technological resources and time present challenges for curriculums that only allot a certain amount of time for covering material, teaching Common Core standards and preparing all students (ESE, ESOL and General Ed) for testing like FCAT and quarterly common assessments.

Study participants were given sufficient access to technology and class time to implement with consistency the weekly use of Gizmos software for Cohort 2 over the 2012-13 school year. Both teachers also received training on the implementation of Gizmos to ensure their proficiency. With these variables controlled and the members of each cohort randomly selected, the study has established parameters to best answer the first study question: What impact does implementing a Gizmos simulation program have on 8th grade science students' achievement on the Florida Comprehensive Assessment Test (FCAT) in science?

Table 4.0: FCAT Scores Analyzed

Cohort	Students in Regular Science	Mean Score	Students in Advanced Science	Mean Score
1	1	25	9	42
2	10	26	2	42

There are four main categories of assessment on the science FCAT. The four categories are: Nature of Science, Earth and Space, Life, Physical and Chemical Science. A student can score a possible 11, 15, 15, and 15 points respectively in these categories for a total of 56 points. These results focused on the categories that are the focus of the 7th and 8th grade classes: Life Science and Physical & Chemical Science respectively. However, the students' overall scores provide an important starting point for examining the results. As shown in the table below, Cohort 1 contained nine advanced science students and one regular science student. Cohort 2 contained two advanced science students and eight regular science students. On the science FCAT, the advanced science

students in Cohort 1 and Cohort 2 both had a mean score of 42 points. They were tested a year apart but the means were the same.

Similar results were found for the students in regular science classes. The one student from regular science in Cohort 1 earned 25 points on the science FCAT. The eight regular science students in the Cohort 1 had a mean score of 26 points. These results seem to imply that the effect of Gizmos on science FCAT scores is not statistically significant; however, a closer look at the two targeted categories reveals a more complicated picture.

Table 4.1: FCAT Scores Analyzed (continued)

Cohort	# of Regular Science Students	Mean Score Physical Science	# of Advanced Science Students	Mean Score Physical Science
1	1	6	9	10.6
2	10	7.9	2	13

On the Physical & Chemical science portion of the FCAT, the one student from regular science in Cohort 1 who did not experience Gizmos earned 6 points out of 15 available. The ten regular science students in Cohort 2 who experienced Gizmos regularly had a mean score of 7.9 points for the Physical & Chemical science portion of the science FCAT. Cohort 2, the group that experienced Gizmos as a regular part of their curriculum over a one-year period, produced mean scores approximately two points higher than their counterparts in Cohort 1.

The two point difference between mean scores was consistent for both sub-groups within the two cohorts. The nine advanced science students in Cohort 1 had a mean score

of 11.1 points. The two advanced science students in Cohort 2 produced a mean score of 13 points, approximately a full two points higher, in the Physical & Chemical science portion of the FCAT.

Table 4.2: FCAT Scores Analyzed (continued)

Cohort	# of Regular Science Students	Mean Score Life Science	# of Advanced Science Students	Mean Score Life Science
1	1	7	9	11.9
2	10	6.3	2	10.5

The mean scores on the Life Science portion of the science FCAT, while consistent between sub-groups within the two cohorts, followed a different pattern. On the Life Science portion of the FCAT, the one student from regular science in Cohort 1 earned 7 points out of 15 available. The ten regular science students in Cohort 2 had a mean score of 6.3 points for the life science portion. The difference was .7 points or approximately 1 full point decrease between the score of the regular science student in Cohort 1 and the mean score of the regular science students in Cohort 2 the following year.

This pattern also emerged between the advanced science students in Cohorts 1 & 2. The nine advanced science students in Cohort 1 had a mean score of 11.9 points. The two advanced science students in Cohort 2 also had a mean score of 10.5 points in the life science portion of the FCAT.

These results provide the context for answering the first question of the study, what impact does implementing a Gizmos simulation program have on 8th grade science students' achievement on the Florida Comprehensive Assessment Test (FCAT) in

science? At an initial glance, the scores do not show a significant statistical difference between cohorts. In fact, the mean scores for Cohort 1 and Cohort 2 among advanced science students are identical. It is only when analyzing the data for the two content areas covered using the Gizmos simulations that a pattern emerges. The mean scores for both the regular and advanced science students of Cohort 2, the group that experienced the Gizmos software as a regular part of their curriculum, was two points higher in the physical science portion of the FCAT than their counterparts in Cohort 1, the group whose curriculum did not include Gizmos.

This pattern was not present in the results for the Life Science of the science FCAT. In fact, there is a decrease in the average points earned in the life science portion of the FCAT among both regular and advanced students.

Teacher Survey Description

Given the research on Gizmos simulations and their positive effect on student content knowledge, the responses to the teacher survey and the second survey question, ‘What are the teacher's attitudes toward the use of Gizmos branded simulations in the science curriculum?’ were not as expected. Based on the survey results, teachers seemed indifferent to the overall effectiveness of the Gizmos simulations as an instructional strategy. See Appendix C for full survey results. In the survey results, 9 out of 10 teacher did not assign Gizmos simulations as a warm-up or as a homework assignment. The majority of the teachers’ agreed that Gizmos is an activity that is best conducted under the supervision of a teacher. This practice is in line with the research indicating that simulations are more effective as instructional tools when teachers utilize scaffolding techniques in tandem with the activity.

The teacher survey indicates that some teachers felt Gizmos lessons were above the academic proficiency level of the students in their classrooms. Scaffolding is recommended for simulations that are used in instructional strategies (Bell, 2007). At the time of the study, the teachers implementing Gizmos simulations did not indicate familiarity with the research stating that simulations should not be administered without scaffolding. The teachers' lack of pedagogical knowledge pertaining to simulations as an instructional strategy requiring scaffolding is an example of a viable instructional strategy losing its potency due to a gap in the TPACK framework.

Gizmos simulations are based on a constructivist pedagogical framework. Instructors administering the Gizmos lessons require a sound foundation in the pedagogy of constructivism pertaining to simulations. In addition to pedagogical knowledge, a teacher requires technological and content knowledge to ascertain the methodology being employed in each Gizmos lesson. Self-efficacy is important here with regards to the level of technological, pedagogical and content knowledge a teacher believes he or she has. The research indicates a person will hesitate to promote activities that they have low self-efficacy in (Holden, 2011). The majority of the teachers surveyed in this case study did not agree that they incorporate Gizmos into their lesson plans at least once biweekly.

A common misconception is that because the simulations are engaging the students, they are learning from them. Simulation research tells us that engagement is important, but it does not always lead to knowledge transfer among students (Prensky, 2001).

Teacher survey revealed that the teachers used the Gizmos simulations as whole class instruction. The onsite training for Gizmos led teachers to believe that the Gizmos lessons were to be used by students on individual computers. Based on the training, teachers believed that students working alone on Gizmos was a more favorable situation

than students working in groups. One on one computer interactions seemed to be the ultimate goal of Gizmos instruction; however, the fact that Gizmos could be presented as a whole group instructional strategy was emphasized at the onsite Gizmos training. Most teachers did not utilize Gizmos lessons and ancillary materials unless they had computers for the individual students. The researcher found teachers who believed that students responded favorably to Gizmos lessons used scaffolding or the teacher worked the simulations via a projector and encouraged students to follow along on their computers.

The fact that successful teachers favored these two techniques can be linked to teacher survey responses that indicated that students seemed overwhelmed by the amount of information required of them to complete Gizmos lessons alone. To complete a Gizmos lesson independently, a student must utilize prior, technological, and even a little pedagogical knowledge.

The Gizmos lesson provides the content, but the student must provide the other three types of knowledge to access the content. Technological knowledge is the first type of knowledge required to even access the program, the lesson and the information within. Then the student is required to recall prior knowledge to make sense of the new content being presented. Finally, the lessons require students to perform higher order critical thinking skills to effectively synthesize connections between old information and new data. For this task, the students must have enough pedagogical knowledge of their own learning styles to navigate the lesson successfully. It is usually with this last portion that students require the teacher's assistance. This is where scaffolding would be adequately employed by the teacher.

Each of the different types of knowledge required to navigate a Gizmos lessons provide a potential obstacle to student success. This is why most teachers found it necessary to devote entire lessons to teaching students' how to download documents from www.explorellearning.com.

The survey revealed that teachers found Gizmos to be less than anticipated by students. All the teachers surveyed disagreed that students talked about Gizmos in their classes. Research indicates there is a strong correlation between what a teacher promotes and what students see value in. A student's perception of a strategy's usability is a major factor in whether or not the strategy will be tried with diligence (Holden, 2011). Another indicator of the effort a teacher or student puts into a strategy's implementation is the person's self-efficacy. Self-efficacy is defined as a person belief or confidence that they can complete or perform a particular task (Bandura, 1986). Self-efficacy with regards to technology is referred to as technical efficacy (Holden, 2011). Self-efficacy is a factor that is independent of the strategy being employed, but it does affect the diligence of the implementation. Over 50 percent of the teachers agreed that they used Gizmos simulations because it was a student-centered activity that engaged their students. One teacher in the survey did agree that he used Gizmos because it was mandated at his school. Gizmos simulations were introduced to the teachers in a 55-minute training at the study school. The trainer was a former science teacher who had raised the standardized test scores of most of her students several years in a row. The former teacher was now working for Explorelearning.com and was very knowledgeable and enthusiastic about Gizmos simulations in the classroom.

Of the teachers surveyed in this study, three won usage awards from Explorelearning.com in 2013 for most Gizmos activity in the district. Overall, the survey reflects that teachers in the study felt Gizmos was engaging to students. Teacher's attitudes toward Gizmos simulations are positive but guarded; 68 percent of teachers feel there is not adequate access to computers and internet for all students in school. This case study turned up teacher comments concerning the equipment used to run Gizmos. Teachers often remarked to the researcher "Do the computers you use stay charged all day?" A situation in which computer batteries are defective caused a classroom

management crisis for a teacher who does not have a firm technological/pedagogical (classroom management) foundation in dealing with such issues. Teachers that did not win Gizmos usage awards in the study school cited “faulty equipment” as a deterrent to running a lesson involving Gizmos simulations. To avoid the “battery” problem several teachers only ran Gizmos lessons in one of the school’s three computer labs. During this case study, three different teachers requested help operating Gizmos simulations from the lead researcher with on at least three occasions. Despite the best intentions of all involved, the tutoring sessions on Gizmos never took place. From the researcher’s perspective, the Explorelearning trainer remained consistently available and willing to provide in house and online help for any faculty interested in learning how to use Gizmos more effectively. The Explore learning instructor ran a Gizmos lesson for the staff to observe for best practices for Cohort 2. Both Teacher A & Teacher B took advantage of the opportunity to review Gizmos techniques with the instructor.

It was emphasized during that training and subsequent emails that Gizmos simulations lessons are targeted toward the benchmarks. A Gizmos lesson contains 4-6 pages of worksheet problems that have to be graded manually. The questions on the Gizmos assessment are not necessarily the questions that are on the common assessments generated at the weekly PLCs. Teachers know that their students are going to be compared via the common assessment with the other students on their grade level. Gizmos worksheets and assessments are not being evaluated by the school administration. Teachers did not have an urgent need to use Gizmos in their lesson plans. Common assessments are required by administration whereas Gizmos simulation usage is not. Findings reveal teacher’s attitudes towards Gizmos is guarded because attributes of inquiry-based learning are not being captured in the common assessments that administration monitors for teaching proficiency. The third research question in this study analyzes: when do teachers implement Gizmos simulations into their lessons?

The survey results indicate that Gizmos were used as the major component of a lesson plan to reach a chosen objective or benchmark. The Gizmos was used to engage students and was utilized as a student-centered instructional strategy. The survey indicates the Gizmos lessons were either administered at individual computers or reviewed as a class on the teacher's projector. There is a perception among teachers at the study school of Gizmos being a one on one computer activity. Teachers in this study rarely used Gizmos if they did not have a class set of computers to conduct the lesson on. Pedagogical knowledge applied to this decision to give every student his or her own computer for every Gizmos lesson would advise to the contrary in cases where promoting a social interaction among students would promote learning through group discussion (Resnick, 1987).

The point at which the majority of the teachers inserted Gizmos into their lesson plans was as the main component. Gizmos simulations were used as instructional strategies that satisfied a curriculum need to differentiate instruction and engage students. Pedagogical knowledge is being fostered but not implemented in depth. An exposure to differentiated instruction or engagement does not warrant effective instruction. Because a student is participating in a concept of effective instruction does not mean he or she is benefiting from the instruction (Prensky, 2001). There are student factors (socioeconomic status, aptitude, work ethic) that may inhibit knowledge from being transferred (Resnick, 1987). However, with in depth pedagogical knowledge; implementation of an instructional strategy technical or otherwise will be enhanced. A clear indication of how Gizmos were implemented into the lessons at the study school is all the teachers surveyed strongly agreed or agreed that Gizmos were not assigned as homework assignments or warm ups. The survey creates a perception of Gizmos simulations being used only as the main component of a lesson to teach a specific benchmark.

The complexity of content knowledge, self-efficacy and motive for using Gizmos simulations are probable factors in how and when they were implemented into lessons. Again, utilizing pedagogical reasoning could have ameliorated the effect and strategy of implementation of Gizmos simulations into lesson plans at the study school. For instance, the value of repetition in learning may have been overlooked with regards to the number of times students were encouraged to run a particular simulation. The Gizmos lessons are presented as lessons similar to textbook lessons. That is to say they are assignments to be completed in a given timeframe or class period. Inquiry-based learning would say simulations allow learners to experience and observe content in ways that a textbook or lecture cannot deliver (Holden, 2011). Therefore, a teacher armed with this knowledge might spend more time demonstrating and encouraging students to experience the cause and effect aspects of simulations. In addition, social interaction among learners fosters learning is encouraged in inquiry-based learning. Taking the time to let students express their reactions to the experience of simulations in their lessons would foster great retention of information (Bell, 2007). Finally, the length of the Gizmos lesson from distributing and signing out computers in addition to running the simulation and completing all the accompanying questions easily exceeds the 55 minute class period at the study school.

Summary

Based on the findings in this study, the implementation of Gizmos simulation lessons on the best practices was mainly technological knowledge on how to operate and present Gizmos simulations. The teacher survey reveals that all the teachers in the survey agree that Gizmos simulations engaged their students. The findings show not all the attributes of inquiry-based learning (i.e. social interaction, self-regulation) were

emphasized. For example, most teachers surveyed agreed individual Gizmos lessons were more effective than group lessons. Inquiry-based learning promotes group activities to allow the social aspect of learning to flourish (Adams, 2008). Chapter V of this study will discuss the patterns and themes and discrepancies observed between the two cohorts in this study as it relates to the three research questions.

CHAPTER V

Purpose of the Study

One of the largest school districts in the southeastern United States is implemented a district-wide rollout of simulation software to supplement traditional direct instruction in the middle school science curriculum. Practically every area of human existence in the industrialized nations has been impacted significantly by technology in the last twenty years (Wise, 2010). In general, students are far more comfortable using computers, smart phones, and texting devices than their parents or teachers (Doyle, 2006). Students are becoming more computer literate, but not necessarily knowledgeable about the content being offered in our schools (Adams, Reid, S., LeMaster, McKagan, Perkins, Dubson, & Wieman, 2008). It is important that educators assess the effectiveness of computer simulations in aiding teachers to raise student achievement (Adams et al., 2008).

The literature on simulations in inquiry-based learning revealed an effective way to train teachers on the use of new technology was Mishra's TPACK framework. TPACK emphasizes the importance of viewing educational technology implementation through a lens of intersecting knowledge bases: technological, content and pedagogical. The TPACK framework was an extension of Shulman's theory on pedagogy and content knowledge. Historically content, pedagogy and technological knowledge were taught independent of one another. TPACK framework establishes the intersection of the three knowledge bases as a reference point to ensure preparedness in teaching a lesson involving educational technology.

Technology has moved into the forefront of everyday life in the 21st century. 4 of the 5 highest valued companies in the world are technology companies: Apple,

Microsoft, Google and IBM. The influence on society is expressed in interactive mediums like Twitter and Facebook. Teenagers are the fastest growing segment of the smartphone industry market. As a result, school districts are increasing pressure on school to incorporate more interactive technologies into school curriculums. Another factor is the USDOE is promoting school districts to transition to digital and interactive notebooks by 2020. Inquiry-based learning is an intricate part of simulations as an educational technology. Constructivists believe that learning should be student-centered and social in context. Constructivists believe that learners construct their knowledge by relating it to and building on to prior knowledge (Resnick, 1987).

Science FCAT results of two cohorts of students who had the same 7th and 8th grade science teachers in the same school and curriculum over a two-year period were collected and analyzed for the impact of Gizmos simulations as an instructional strategy. Parental attitudes were analyzed via customer survey of the school's parents. Teachers' attitudes towards Gizmos simulations were interpreted from teacher survey results.

Conclusions

This study did not conclusively determine a negative or positive effect on the science FCAT score of students in this study. The scores were not significantly different from one cohort to the next. The average score among advanced science students were identical and among regular science students the average from cohort 1 to cohort 2 was within 1 point. It is logical to conclude that within one year of implementation of Gizmos at the study school the effects positive or negative had not surfaced. This was a case study to improve the practice of practitioners at one study school. Secondly, the information gathered on teachers' attitudes towards the implementation of Gizmos at the study school is positive however; there is a reluctance to utilize the Gizmos simulations

as an instructional strategy because of constraints at the study school. Finally, Gizmos simulations are implemented the majority of the time as the main component of a lesson when they are utilized at the study school. Less than 1 percent of the teachers surveyed utilized Gizmos as a homework assignment. All respondents in the teacher survey agreed or disagreed with the statement: “I use Gizmos mainly as a warm up in my lesson plans.”

Themes

- Teacher need more time

As the researcher administered the survey among the teachers at the study school teachers commented on the lack of time available to effectively implement Gizmos simulations in to their lesson plan. One teacher with over thirty years of teaching experience answered the first 9 survey questions and ask to write a comment concerning Gizmos. She “regrettably” apologized for being unable to complete the survey because she had not found the time to use Gizmos at all in her lesson plans. She indicated that 52 minutes was not enough time to distribute computers and the accompanying worksheets. Another teacher indicated that the paper need to run Gizmos was simply not available to her.

- Teachers need more training.

Training was a theme that keep coming up as an issue. Teachers felt uncomfortable incorporating Gizmos into their lessons without the needed confidence in themselves and the equipment to complete the task. Teachers often expressed dissatisfaction with the computers available. For instance by the 2nd year of this study the Apple computer carts were unable to perform Gizmos simulations due to their inability to run the updated Gizmos software..

- Teachers need to be trained with technology and pedagogy in order to teach with technology and pedagogy.

Best practices in teaching indicate engagement is the first step in a process that leads to learners reaching their goals (Oblinger, 2004). The professional development associated with Gizmos simulations was adequate enough to ensure all the teachers both were comfortable running Gizmos demonstrations and lessons. Teachers requested more time to implement and practice the use of simulations in inquiry based learning. It appears that the lack of time to incorporate Gizmos into lessons precipitated lack of buy-in and has discouraged the majority of teachers from utilizing Gizmos at least once biweekly.

Professional development needs to reflect the best practices they are teaching. Too often professional development in the teaching profession is taught as do as I say not has I do. Gizmos was introduced to teachers as an internet technology delivered via a computer to students and teachers. Pedagogical knowledge was not emphasized in the Gizmos training. Teachers tend to be defensive about what instructional strategies they must or should employ in their classrooms (Marzano, 2007). For the most part individuals do not want to be seen as incompetent in anything related to their compensation.

Gaps in the teachers' TPACK cognitive framework between technological and pedagogical knowledge could explain the lack of buy in to using the Gizmos software more frequently. In addition, teachers indicated Gizmos lessons can generate more paperwork for an instructor therefore; some teachers will forego using the new technology. Teachers have not indicated or implied that the training for or the Gizmos themselves were inadequate or lacking. All the teacher responses have indicated the Gizmos training and software were adequate. The theme is time is a factor. Time is a factor as the length of time in training or lack of time spent training prevented teachers from gaining enough confidence to fully implement a Gizmos lesson into their practice. There is intense competition for the time teachers have allotted for instruction.

Gizmos is not the only instructional strategy available to teachers. As discussed in Chapter II of this study teachers' can utilize an array of technology tools like Khan Academy.org or FCAT Explorer that tailored specifically for FCAT testing. One teacher that was surveyed conveyed that she used Gizmos for specific benchmarks. She repeated several times Gizmos is better on some objectives than others. She was the one teacher that insisted she did not have time to dedicate an entire class period to a Gizmos lessons. This teacher had exhibited technological self-efficacy. Her contribution to this study was an affirmation of there simply is not enough time in a school year to utilize all the instructional strategies she has at her disposal. She appeared to be selective about strategies she did employ. She wanted be to know that Gizmos was not all inclusive by itself. The discrepancy here is Gizmos was never meant to be all inclusive; research indicates simulations should be supplemented with teacher interaction for maximum benefits (Bell, 2007).

Teacher are responsible for a multitude of benchmarks on any given day. It is imperative that teachers a competent in their management of time. Federal data reports that over 50 percent of students in in middle school are reading below proficiency in math and reading in our nation's schools. Some government officials are calling for higher order or critical thinking in our curriculums. Common Core curriculums have been promoted in 48 states in America that emphasize an increase higher order thinking skills. There are students in class with learning disabilities, post-traumatic stress syndrome and language barriers that require teacher guidance, scaffolding and tutoring that are required by federal law. Oftentimes there is not any additional support in class with the teacher. Services are delivered by area specialists outside of the classroom. Students are called out on a daily basis for services. Research shows a high turnover rate of teachers is due to stress and burnout. Teacher mismanagement of time in planning and

classroom management can contribute to stress and low productivity from otherwise effective instructional strategies.

Educational technology integration into a school or classroom can be seen by some teachers as another tasks or responsibility that he or she must add to the list of things to start, maintain and begin reporting on. I would argue that technology has increased the responsibilities of the average teacher. For example, email and text messaging and tweets have all have to be answered on a daily basis. Teachers use technology to give grades and answer administrative inquiries of practice and professional growth plans. Teacher have to attend weekly professional learning community (PLCs) meeting to talk about curriculum and lesson planning.

This study has made the case that properly position simulations as an instructional strategy effectively engages students and further research should be conducted to pinpoint the most effective use of simulations in classrooms to promote learning gains in students. This will be difficult unless the effort to train and educator teachers on the foundational premises of simulation learning. The Gizmos I encountered in this study at times seemed too complex for some of my students however, I can see the value in the complexity. Some Gizmos lessons require scaffolding and that is appropriate according to Vygotsky's concept of Proximal Zone of Development (Moll, 2001).

1. Recommendation for more frequent trainings

The researcher recommends that Explorelearning.com create a training program for teachers using Gizmos. They should be educated on the pedagogical principles that the program is based on. The Gizmos trainings observed promoted the learning gains students acquired utilizing Gizmos without explaining pedagogy influencing the instructional strategy. Understanding that marketing requires promoting outcomes but educators are inundated with marketing ploys. Teacher who are looking to improve their

practices with learning gains among their students would be wise to invest the time in exploring effective uses of simulations in his or her practices.

2. I recommend the Gizmos modules be set up as different levels of accomplishments for students.

Students respond to being accomplished in undertakings. I recommend levels in Gizmos to take advantage of students being able to get peer approval for being successful in Gizmos. Peer approval is more important to some students than grades or teacher and parent approval. Students will complete Gizmos by seeking information and techniques to achieve status as opposed to learning facts and processes for an upcoming test (Oblinger, 2004).

3. Recommendation for a lesson study of Gizmos simulations.

The grade level PLC should afford time for teachers to collaborate and create a lesson around a Gizmos lesson. The lesson could be used to conduct a lesson study. The teachers that collaborated to create the lesson around the Gizmos will take turns presenting the lesson featuring Gizmos to students while the other teachers observe the students' reaction to the lesson. The lesson will be observed for effectiveness with engagement as one of the key parameters. The student work generated will be analyzed for themes, patterns, and discrepancies. Areas of need for improvement will be discussed and modified. This recommendation would allow for teachers to cross-train one another in areas in all three of the areas: pedagogical, technological, and content knowledge emphasized in the TPACK framework. In addition, by collaborating, teachers will be able to gauge among their peers whether or not they are using planning and instructional time effectively in implementing Gizmos in the classroom.

4. Recommendation: Gizmos training should be linked to national certification in constructivist and inquiry-based best practices.

The pedagogy inherent in inquiry-based learning is an integral part of Gizmos simulations. The professional development involving Gizmos training need to use a constructivist approach to training teachers in the use of Inquiry-based learning. Teachers trained in the best practices of constructivist and inquiry-based strategies would be more likely to use them on their students. Science is based on empirical evidence and teachers should be allowed to experience the lessons prepare for their students. Furthermore, there should be a certification in Gizmos that certifies that the teacher is aware and capable of using the features and attributes of Gizmos simulations to its full capacity. This certification in the Gizmos lessons would increase the self-efficacy and technological-efficacy of the teacher certified. Increased self-efficacy and technology efficacy should increase usability of educational technology by teachers that have experienced the increases (Holden, 2011).

Patterns

In the quantitative data advanced students tended to average 20 points higher overall on the science FCAT than regular students in the two cohorts. There was also an increase in the physical science test scores in Cohort 2 versus Cohort 1. Teachers that did not use Gizmos frequently complained about the negative aspects associated with the available computers . Teachers that participated in the additional training had more usage and favorable comments about Gizmos simulation lessons.

The leadership at a school implementing a new instructional strategy like Gizmos simulations should create an environment in which teachers feel they have the time to experiment, or try a new instructional strategy without falling behind in areas that are being assessed for teacher effectiveness. Perhaps a Gizmos lesson could be used as the common assessment one quarter in the semester in lieu of a teacher generated common

assessment. The study revealed that Gizmos lessons on average took the student longer than 55 minutes to complete and required teachers more than 55 minutes to grade one classes Gizmos worksheets. When dealing with adolescence it is critical that the content being assessed be shown to them more than one time. Research recommends four exposures including practice and interaction with materials for long term retention of content (Holden, 2011). Most teachers administered Gizmos as an individual lesson with a computer for each student.

Recommendation Teachers should reflect on the pedagogical benefits of using simulations in a lesson plan.

Teachers should reflect on the principles inquiry-based learning before planning to use a Gizmos. The research leads us to believe a more social interaction among students promotes learning. Self-discovery and reflection on the purpose and or process of any instructional strategy employed is essential to delivering a high quality education to students.

Recommendation: Teachers should be trained in Gizmos simulations by allowing teachers to perform and conduct a Gizmos lesson for a class. The teachers should hand in their assignments for grading by the instructor. The current training receive did not allow the teachers being trained to experience what it feels like to run and answer Gizmos questions. I believe the goal of this recommendation is to build empathy for the students require to complete Gizmos. This would give teachers insight as to the perspectives that can be heighten by participating in a Gizmos lesson. This would also allow teachers to experience problems and difficulties that may occur in class while administering a Gizmos lesson. This recommendation would allow teachers to build their technological knowledge while experiencing the benefits of the pedagogical benefits that are offered by Gizmos simulations. The TPACK framework for educational technology should be utilize in Gizmos simulation training. The training should provide a learning

environment in which is acceptable to expose weakness in one of the three (technological, pedagogical, content knowledge) groups. The TPACK framework for educational technology implementation is ideal for alerting educators to the blind spots in lesson plans involving technology. A teacher educated in the pedagogical foundation of an instructional strategy should be more effective in the implementation of that strategy. For example Vygotsky pronounced the importance of teaching through language. That often times human beings natural learn in social settings involving conversations. Vygotsky promoted that language plays a crucial role in how we learn in our daily lives (Moll, 2001). Educators have to be more deliberate than a mother is in teaching a baby new words. Teachers have curriculums with time constraints and impediments like language barriers and students with physical and cognitive disabilities to overcome in the delivery of instruction (Moll).

What has surface is the importance of teacher perception of the technology versus its usability and the self-efficacy of the teacher in relation to computers and technology (Holden, 2011). Historically there a three major reasons teachers will use a new instructional strategy at the recommendation of a respected colleague whether it be a teacher or an administrator. Or a teacher will try a new instructional strategy because the strategy is researched based. The third reason a teacher will employ a new instructional strategy is least effective that is because of an administrative mandate. Research had proven in most case that teacher buy in to a new instructional strategy is essential. Gizmos simulation in to the science curriculum at the middle school studied (Spector,2008).

Only two teachers were selected to conduct this study because the researcher felt only the selected teachers could be counted on to give the Gizmos Simulations a fair chance during implementation. The majority of the teachers on staff did not have the technological self-efficacy to believe they could incorporate Gizmos into their lesson

plans. The Gizmos software links all their lessons to the state standards, however not all the content on the state standards is assessed on the science FCAT. Higher order or critical thinking is required to complete most Gizmos lessons on the middle school level. Higher order or critical thinking is what schools districts want to teach, however, it is difficult for teachers to believe that teaching students deficient in math and reading higher order skills without first addressing their deficiency in basic skills in math and reading. Students are also required to acquire technological knowledge in addition to content knowledge to successfully utilize all the embedded attributes of a Gizmos lesson. Gizmos lessons have embedded content knowledge in its activities and questions. For example, students are instructed to view simulations that depict cause and effect relationships between organisms, an objective that allows students to construct knowledge based on their observations. Students are allowed to observe things like plant growth, photosynthesis and different forms of cell reproduction like mitosis.

Pedagogical knowledge is supplied by the teacher. Differentiated instruction is designed to meet students where they are developmentally. A teacher is encouraged to find what interests a child and frame the lesson to build off the child's interest. Many educational experts conclude that students should be continuously assessed for understanding of the lessons being presented (Popham, 2007). Teachers in the school under study are encouraged to differentiate instruction and provide accommodations for students with disabilities. The use of Gizmos lessons helps facilitate differentiated instruction in a class room. Twice the researcher offered students an alternative to a Gizmos activity and the majority of students chose to do a different activity. Gizmos lessons can be challenging for students not reading on grade level.

Teachers should reflect on the efficiency of their preparation and diligence in incorporating a new instructional strategy or technology into their lesson plans. Practitioners should not assume a strategy is inadequate or ineffective because results are

not obtained expeditiously. It would be prudent for practitioners to ensure that a lack of time to properly explore the possibilities of another new instructional strategy or technology does not impair their ability to achieve a fair and accurate assessment of the strategy in question. In some cases, improving time management may improve the results obtained while implementing a new instructional strategy. Professional development should be explicit in identifying the premise that the instructional strategy is based on. In this way teachers implementing a new educational technology in their lesson plans can look for quantifiable results in the areas that the instructional strategy is targeting for improvement. With regards to educational technologies like simulations, practitioners should strive for far more than engagement but transference of the culture and context of the subject matter being taught.

Limitations

As the researcher implemented the methodology described in Chapter 3 it became apparent that the ratio of advanced to regular students of the two cohorts were reversed. The researcher intended to compare an advance cohort of students to an advanced cohort of students who saw the treatment. Unfortunately there were not enough students who fit that criteria. Therefore, the study had to continue with two cohorts who had less in common academically than the research had hoped for. The study unable to examine whether or not advance students responded positively or negatively to gizmos simulations. The results came back with no significant difference in the test scores of students exposed to the treatment and those who did not receive the treatment.

The students in the physical science portion of Cohort 2 scored higher on the science FCAT than the first cohort. Why, it could be the test was not as difficult as the

year prior. Without knowing the specific questions asked each year the research can only speculate as to why the Cohort 2 results were higher than Cohort 1's.

This is a case study however; the sample size of students prohibited the research of doing in depth statistical analysis. The research intended to use a sample of 50 or more students in the study. Also, the comments from teachers as they completed and returned their surveys were more expressive than the researcher anticipated. The parent surveys from the parents in the survey were not available due to inability to get district approval prior to the publishing of the study. The parent survey used in the study had a strong statistical foundation than the survey prepared by the researcher. The parent survey used to create the baseline for the study surveyed 1545 parents with 106 respondents.

Discrepancies

Cohort 2 improved the FCAT test scores in Physical and Chemical Science and diminished scores in Life Science, after being exposed to Gizmos simulations. Teachers all agreed that Gizmos simulations were engaging to their students but they did not all implement Gizmos into their weekly instructional strategy. In addition, teachers had favorable impressions of the training and Gizmos software but failed to utilize them at least once biweekly.

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APPENDIX

APPENDIX A: Teacher Survey

1. My student talks about Gizmos in my class.

Strongly disagree Disagree Agree Strongly Agree

2. I display Gizmos on the projector in the classroom during.

Strongly disagree Disagree Agree Strongly Agree

3. My Gizmo lesson instructions always include explaining the directions and using the Gizmo with the students.

Strongly disagree Disagree Agree Strongly Agree

4. The students in my class are expected to complete the five questions at the end of the Gizmo.

Strongly disagree Disagree Agree Strongly Agree

5. My student is very clear on how the students should behave during Gizmo lessons.

Strongly disagree Disagree Agree Strongly Agree

6. My students know the expectations for all Gizmos activities in my classroom.

Strongly disagree Disagree Agree Strongly Agree

7. My lesson plan provides time for students to work on Gizmos lessons.

Strongly disagree Disagree Agree Strongly Agree

8. I review the Gizmos lessons with my student when they finish the Student Exploration.

Strongly disagree Disagree Agree Strongly Agree

9. If a student does not understand a part of the Gizmo lesson, I usually stop and explain it to them.

Strongly disagree Disagree Agree Strongly Agree

10. I always let my students know when they are doing good work with the Gizmo lessons.

Strongly disagree Disagree Agree Strongly Agree

11. I incorporate inquiry-based instructional strategies into most of my lesson plans.

Strongly disagree Disagree Agree Strongly Agree

12. The concepts and processes I am teaching in class are interesting and challenging.

Strongly disagree Disagree Agree Strongly Agree

13. When I incorporate Gizmos stimulations into the lesson is to teach a targeted lesson objective.

Strongly disagree Disagree Agree Strongly Agree

14. I usually look forward to using Gizmos in my teaching practice.

Strongly disagree Disagree Agree Strongly Agree

15. When using Gizmos I get so engaged in the process I don't want to stop the lesson.

Strongly disagree Disagree Agree Strongly Agree

16. We often relate the learning of this subject to situations outside of school.

Strongly disagree Disagree Agree Strongly Agree

17. Many of my colleagues are fond of using Gizmos to teach this subject.

Strongly disagree Disagree Agree Strongly Agree

18. I incorporate Gizmos into my lessons as a virtual lab for the most part.

Strongly disagree Disagree Agree Strongly Agree

19. I assign Gizmos activities as a homework assignment.

Strongly disagree Disagree Agree Strongly Agree

20. I use Gizmos simulations to conduct whole class instruction for the most part.

Strongly disagree Disagree Agree Strongly Agree

21. Gizmos simulations are engaging to my students.

Strongly disagree Disagree Agree Strongly Agree

22. You believe Gizmos simulations are effective tools in teaching your students?

Strongly disagree Disagree Agree Strongly Agree

22. You are able to find Gizmos simulation at the right complexity for the student you are instructing.

Strongly disagree Disagree Agree Strongly Agree

23. You incorporate Gizmos into your lesson plan because you are required to.

Strongly disagree Disagree Agree Strongly Agree

24. You incorporate Gizmos into your lesson plan because it inquiry-based.

Strongly disagree Disagree Agree Strongly Agree

25. You incorporate Gizmos into your lesson plan because it is student-centered.

Strongly disagree Disagree Agree Strongly Agree

26. Students learn more from Gizmos group than individual Gizmos activities.

Strongly disagree Disagree Agree Strongly Agree

27. You incorporate Gizmos into your lessons plans at least once biweekly.

Strongly disagree Disagree Agree Strongly Agree

28. I use Gizmos simulations mostly as a warm-up to my instruction.

Strongly disagree Disagree Agree Strongly Agree

29. I use Gizmos simulations as a complete lesson activity.

Strongly disagree Disagree Agree Strongly Agree

APPENDIX B: Parent Survey

18th Annual (2011-12)

1. My child's teacher(s) believe(s) that he/she can succeed.
2. My child's teacher(s) inform(s) him/her about his/her academic progress.
3. My child's teacher(s) present(s) material in a way appropriate for my child.
4. My child's teacher(s) treat(s) him/her with fairness.
5. I am encouraged to volunteer at my child's school.
6. My child is safe at school.
7. This year, school staff has helped my child to select courses that challenge his/her abilities.
8. Rules are applied fairly to all students at my child's school.
9. When I contact my child's school or the school district, I feel welcomed and I am treated with courtesy.
10. My child's school is kept clean and in good condition.
11. There is an adult at school I can talk to about my child's problems.
12. My child's homework assignments are challenging.
13. My child meets with a guidance counselor when he/she needs assistance in school.
14. The principal at my child's school responds to my concerns.
15. Administrators are highly visible throughout my child's school.
16. Students bring drugs or alcohol to my child's school.
17. Students carry weapons at my child's school.
18. My input on school decisions is solicited and valued.
19. My child is accepted and feels like he/she belongs at this school.

20. This year a guidance counselor, teacher(s), or other school staff have helped me understand my child's recent test scores or schoolwork.
21. My child has sufficient access to computers and technology at school to do his/her schoolwork.
22. My child's current teachers have taught him/her how to use technology (computers and Internet) to do his/her schoolwork.
23. My child's school contacts me when behavior problems occur at school
24. I have used the district's BEEP Web site, during this school year, to access Virtual Counselor or information about my child's education.
25. My child's school informed me about the Anti-Bullying policy this school year (e.g., parent meetings, newsletters, other communications).
26. Students at school bully or cyberbully my child.
27. I am familiar with the Next Generation Sunshine State standards for curriculum and assessments in my child's grade.
28. I am familiar with the Common Core State Standards that are being implemented with the current curriculum.
29. (High School Only) This year, school staff has helped my child to plan for life after graduation.
30. Students get grades A, B, C, D, or F for the quality of their school work. What overall grade would you give to your child's school?

A, B, C, D, F

APPENDIX C: Permission to Use Explorelearning Survey

Print

Page 1

Subject: RE: Teacher Attitude Survey on Gizmos/ Student Usage Data
From: Desiree Sujoy [REDACTED]
To: [REDACTED]
Date: Wednesday, February 19, 2014 1:37 PM

Perfect – you have my permission :)

Desirée Sasko Sujoy, M.S., NBCT

Project Manager, PD

ExploreLearning

[REDACTED] (direct)

[REDACTED] (toll-free)

[REDACTED] (fax)

[REDACTED]

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From: Timothy Hall [mailto:[REDACTED]]
Sent: Wednesday, February 19, 2014 1:34 PM
To: Desiree Sujoy
Subject: Re: Teacher Attitude Survey on Gizmos/ Student Usage Data

Yes only for science teachers instructing at Ramblewood for the school years 2011-12 and 2012-13. Thanks Desiree.

APPENDIX D: Permission to Use Explorelearning Survey Continued

From: Desiree Sujoy <[REDACTED]>
To: Timothy Hall <[REDACTED]>
Sent: Wednesday, February 19, 2014 9:53 AM
Subject: RE: Teacher Attitude Survey on Gizmos/ Student Usage Data

Great! Very quickly – is this survey for Ramblewood only? I certainly give my permission to use the survey at Ramblewood and in your dissertation. I will just need to check into any other legalities within the company.

Desirée Sasko Sujoy, M.S., NBCT
Project Manager, PD
 ExploreLearning

[REDACTED] (direct)
 [REDACTED] (toll-free)
 [REDACTED] (fax)
 [REDACTED]

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ExploreLearning Reflex: Math Fact Fluency – Problem Solved!
 Learn more at <http://www.reflexmath.com>

From: Timothy Hall <[REDACTED]>
Sent: Wednesday, February 19, 2014 9:51 AM
To: Desiree Sujoy
Subject: Re: Teacher Attitude Survey on Gizmos/ Student Usage Data

Thanks I will make the change to question 22. I will be glad to be in your Spotlight once I completed school in May. Feel free to share my email with the other teachers writing about Gizmos. Thanks Desiree!

From: Desiree Sujoy <[REDACTED]>
To: Timothy Hall <[REDACTED]>
Sent: Wednesday, February 19, 2014 7:17 AM
Subject: Re: Teacher Attitude Survey on Gizmos/ Student Usage Data

Hi Tim.

Your attached survey is going to which teacher audience? Ramblewood only?

#22: it should read: a Gizmos simulation, or a Gizmo

I've met 2 others that are using Gizmos for their doctoral dissertation (one in Broward & one in Palm Beach)- I hope that I can somehow put you all in touch so that you could bounce ideas off of each other!

Desirée Sasko Sujoy
Project Manager, PD
 ExploreLearning

APPENDIX E: Letter to request Permission to conduct study in Broward County Schools

February 25, 2014

Broward County Public Schools
Student Assessment and Research
Kathleen C. Wright Building
600 Southeast Third Avenue
Fort Lauderdale, Fl 33301

Dear Sir or Madam:

I am a Broward County Public Schools' middle school science teacher and a student at Lynn University, Ross School of Education Department doctoral program under the supervision of Dr. Taylor-Dunlop. This letter is to request your participation in a research study entitled: Simulations in Inquiry-based Learning. The research study focuses on the use of simulation technology to increase student achievement. The purpose of the study is to explore the relations that may exist between simulations as an instructional strategy supplement and students experiencing improved performance on the Florida Comprehensive Assessment Test (FCAT) in 8th grade science. The study will compare the results of the 8th grade science FCAT of two cohorts of students. The major factor effecting or differentiating the groups is one group has been instructed with the instructional strategy supplement of Gizmos simulations and one has not.

Approval to conduct this worthwhile research study would be greatly appreciated in the pursuit of improving academic achievement amongst Broward county science students.

Respectfully Submitted,

Timothy E. Hall MBA

APPENDIX G: Dissertation Advisor Approval Letter

LYNN UNIVERSITY

BOCA RATON, FLORIDA

March 10, 2014

Broward County Public
Schools Att: Research
Department
600 S.E. 6th Avenue
Ft. Lauderdale, FL 33301

Re: Tim Hall, dissertation study: "Simulations in Inquiry-based Learning"

This letter of confirmation and endorsement is sent to you to confirm the following:

I am Tim Hall's research advisor and have reviewed and approve his research design.

I approve and endorse his analysis of data plan.

The research committee has extensively reviewed and approves of the text of his proposal. His committee members are Dr. Korynne Taylor-Dunlop, Dr. William Leary, Dr. Suzanne King, and Dr. Priscilla Boerger.

I have read and approve the student's proposal *as* submitted on the SBBC Proposal to Conduct Research form.

Thank you.

Dr. Korynne Taylor-Dunlop

Coordinator, Ed.D. Program in Educational
Leadership Chair, Tim Hall's dissertation

3601 North Military Trail, Boca Raton, Florida 33431-5598 (561) 237-7000
www.lynn.edu

APPENDIX H: Lynn IRB Approval Letter

**LYNN UNIVERSITY**

**3601 North Military
Trail Boca Raton,
FL 33431-5598**

Tim Hall

Sent by email 3/25/14

IRB #2014-066

Dear Mr. Hall:

The proposal that you have submitted, "Simulations in Inquiry-based Learning", has been granted for approval by the Lynn University's Institutional Review Board.

You are responsible for complying with all stipulations described under the Code of Federal Regulations 45 CFR 46 (Protection of Human Subjects). This document can be obtained from the following address:

<http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.htm>

Form 8 (Termination Form)

https://my.lynn.edu/ICS/Portlets/ICS/Handoutportlet/viewhandler.ashx?handout_id=b1e2f159-ce0f-4774-b727-3dd56c4bfb34 needs to be completed and returned to Macey Cooper ([REDACTED]) when you fulfill your study. You are reminded that should you need an extension or report a change in the circumstances of your study, an additional document must be completed.

For further information, please click on the following
<http://www.hhs.gov/ohrp/humansubjects/anprmchangetable.html> Good luck in all your future endeavors!

Warmest regards,

Dr. Jill Levenson

Jill Levenson,
PhD, LCSW IRB
Chair

Cc: Dr. Gregg Cox
Dr. Katrina Carter-Tellison
File 2014-066

APPENDIX I: Broward County Schools IRB Approval Letter



THE SCHOOL BOARD OF BROWARD COUNTY, FLORIDA
INSTITUTIONAL REVIEW BOARD

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ROBERT W. RUNCIE
Superintendent of Schools

July 2, 2014

Mr. Timothy Hall

Dear Mr. Hall:

Thank you for submitting your research proposal, #795 — *Simulations in Inquiry-based Learning* — for consideration by Broward County Public Schools (BCPS). Staff has reviewed your research proposal and approval has been granted for you and/or members of your team to contact Mr. Shawn Cerra at Taravella, J.P. High School and Mrs. Christine Recchi at Ranbiewood Middle School only.

This approval means that we have found your proposed research methods to be compatible with a public school setting and your research questions of interest to the school district. The expiration date of your proposal is *Thursday, July 2, 2015*. The anticipated date for submitting an electronic copy of your research findings is *Monday, November 2, 2015*. If you are unable to complete your research by the expiration date, you must submit a *Request for Renewal*, (<http://www.broward.k12.fl.us/sa/docs/IRB.pdf>), to the Student Assessment & Research Department *one week* prior to the expiration date.

Implementing your research, however, is a decision to be reached by the affected school-based staff on a strictly voluntary basis. To assist the school-based staff in their decision to participate, please outline the operational steps to be performed at their school. Based upon this information, each school-based staff would then make a decision to participate or not. School-based staff have been instructed not to cooperate unless you provide this District Approval Letter and the Principal Approval Memorandum.

PLEASE NOTE: All researchers and team members must complete the District's security clearance procedures to receive a Security Identification Badge before entering a BCPS campus or sponsored school event, or having contact with students or staff under any circumstances. Researchers who do not complete these procedures before visiting a school site will have their IRB approval suspended.

If additional assistance is needed from our staff, please contact us at [REDACTED].

Dean W. Vaughan

DWV:RWC:xt
Attachments