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What Impact Does Technology Integration Have on the K-12 Classroom?

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WHAT IMPACT DOES TECHNOLOGY INTEGRATION HAVE ON THE K-12 CLASSROOM?

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Abstract

Technology use is part of our everyday lives and as technological advances continue at a rapid pace, school districts are integrating technology into the K-12 classroom. This paper explores how technology integration may impact four areas in the K-12 classroom. These four areas are: student achievement, student motivation and engagement, the ability to differentiate instruction, and the learning of, or enhancement of, 21st Century skills. Another concept explored in this paper is the need for professional development to correspond with technology initiatives. While several studies show a positive correlation by implementing technology initiatives, opposite findings are also identified and discussed in this thesis.

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CHAPTER I: INTRODUCTION

As we move through the 21st Century, technology becomes more and more evident in our everyday lives. Phones are no longer used only as a communication tool, but also an organizational template, an entertainment device, our main source of capturing photographs, our navigational best friend, our 24/7 way to stay connected to the world around us, and Siri can help us find an answer to almost any question. Now add in technology such as iPads, chromebooks, and laptops, just to name a few. With all of these options come unlimited resources and capabilities, such as researching, creating, drawing, problem-solving, communicating, and organizing. With technological advances and access becoming more and more integrated into our daily lives, technology has also become more integrated into the world of education. The purpose of technology integration differs from school to school and district to district. Common goals include increased student achievement, improvements in student motivation and engagement, and opportunities to learn, reinforce, and broaden technology skills and 21st Century skills. Research suggests promising findings for implementing technology in K-12 classrooms.

Historical Context

Technology to enhance learning is not a new concept. The invention and implementation of technological advances dates back thousands of years. The invention of the abacus, around 3,000 BC to 500 BC, was the first time people could use a device to help them calculate and better understand math. In 1646, the Magin Catacoprica, or magic lantern, was a device implemented in some classrooms to enhance learning and student engagement. This device enabled photographic glass slides to be inserted one at a time allowing groups of people to view specific images or subject matter as the photograph was projected onto the wall and would lead the way to ideas for overhead projectors and interactive whiteboards.

During the 1800's, the cost to manufacture paper was high, so the more affordable slate and slate pencils or chalk were used in the classroom. Slate use led to the larger concept of blackboards, which James Pillans, the headmaster of the Old High School of Edinburgh, Scotland, is credited with inventing (Buzbee, 2014; Muttappallymyalil, Mendis, John, Shanthakumari, Sreedharan, & Shaikh, 2016). According to Wylie (2012), the chalkboard was a way for teachers to display information for an entire class to see, resulting in more expansive and engaging teaching strategies not achieved by a slate or book. Many believe the blackboard to be one of the most beneficial contributions to education. Overhead projectors were in use in the early 1930's, allowing teachers to write information on a plastic sheet that could then be displayed on the wall or blackboard. Transparencies could be prepared prior to class time, enabling the teacher to create a more student centered discussion platform. Completed transparencies could then be stored for use the following day or year, a luxury for teachers that had not been available thus far. The invention of the slide rule in the 1950's was used to help with math calculations, but was short lived as Texas Instruments invented the handheld calculator in 1967 and in the 1970's, calculator use was being seen more often in classrooms. Starting in the 1960's, Seymour Papert was at the forefront of recognizing the potential computers had on learning and education. Papert was greatly influenced by Jean Piaget's constructivist theories and shaped how Papert viewed the way children learn about the world around them. According to Kahn (2016), Piaget's influence led Papert to the idea for *Logo,* the first programming language for children. *Logo* would be used for years to come, not only within its own technology programs, but also in Apple and Texas Instrument programs and devices found in the classroom. In 1977, Apple released the Apple II desktop computer which was designed for use by anyone, not just computer hobbyists, creating opportunities for computers to be used in the classroom. According to Watters (2015), Apple started the *Kids Can't Wait* Initiative in 1983 in California. This allowed eligible schools in California to receive an Apple II computer for free, and led Apple to become a leader in classroom technology for several years.

Legislative acts also influenced technology use and integration in the classroom. *The Goals 2000: Educate America Act* of 1994 was legislation designed to enhance educational technology in all United States public schools by infusing technology and technology planning into educational programs and training. Along with more use by students, this legislative movement also called for more and continuing technology learning opportunities for teachers in order for educators to obtain the knowledge and skills necessary to integrate technology into their curriculum (*Goals 2000*, 1994). In 2002, Congress passed the *No Child Left Behind* Act, which held schools more accountable for student achievement with one goal, of many, to improve student academic achievement through the use of technology (U.S. Department of Education, Part D, 2004). More recently, The National Education Technology Plan (NETP) developed the vision for United States public schools as part of the Every Student Succeeds Act which was authorized by Congress in December 2015 (U.S. Department of Education, 2017). This vision recommends students have more access to devices and high speed connectivity along with technology-enabled assessments, implying schools that do not currently have these opportunities need to create an infrastructure to support implementing technology into their school systems in order to meet the NETP vision.

By the late 1990s, the blackboard was gradually being replaced with an interactive whiteboard (IWB), allowing educators the ability to connect computer capabilities to the whiteboard screen for viewing by students with the potential of creating more interactive lessons and presentations. This was especially relevant as online learning tools, video chat systems, and unlimited video options could be accessed from online tools and websites such as Skype, developed in 2003, YouTube, developed in 2004, and Khan Academy, started in 2007. According to Parson (2017), smartphones increased in classroom use between 2007 and 2010 but were not widely accepted as a classroom learning device until the iPad was introduced in 2010. This brought Wi-Fi enabled devices, like smartphones, to the forefront as tools that could be used to enhance classroom learning. To date, interactive mobile apps, websites, and learning management systems, for all types of devices, can be found in all types of classrooms ranging from pre-kindergarten through college level, and are considered by many to be the center of classroom learning (Parsons, 2017).

Definition of Terms

The terms technology integration, immersion, and initiatives are used to describe the idea that technology is infused in the curriculum of general content areas in education. This infusion of technology is to achieve certain district set goals such as allowing students the opportunity to learn and enhance computer and technology skills while learning, problem-solving, or demonstrating mastery of concepts within the content area or improving state test scores. Often times, these terms do not indicate the specific way technology is used or how often, but they imply that teachers are integrating technology in their curriculum more often than they previously had.

The experimental, intervention, or test group refers to the group of students that are part of the technology initiative. Depending on the study being analyzed, the experiment or test group students are utilizing technology in a new, more advanced, more precise, or more frequent manner compared to their previous learning experiences. In contrast, the control or comparison group is the group that will not be utilizing technology at all or technology use is very limited. Their data is used as baseline or comparison data.

Student achievement will be used often throughout this paper. This refers to a quantifiable measurement or score on an assessment. In some studies this will be a large scale assessment such as a standardized state test. In other studies, student achievement will be measured at a smaller scale such as a chapter test within one learning segment or a pretest versus posttest comparison.

One-to-one or 1:1 technology refers to the idea that each student within the experimental or test group has a technological device in their possession. Depending on the details of the particular study, this might be 1:1 within one specific class, 1:1 throughout the school day only, or students may have a device in their possession during the school day and they would take that same device home for use outside of the school day.

Guiding Questions

As a new teacher entering the workforce at a later stage in life, I was faced with the fact that technology may be a large part of my teaching experience. Because I was older, I had not utilized technology in my K-12 years of learning and therefore did not have personal experience to rely on to fully understand the impact of technology in the classroom. This led to questions of how technology use can impact the classroom. Through research, four main themes were of interest to me. The first area of interest was how technology integration could impact student achievement. Whether we all agree or not, as a teacher, student achievement is at the forefront of what we do. State test scores are posted on school websites and used as marketing tools to keep families within a district and attract new families, student achievement is one area colleges look at to determine admittance, and involvement in extracurricular activities can be taken away if student achievement is not at a certain level. My question was does technology help improve or lead to increased student achievement? The next question was does technology improve student motivation and engagement in the classroom? My thought process was if students are motivated and engaged, student achievement may be improved as well. The third area of study is differentiation and technology. One of the most difficult tasks for a teacher is to try and reach all students learning styles and abilities, mixed within one class. Could technology help differentiate? The last area of research related to student impact is does technology develop or improve the 21st Century skills that are necessary as students enter higher education and the workforce. With the integration of technology and the impacts on the classroom, the last question to investigate was the correlation between or necessity of professional development for teachers involved in technology integration.

CHAPTER II: LITERATURE REVIEW

Research Strategies

Literature studies for this thesis were found utilizing searches within Academic Search Premier, Google, Google Scholar, ERIC(EBSCOhost) and Scopus, for publication years from 2000 to 2017, with the most emphasis on literature from 2005 to present day. Search fields were narrowed by focusing on studies, articles, and literature from academic peer-reviewed journals that focused on technology initiatives and integration in K-12 classrooms. The keywords that were used in these searches were "1:1 initiatives and education," "technology and the classroom," "1:1 devices and classroom or education," "technology and classroom and academic achievement," "technology and classroom and differentiated instruction," "technology and education and professional development," "technology and education and iPad or laptop," "iPad or laptop and education," "technology and education and 21st Century skills," and "technology and education and motivation or student engagement". The structure of this chapter is to review the literature on technology initiatives in the K-12 classroom and the impact technology has on student achievement, student engagement and motivation, teacher's ability to differentiate instruction, 21st Century skills, and professional development.

Increased Student Achievement

Does the use of technology in the classroom automatically correlate to increased learning and/or increased test scores? Rosen and Beck-Hill (2012) designed a mixed-methods study to investigate the effects of the *Time to Know* program on student achievement. The *Time to Know* program is made up of an interactive core curriculum and a digital teaching platform designed for use within the classrooms. The initial program was available for fourth and fifth grade math and English language arts classes. The Rosen and Beck-Hill (2012) study involved fourth and fifth-grade students and their teachers in a Dallas area school district. In grade four, 129 students were in the experimental group and 77 in the control group. In grade five, 154 students were in the experimental group and 116 students in the control group. The experimental group had a one-to-one laptop environment and interactive digital learning curriculum aligned with state standards. This was compared to the control group which learned in a more traditional method. The total student body was very diverse in nature, 63.1% Hispanic students, 17.6% black students, 15.1% white students, 3.7% Asian students, and 0.5% American Indian students. The study by Rosen and Beck-Hill (2012) was designed to compare the TAKS, Texas Assessment of Knowledge and Skills, scores before the technology program was introduced to the TAKS scores a year after the technology program was implemented. Both the experiment group and control group received 90 minutes of math and English/Language Arts instruction every day.

The spring of 2010 fourth grade reading score results in the experimental group was a mean (M) score of 621.9 and in 2011, a mean of 665.9. This was an increase of 44 points. Comparatively, the spring of 2010 fourth grade reading scores in the control group were M = 643.0 and in 2011, M = 650.3. This was a difference of 15.6 points between control group and experimental group mean scores in 2011. Similar results were reflected in Math. Fourth grade 2010 results for the experimental group showed M = 597.6 compared with 673.9 in 2011. During the same period, the control math group 2010 scores were M = 611.6 compared with 660.1. A 13.9 point difference was recorded between the 2011 control group scores and experimental group scores. Fifth grade reading scores increased from 2010 to 2011 by 61.2 points in the experiment group and math scores increased by almost 46 points. This was compared to a 40.1 point increase in the control group reading scores and a 27.7 point increase in math scores. Clearly the results of this study show an increase in test scores for the students involved in the technology initiative.

Gulek and Demirtas (2005) found similar results in their three-year study revolving around 1,344 students in Harvest Park Middle School in Pleasanton, California. This study examined student achievement for the 259 students in a laptop immersion program compared to the 1,085 students not in the laptop program. The student achievement measurements included student's overall cumulative grade point averages, end-of-course grades, writing test scores based on the District Writing Assessment, and California state-mandated standardized test scores. The baseline data conducted prior to the start of this study showed there was "no statistically significant difference in English language arts, mathematics, writing, and overall grade point average achievement between laptop and non-laptop students prior to enrollment in the program" (Gulek and Demirtas, 2005, p.3). The 259 students in the laptop program received the same curriculum as the other students in the school and district. The differences were found in how the curriculum was delivered and the options students had to portray their level of understanding and mastery of each topic. This program started as a pilot program for sixth graders at the beginning of the 2001-2002 school year and seventh and eighth graders were added to the program the following school year. Results for the Gulek and Demirtas (2005) study were recorded at the end of the 2003-2004 school year.

As shown in Appendix A, students in the laptop immersion program attained higher grade point averages compared to the students not enrolled in the laptop program, with the greatest difference recorded in the sixth-grade data. Appendix B represents the end of course grades for the English Language Arts and mathematics course participants. As indicated in the table results, a higher percentage of laptop students earned A grades and a lower percentage attained F grades in their English and mathematics courses with one exception being the eighth grade English results. The results of the District Writing Assessment did not show significant differences between the laptop participants compared to their peers that were not enrolled in the program. The last area of measurement was the California Standards Tests (CSTs). Public school students in grades 2-11 take these assessments as part of the state's Standardized Testing and Reporting (STAR) Program. As shown in Appendix C, the CST results from this study indicate students in the laptop immersion program had a significantly higher percentage of students meeting or exceeding standards in the areas of English Language Arts and Mathematics compared to their non-laptop peers. This study has several areas of measurement that reflect significantly higher test scores and letter grade results for those students involved in a technology based program compared to students that did not have technology in their everyday learning.

Dunleavy and Heinecke (2008) designed a study to determine how a 1:1 laptop initiative affected standardized achievement test scores of randomly selected students. Fifty-two students were in a 1:1 classroom and 111 students were not. This study was conducted over a two-year span in an urban middle school with a 60% poverty rate and 87% of the students identified themselves as minority status. Pre-tests and post-tests were given and fifth-grade scores were used as a comparative factor. It was found that students in the 1:1 setting showed the most change in their science test scores, especially males. The post-test mean score for males in the 1:1 group was 442, up 54 points from the pre-test mean of 388. This was compared to the males in the non-1:1 classroom setting with a pre-test mean of 396 and post-test mean of 416, an increase of only 20 points. Females in the 1:1 classroom had a pre-test mean of 387 and post-test mean of 422, which was a slight increase compared to the females in the non-1:1 classroom as they had a pre-test mean of 387 and post test mean of 420.

A year long study done by Zheng, Warschauer, Hwang, and Collins (2014) also looked into what impact technology implementation has on academic achievement in science, but more specifically how scores changed in relation to English Language Learner (ELL) status, ethnicity, or socioeconomic status. This study focused on fifth-grade students in a Southern California urban school district. Eight schools were used in this study, four in the experimental group and four in the control group. Appendix D summarizes the demographics of the students in both groups. The students in the experimental group were provided net-books to be used in school and at home. As part of this technology initiative, teachers were provided professional development which included a four-day introductory training program during the summer and weekly teacher meetings throughout the 2010–2011 school year. Professional development also included face-to-face meetings, a wiki-discussion forum so that teachers could have discussions, share ideas, notes, and resources at any point in time, specific trainings set up to provide teachers with instruction and guidance on utilizing the science specific software, and training on general technology proficiency and implementing technology into the science classroom. As a source of quantitative data,

> de-identified California Standards Test (CST) science scaled scores (150–600) for fifth-grade students in Spring 2011 were collected in both the experimental and control schools as the outcome data. Since California does not provide CST science tests for fourth graders, and because a high correlation exists between students' mathematics scores and their science scores, students' CST mathematics scale scores in 2010 were used as the baseline data. (Zheng et al., 2014, p. 595)

The overall results showed that the laptop program did not have a significant impact on science scores when looking at the total results. However, Zheng et al. (2014) found there was a positive correlation between ELL students and treatment, indicating ELL students that participated in the technology program had higher science scores compared to their control group counterparts. Test results also indicated that Hispanic students and free-lunch recipients in the laptop program had higher test scores compared to their Hispanic peers and free-lunch recipient peers in the control group.

Findings from a study by Sung and Hwang (2013) indicate a relationship between technology use and increased learning achievement in the science classroom. The study used quantitative data comparing pre-test results to post-test results. It was found that the students in the experimental group, which were those utilizing the greatest amount of technology to aid their learning, had the highest post-test results compared to the control group's scores. The experimental group had a mean post-test score of 57.26 compared to the control group score of 43.07.

Another science classroom study was conducted by Hwang, Wu, and Chen (2012). Quantitative data was used to compare the results of post-test scores between the experimental group, which utilized very specific technology to assist in learning about butterfly ecology, to the control group, which utilized worksheets and less-precise web searches to learn about the same science lesson. The study results found the post-test mean scores of the experimental group to be 80.94 and 60.09 for the control group. These results indicate a significantly positive effect of technology aiding in the learning achievement of the experimental group compared to the control group.

Grimes and Warschauer (2008) developed a study that took place in a semi-urban school district in Southern California and concentrated on three schools within the same district. School A was a junior high school in a low socioeconomic community. The laptop program for this school was launched in the seventh grade and all 554 students received a laptop. School B, a K-8 school with a focus on science and technology, was located in a high socioeconomic community. Three hundred and ninety-five students, in grades three through seven, were part of the laptop program in School B. School C was in an economically diverse community. The laptop program was started in two Gifted and Talented classes, one at the grade 3/4 level and one at the grade 5/6 level, with 62 students involved in the program. This study analyzed results using information from teacher and student surveys, interviews with teachers and students, observations, documents, and records. This study is also based on longitudinal data as the same group of students were followed for a two-year span. California State Tests (CST) are taken during the spring semester, and scores were recorded for students that took the test in this same school district over the consecutive years of 2004, 2005, and 2006. The 2004-2005 and 2005-2006 scores were a comparison between district students who were in the laptop program versus outside the laptop program. The 2004 data was not compared within the district as the 2003-2004 school year was not part of the laptop program and was therefore used as baseline data only. Junior-high students accounted for the majority of participants in the laptop program that also took the CST assessments. Their test results for English Language Arts (ELA) and Mathematics were the focus of data for the study and results recorded show how much the mean scores rose or fell for students in the laptop program compared to the students not in the program. Data shows the English Language Arts (ELA) results of laptop users performance on the CST declined in 2004-2005. Laptop users had a -1.0 relative change in their CST scores whereas non-laptop users CST scores changed by a score of 7.0. The ELA laptop user test scores rebounded significantly in the 2005-2006 school year where relative scores for laptop users had a 9.4 change compared to the 0.6 relative change for non-laptop users. According to Grimes and Warschauer (2008), “the initial decline in ELA scores for laptop students vis-à-vis their non-laptop peers may have been due to the complexity of introducing such a fundamental change in the basic tools of learning, rather than any inherent disadvantage of using laptops” (p. 328). For both years, the mathematics scores for the laptop users increased compared to the non-laptop users. In 2004-2005, the relative change for laptop users was 1.2 and in 2005-2006 the relative mean score change was 11.5 compared to the non-laptop scores of -7.3 and -2.1 respectively.

Kposowa and Valdez (2013) found similar correlations between technology and test scores during their one-year study in an elementary school in Palm Springs, CA. Students in the test group were given ubiquitous use of laptops over one academic year compared to the control group only utilizing technology while at school and as scheduled by each teacher. It was found that the students in the test groups outscored their peers in the control groups on both California Standards Tests in English/Language Arts and Mathematics. The English Language Arts test scores resulted in a mean (M) of 392.7 for laptop users compared to the control group's score of M = 338.54. In Mathematics, students with laptops earned a mean of 448.1 compared to the control groups mean of 365.05.

A study designed specifically for the physics classroom analyzed pre- and post-test knowledge for an electronic and atomic physics unit. The participants in this Chandra and Watters (2012) case study were 12th grade students from a high school in Australia. The control group of 32 students studied the physics units in the traditional mode, whereas the treatment group of 48 students studied the same unit in the blended environment using a physics website, Getsmart, specifically designed for this unit. The goal of the Getsmart technology was to enhance students' knowledge of physics concepts. The Getsmart internet lessons accounted for 15-20% of students' physics contact time in school. The website included additional learning information, online quizzes, and chat rooms between students and instructors to discuss content, ask questions, and further explore ideas. More than 90% of students utilized the Getsmart website after school hours. The same two teachers taught both the control group and the treatment group. Scores were assessed across the three areas of Knowledge, Science Processes, and Complex Reasoning Skills, with the hypothesis that the testing area of Knowledge would be most influenced by the utilization of the Getsmart site. The Knowledge section examined students' abilities to recall and apply their understanding to simple situations. The Science Processes questions measured students' abilities to collect, present, and interpret data, and questions focusing on Complex Reasoning Skills measured their ability to apply themselves in problem-solving situations.

Once the 10-week unit was complete, both the control group and treatment group students completed the post-test to compare scores to their pre-test scores. As previously mentioned, the hypothesis was to determine if the specifically designed Getsmart technology would enhance the physics knowledge and increase the test scores of students compared to students who studied in a more traditional format, without technology. Based on test scores, it was found that the test group had a significant change in the pre-test to post-test scores. The treatment group mean score for pre-test Knowledge was 59.2% and post-test was 72.0%. This was a change of over 12 mean percentage points. This is compared to the control group's mean score of 66.2% pre-test and 66.4% post-test, a change of less than 1%. In addition to the anticipated increase in Knowledge scores, it was also found that the technology implementation also increased test scores for Complex Reasoning Skills as the post-test mean score for the test group was 34.4% compared to the control group score of 25.8%. While this was a small, short-timeframe study, the results are promising to reflect how technology, used as an additional tool, can enhance and increase the learning and test scores within the classroom.

Suhr, Hernandez, Grimes, and Warschauer, (2010) also looked into the correlation between technology and test scores, specifically in the English Language Arts classroom of upper elementary students. Both the experimental and control groups consisted of 54 students in the fourth-grade. The experimental group was in a 1:1 laptop program while the control group had varying degrees of computer access throughout the school day but had six hours or less of individual computer access per week.

Over this two-year study, both qualitative and quantitative results were collected and examined. It was found that during the first year of the study, the non-laptop group and laptop group both made significant gains in their ELA scores. The laptop experimental groups progress was up 19.57% and the non-laptop control groups progress was 26.67%. It was during the second year that the changes between the two groups were most evident. The experimental group continued to increase their ELA progress by 2.17%, whereas the control group lost much of their ELA progress and decreased by 16.83%. While there could be many outside influences affecting these results, the findings in this study are on par with those findings of many others researching classroom technology use in relation to test scores and student achievement.

Increased Student Engagement and Motivation

Designing daily lesson plans and activities that keep students motivated and engaged are the ongoing goals and struggles for classroom teachers everywhere. Could the implementation of technology increase student engagement, learning attitude, and motivation? Sung and Hwang (2013) designed a study to investigate if technology integration influenced learner attitudes, motivation, and self-efficacy. Their study involved three classes of sixth graders from an elementary school in southern Taiwan. A total of 93 students participated in this study. One class containing 31 students was the experimental group. Two more classes, containing 31 students per class, were deemed the control groups. The same teacher was assigned to all three groups. The specific hypothesis of the study was to examine if a computer game, focusing on collaborative effort, could lead to a better learning attitude, higher motivation to learn, and increased self-efficacy.

Sung and Hwang’s (2013) study was conducted during the school's natural science course and the Knowing Campus Plants unit of instruction. Appendix E shows the experimental design of this study. At the beginning of the learning unit, all students in this study completed a pre-questionnaire asking about learning attitudes, learning motivation, and self-efficacy of group learning for science. The pre-questionnaire used a Likert scale to evaluate learning attitude and self-efficacy, and the motivation questions used a seven point rating system. A pre-test for evaluating the students’ basic knowledge about plants was also given to all students. After a two-week learning segment about the basic function of plants, the students moved on to continue their learning by using a computer-based game. The students in the experimental group learned with the highest level of technology implementation that included a collaborative educational computer game with a repertory grid approach, which was designed specifically for this study. This computer game was a role-playing game where three or four students worked as a team to complete the learning tasks within the story of the game. In addition to the game, the experimental group teams had to complete a repertory grid, which is a type of matrix that helps students collect and organize information based on the content of the learning segment. The students in control group A also worked collaboratively in teams of three or four to complete the role-play technology game. They did not have a repertory grid, but instead completed learning worksheets. Control group B worked individually to complete the role-play technology game and developed their own repertory grids. After the game-based learning activity, the students took a post-test and a post-questionnaire to measure any changes in learning as well as any changes in their learning attitudes, motivation, and self-efficacy.

Sung and Hwang (2013) found that the students in the experimental group paid more attention to completing the online repertory grid. Control group A also worked collaboratively, but spent most of their time focused on how to complete the game missions instead of organizing the knowledge gained within the game, which did not increase their motivation and attitude toward learning the material. As previously mentioned, it was found that the experimental group had a higher increase in scores from pre- to post-test, but they also had a higher mean when asked about learning attitudes, motivation, and self-efficacy compared to both control groups. According to Sung and Hwang (2013), this increase in attitude and motivation for the experimental group could be because of the technology based organization of the repertory grid. Students had a clear and challenging objective that made them more interested and motivated in learning from the game instead of working on a worksheet or in a more traditional learning format.

Similar to Sung and Hwang's study, Hwang, Wu, and Chen (2012) based their study around technology that was aligned to that of a specific learning segment. The experimental class of 29 fifth and sixth graders utilized an educational computer game to further their learning on butterfly ecology. The 21 fifth and sixth-grade students in the control group used learning sheets and keyword Internet searches to guide their learning. Both the experimental group and control group were taught by the same teacher. A pre-questionnaire and post-questionnaire were given to the students to measure learning attitudes and interest as well as motivation for learning. It was found that the experimental group was more motivated with a higher level of improvement in their interest level and attitude toward learning compared to that of the control group.

Moos and Honkomp (2011) used action-based technology to test student motivation. Qualitative measures were extracted through the use of interviews with the seventh and eighth grade students involved in this study. One of the teachers in a Minnesota middle school climbed Mt. Kilimanjaro. During his experience, he created daily lessons and emailed these lessons to his students back in Minnesota. "These daily emails included a "lesson of the day," latitude and longitude coordinates of his position linked to Google Maps, a spotlighted "animal of the day," and an audio update recorded using a satellite phone" (Moos & Honkomp, 2011, p. 233). The qualitative interview questions and results from the Moos and Honkomp (2011) study found that student motivation and interest levels increased as a result of using the action-based technology scenarios provided by their teacher compared to the motivation and interest level to learn this same information using non-technology resources such as reading books and doing worksheets.

Smith (2014) designed a mixed-methods study to determine if a game-based learning environment increased the engagement level of elementary students. The technology game was a science-based virtual world that revolved around the field of genetics. Observations and surveys were administered to the 15 fourth-grade students involved in this study. Students navigated through the virtual world following game directions and scenarios. Based on the survey data, 90% of the students indicated that the game-based technology learning was more engaging than traditional learning methods.

Based on qualitative results, Suhr, Hernandez, Grimes, and Warschauer (2010) also reported an increase in engagement and interest when students used technology in their learning. Of the almost 200 fourth and fifth-grade students surveyed, they found that 83.8% of the students preferred to use laptops while learning, 79.9% thought schoolwork was more interesting if they could use their laptop, and 71.5% found they were more motivated to work on revisions and editing while using their laptop compared to paper and pencil revisional work.

Mouza (2008) worked with four elementary classrooms over the course of one academic year to identify the impact of technology on student educational experiences. Two classrooms, with 50 students total, were included in the laptop test group and two classrooms served as the comparison group, also consisting of 50 students total. Results were based on data collected from students that completed surveys and focus group interviews throughout the school year. It was determined that students in the laptop group were more motivated to complete their school work and improve their quality of work by going above and beyond the requirements for assignments. Students in the test program expressed that laptops helped them enjoy school more and therefore made them more motivated and engaged in learning.

Bebell, Clarkson, and Burraston (2014) explored the impact a 1:1 device implementation had on the engagement level of sixth-grade students. In this year-long study, 46 students were involved in the pilot program where each student received a netbook for use throughout the entire school day. The two control classrooms, consisting of 45 students, only had occasional access to the school's computer lab and to mobile laptop carts shared across the school. Using classroom observations, student surveys and teacher surveys, this study sought to measure changes in student engagement. Based on teacher-reported levels of engagement, it was found that sixth-grade engagement drastically decreased in the control classrooms compared to the 1:1 pilot classrooms. Teachers reported that 91% of pilot students were engaged in the curriculum compared to 55% of the control group.

A study involving nearly 400 hours of observation in 11 Florida school districts was conducted by Dawson, Cavanaugh, and Ritzhaupt (2008). The goal of this study was to determine if laptop integration caused teaching practices to change and what implications this had on student engagement and interest level. Observations were conducted in the fall to serve as baseline data and again in the spring to serve as comparison information. The observations were developed to determine the extent to which traditional and alternative teaching practices were used to capture information about student access to, ability with, and use of technology. After all data was collected and analyzed, the greatest differences from before technology integration to after integration were seen in a decrease in teachers use of independent seat work and an increase in project-based learning, collaborative learning, and more inquiry and research based learning. As the shift from traditional methods to more learner-centered methods was made, a significant change was also observed and documented in student engagement, attention, and interest in learning as all three of these areas seemed to increase or were heightened because of the technology infused curriculum.

Opportunities to Differentiate Instruction

Differentiated instruction is key to helping students progress in their learning, no matter their learning level. According to Rosen and Beck-Hill (2012),

> differentiated teaching and learning refers to providing students with different avenues to acquiring content; to processing, constructing, or making sense of ideas; and to developing teaching materials so that all the students within a classroom can learn effectively, regardless of difference in ability. (p. 228)

The Rosen and Beck-Hill (2012) study previously discussed not only found evidence to support growth in academic achievement, the study also found technology implementation could provide teachers more opportunities to differentiate within their curriculum. The *Time to Know* program contained a DTP (digital teaching platform) that enabled the teacher to plan and conduct a lesson, and then receive feedback from formative and summative assessments. This DTP system was designed to differentiate materials, which could then be assigned or available to the differing ability levels within a classroom setting. The observational data from this study indicated more differentiated teaching in the experimental lessons compared to the control group lessons. In 83% of the experimental lessons, it was observed that teachers were adjusting the instruction in response to learning progress and students' interests. This is compared to only 30% in the control settings. It was found that every experimental lesson implemented some form of independent learning, compared to half of the control lessons. Independent learning includes those opportunities for students to increase their independence, responsibility and self-management, allowing more one-on-one time for the teacher to assist students as needed, allowing students to work at their own learning level pace.

Clariana (2009) conducted a study to determine if technology helped or hindered a teacher's abilities to differentiate. This study involved eight elementary schools within the same district in Pennsylvania. One group of 66 sixth graders served as the test group within their mathematics classroom. Each class, consisting of approximately 23 students, had a laptop readily available during their mathematics class time. The other seven elementary schools served as the control groups. The control groups mathematics class time usually involved a teacher directed lesson, followed by independent student work, which was usually a worksheet, and the final minutes of class involved receiving the homework assignment. Occasionally, the control students would work in a computer lab where students would complete tasks from the Compass Learning mathematics software. These math lessons were aligned to Pennsylvania state standards and district benchmarks.

The test groups also started with a teacher-centered lesson to either review previous concepts that many students were struggling with, or to introduce new concepts. Once this teacher led lesson was complete, the classroom activities in the test group differed from the control groups. Students were allowed to choose how they spent their work time. Some students picked a laptop to use to investigate the day's lesson in further detail or to complete the Compass Learning software lessons at their own pace, other students picked up a worksheet to use as practice, some worked on the unit test, some worked one-on-one helping others, some students lined up at the teacher's desk for 3-5 minutes of one-on-one help, and others updated their progress chart which was located at the front of the classroom. According to Clariana (2009), this technology based classroom allowed the teacher to differentiate instruction as the technology based option freed the teacher from generic whole group instruction to more student-centered and one-on-one instruction, thus giving students the freedom of choice and speed at which they completed tasks, and allowed the teacher to individualize instruction based on student need.

In the science classroom, scientific concepts and vocabulary can be very difficult and new for many students. This is especially true for at-risk learners, such as ELL (English Language Learners) students. According to the Zheng, Warschauer, Hwang, and Collins (2014) qualitative data, based on teacher and student interviews and classroom observations, technology helped students and teachers find various technological supports at varying levels to aid in students learning development. With the support of technology, students were able to interact with visual scientific representations and occurrences, instead of traditional books with only a few pictures as representations of the science phenomena. Differentiation because of technology also allowed students to work at their own pace.

A two-phase, mixed-methods study by Milman, Carlson-Bancroft, and Vanden Boogart (2014) was conducted during the 2011-2012 academic year. The focus of this study was to determine if teachers in grades PreK–4th found technology increased their ability to differentiate within grade levels and across content areas. Mid-year and end-of-year interviews were conducted with the seven observed teachers, with at least one teacher in each of grades PreK-4th, the principal, one assistant teacher, and three specialist teachers. A 28 question, end-of-year web-based Likert scale survey was administered to 44 teachers, with a 75% return rate. Survey questions revolved around teachers' use of iPads in the classroom, beliefs about technology use, and attitudes towards technology use. Observations were also conducted throughout the school year.

The study was conducted in a United States elementary school where an iPad initiative was implemented. All elementary students and teachers were given an iPad with iPad use training administered to all at the beginning of the school year. A school policy indicated that iPads were to be used in school, under teacher supervision, and elementary students were not allowed to take their iPad home at the end of the school day.

Based on survey data, 80.6% of teachers indicated they were able to use technology websites and apps to differentiate instruction and address learner needs within the classroom. "For instance, survey respondents noted using the following applications to differentiate instruction: BookCreator (35.5%), Coin Math (31.3%), ChalkBoard (22.9%), iMovie (25%), and Keynote (25%), among several others" (Milman, Carlson-Bancroft & Vanden Boogart, 2014, p. 124). Observations showed that teachers used technology to differentiate content in order to reinforce concepts or take ideas one step further. Furthermore, teachers were able to set technology based applications at different levels based on the student ability level. As an example, e-books were utilized and could be administered at appropriate and differing levels, as could math BINGO. Student work also reflected an ability to display their understanding utilizing different options. These options included technology based programs such as iMovie, iMovie Trailers, Keynote presentations, iStop motion app, and the BookCreator app. Teachers were also able to use the iPads to address multiple content areas within the same lesson, which most often occurred in activities that combined the language arts content with math, science, or social studies. As a whole, the results from this study support the idea that technology can be used to differentiate instruction within the classroom to better serve students at all academic levels.

Liu, Navarrete, and Wivagg (2014) also suggest that implementing technology into the classroom can help differentiate instruction. Their study was a two year format designed to investigate how a one-to-one device implementation can be used as a teaching and learning tool, especially for ELL students. The participants in the first year (during the 2010-2011 school year) were two ELL middle school teachers and their students and the second year (during the 2011-2012 school) were two ELL elementary school teachers and their students. Data was collected from interviews with teachers, classroom observations, and surveys from students.

During the first year of implementation, it was found that teachers used varied apps and resources, allowing students access to differing levels of language tasks and instruction. Teachers could assign the activities and games appropriate for students' learning levels and were able to scaffold more easily with the iPod touch compared to traditional teaching and learning methods.

Year two results were similar to year one as teachers became more comfortable and confident in using technology in the classroom. Students utilized technology as a resource to investigate and research ideas, resources such as online dictionaries were used to help students learn and define words, and educational game playing helped students reinforce skills such as reading and multiplication, while working at their own learning level and pace.

Opportunities to Develop and Enhance 21st Century Skills

As students enter the workforce after high school or college, they are expected to have the skills that help them perform information-age jobs. Skills that promote high level or deep thinking, the creativity and ingenuity to solve world problems, the ability to work in teams, teams that may be composed of people around the world and not solely within the same building, communication skills using different modes, and the capacity and flexibility to learn ever-changing technologies. Mouza (2008) points out that the use of computers can change what students learn by exposing them to ideas and experiences that may otherwise be inaccessible. These opportunities can be particularly useful in developing 21st century skills such as critical thinking, analysis, and inquiry. Skills that are necessary for success in the real world. Bebell, Clarkson, and Burraston (2014) and Spektor-Levy and Granot-Gilat (2012) point out that educational systems worldwide are beginning to understand that they must help students prepare for the 21st century in various ways. As the requirements for skills in originality, time-management, organization, problem solving, and self-discipline continue to grow, technology embedded in educational systems will help graduates adapt to the constantly changing environments and complex work systems that require skills of various kinds. With an increase in technology use within the classroom, the idea is to better prepare students for their future, no matter the path they choose and skill set required.

A three-year study in Texas by Shapley, Sheehan, Maloney, and Caranikas-Walker (2011) focused on research questions involving how technology affects students learning opportunities and technology skills. Forty-two middle schools in Texas were selected for this study with 21 schools in the Technology Immersion Program and 21 schools as the control groups used for comparison. The selection of control schools was based on statistical factors that matched treatment schools as nearly as possible. These factors included similar size, location, economical standing, along with number of minority students enrolled, and the percentage of students passing the Texas Assessment of Knowledge and Skills (TAKS) tests. Two-thirds of the students in the 42 schools were economically disadvantaged and the groups were also ethnically diverse with roughly

58% of the population identifying as Hispanic, 7% African American, and 36% Caucasian.

Data was analyzed for two cohorts of students. Cohort 1 was for students that attended school for three years of the technology project implementation and specifically for all of grades 6-8. Cohort 2 consisted of students that were in attendance for two school years of project implementation, grades 6-7. Research data was analyzed based on information from surveys taken throughout the study. Cohort 1 completed a survey at the beginning of the study and at the end of each school year for three years, which results in four surveys in total. Cohort 2 also completed a survey at the beginning of the study but differed from Cohort 1 in the fact that the students completed a survey at the end of two school years resulting in three surveys in total. Students' technology proficiency was questioned in relation to the Texas Technology Applications Standards. Students completed the survey questions based on a five-point Likert scale. Results showed that students in the technology based treatment group of both cohorts reported higher technology proficiency compared to their peers in the control group. More specifically, in both cohorts significant growth in technology skills was identified in the economically disadvantaged students compared to the more economically advantaged students within the treatment schools. Results indicate Cohort 1 economically disadvantaged students at treatment schools grew in proficiency at 0.38 scale-score points per year, the more affluent immersion peers grew at 0.31 scale-score points per year, and the control-group students grew in proficiency at 0.27 scale-score points per year. Results for Cohort 2 indicate economically advantaged and disadvantaged treatment students grew in technology proficiency at 0.43 scale-score points per year compared to their counterparts in control schools with 0.27 scale-score points. According to Shapley et al. (2011), the increased use of technology in the classroom indicate a positive correlation to increasing students' 21st Century technology skills and competencies which better prepare students for their future academic and career options.

Lei and Zhao (2008) conducted a one-year study that involved 237 students in the seventh or eighth grade of a middle school located in the northwestern part of the United States. Before the 1:1 technology initiative started at the beginning of the 2003-2004 school year, this school had one computer lab and two mobile carts of laptops. Students were given a survey at the beginning of the school year and again towards the end of the same school year. The surveys were administered to all 237 students in the school, with 133 of these students filling out both surveys completely. Survey information was divided into four sections. Section one pertained to demographic and socioeconomic information, section two pertained to technology use and time, and section three used a five-point Likert scale with questions pertaining to student's attitude towards and perception of technology use. The final section measured students' information technology proficiency. According to Lei and Zhao, the participating students applied problem-solving skills to a series of technology based situations. Students then selected a multiple choice answer based on their solution. Using the technology proficiency measurements from survey data, it was found that technology proficiency increased from the beginning of the school year compared to the end of the year. At the beginning of the year students did not know how to use email, nor did they have the skills to work with basic word processing programs such as PowerPoint and Word. By the end of the year, students were using email to communicate with each other and their teachers, utilizing basic technology skills on a everyday basis, and also moved into more advanced skills such as using iMovie production, website design, and programming.

Using a quantitative assessment tool, a study by Spektor-Levy and Granot-Gilat (2012) focused on 181 students ranging in age from 13-15. All students studied at one of two Israeli middle schools. One hundred students were in the intervention group and this group utilized their own personal computer throughout the school day and would then take their device home at the end of the day. For the intervention group, studying and instruction would often take place utilizing the one-to-one model and most instructional materials could be found on the school's Learning Management System. Examples of daily digital usage by the intervention groups included students watching video clips and commenting about them, students using tools for organizing data and knowledge, and online research of information to complete individual or group projects. The other 81 students were the comparison group and studied the traditional way without laptops. Students in the comparison group were engaged in computer use at school only several times a year when time was scheduled in the school's computer lab.

To compare the intervention group and the comparison group, this study utilized a quantitative assessment tool which was a complex assignment based on the subject of Israel's water crisis. Students were expected to research the crisis and determine a research based solution. Using a digital device, students were given 90 minutes to complete the assignment and then submit their work. Students were given a detailed rubric that outlined all requirements for the assignment. The assignment consisted of using a digital device to demonstrate skills such as retrieval and selection of pertinent and relevant information, comprehension and processing of online information, development of an argumentative paragraph, and preparation of a findings based poster or leaflet to present their information in a clear and precise manner. The rubric outlined 14 different criteria with three levels of performance for each criteria.

After analyzing results, this study found significant differences between the students who learn with personal laptops in 1:1 classes and students who learn with very little to no digital contact during their school day. Students from 1:1 classes outperformed their comparison peers in nine of the subcriteria, and in the total score. It was found that the average of the assignment's total scores in the intervention group was ($M=65.95$, $SD=7.64$) in relation to that of the comparison group ($M=58.65$, $SD=7.94$). The areas of higher abilities were noticed in skills such as understanding the instructions, the ability to locate and select digital information, organizing information into a digital table, evaluating information and identifying reliable and unbiased data, increased quality in writing the argumentative paragraph, and better production of a leaflet/poster using computerized tools. This study supports the idea that increased use of technology in the classroom leads to the development of 21st Century, digital based skills that will be used as students continue along their educational or career path.

Professional Development

Implementing technology in the classroom is no easy feat. Many administrators and stakeholders are involved in the decision, as well as huge amounts of funding. Once the decision is made, research has found that teacher professional development is key in having a successful transition. According to Dawson, Cavanaugh, and Ritzhaupt (2008), "teachers enter the classroom with a wide range of attitudes, experiences, and skills related to teaching with technology. For this reason, professional development requires as much emphasis as the technology in a school technology initiative and in the research into such initiatives" (p. 145). Yadav, Hong, and Stephenson (2016) agree as they point out professional development needs to go hand-in-hand with the curricular needs and lesson plan development for each teacher. In addition, they also suggest the need for teacher education programs to provide more opportunities to learn how to utilize technology in the classroom. Without teachers understanding how to use technology in their classroom, it is difficult for students to find success in relation to student achievement and 21st Century skills, nor will students be more engaged and motivated if technology use does not directly apply to the learning at hand.

Inan and Lowther (2010) examined factors affecting teachers' technology integration into the classroom. Seventy-six schools with 379 teachers participated in this study. Using a five-point Likert scale, teachers rated their agreement with questions and statements in regards to technology integration areas. Survey data found that professional development and technology support within the school had the greatest effect on teacher readiness to integrate laptops into their curriculum.

Ekanayake and Wishart (2015) developed a study using 1:1 mobile devices to determine the link between professional development and the use of mobile devices as a learning tool. Eighteen teachers were selected to participate in the study. Three days of professional development planning workshops allowed teachers to develop their personal skills and attitudes towards mobile devices. The workshops also allowed teachers to share ideas and knowledge with each other in order to help each other develop better lessons utilizing the technology. Lessons were then implemented by each teacher. The 18 teachers then participated in a professional development review workshop.

Participating teachers could share their success stories on how the technology enhanced learning or allowed for more personalized learning, but teachers also shared the problems they encountered and how these problems could be avoided in the future. Most teachers agreed that the planning and review workshops were a very important aspect of their professional development. These workshops provided the opportunity to develop teachers' attitudes, knowledge base, and skills in using mobile devices in their curriculum in order to enhance students' learning opportunities.

Storz and Hoffman (2013) designed a study to investigate a 1:1 technology initiative in a Midwestern urban middle school. This study involved eight, eighth-grade teachers. Sixty to seventy minute interviews were conducted with each teacher with questions pertaining to teacher instructional practices and attitudes before the technology initiative compared to after the implementation. In terms of professional development, teachers found professional development in this first year of implementation was inadequate and lacking in useful information. The teachers stated the training was brief and focused more on the student software rather than how to utilize technology in the classroom from the teacher perspective. Most of the teachers from this study felt unprepared and frustrated with how to use technology; hence the need for professional development that delves into more advanced uses, ideas, and examples of how to use technology in the classroom.

The study by Zheng, Warschauer, Hwang and Collins (2014) previously discussed findings that technology integration led to an increase in student achievement. The study also utilized survey and feedback information to gain knowledge on teacher attitude towards the technology implementation. Teachers in the program did receive four days worth of training during the summer and weekly teacher meetings throughout the 2010–2011 school year. Professional development focused on teachers' proficiency with technology and infusing technology into the science curriculum. In addition to weekly meetings, an online wiki discussion forum was created so teachers could share resources, ideas, and issues, and experiences and discuss questions with each other. Information from the surveys and feedback discussions, it was found that teachers wanted more specific professional development throughout the year that focused on how to use technology within their curriculum. They also stated the four day session in the summer was too much information, too quickly, with very little time to explore and ask questions. Teacher training that focuses on learning one tool at a time was suggested as an improvement to professional development sessions going forward. Another suggestion was for more opportunities for teachers to share ideas with one another on how they were actually utilizing technology in the classroom that was leading to the success of their students.

Opposite Findings

Although several case studies support the use of technology in the classroom, there are opposite or differing findings to indicate that technology initiatives do not always correlate to positive outcomes. A study conducted by Fried (2008) set out to determine the correlation between laptop use and student learning. This study was conducted over a 20-week period, using 137 students in two sections of General Psychology, which were taught by the same instructor. Laptop use was not a requirement, and therefore was not utilized in an organized manner. Students were free to bring laptops for note taking throughout the lecture period. Ten surveys were given to students, over the 20-week period, asking questions about attendance and how often or how much students used their laptops for class related tasks vs. non-class related tasks like email, instant messenger or game playing. The survey results showed that when students used laptops, approximately 49% of the time was used on class related tasks. Approximately 17 minutes of the 75-minute class period was used off task, which is approximately 23% of class time. This study also measured the relationship between laptop use and student learning. This relationship was analyzed using linear regression. Each student had a ratio of laptop use calculation based on the number of times they reported attending class and the number of times they reported using their laptops during class. Using ACT scores, high school rank, and class attendance, this study found that laptop use had a negative correlation on scores. The conclusion found was one that students were distracted by their laptops and not engaged in listening to the lecture material or in the note-taking process, which in turn resulted in lower test scores.

Bebell and Pedulla (2015) also found very little evidence that 1:1 technology implementation correlates to increased test scores. Their research involved an iPad implementation that took place in grades K-2 within the Auburn, Maine school system. The study was twofold in nature. At the beginning of the 2011 school year, a 9-week trial was conducted in which eight Kindergarten classes used apps concentrating on literacy and numeracy. These eight classrooms served as the test group. The control groups were eight Kindergarten classes that used their traditional (non-iPad) resources. Pre-test and post-test scores were used as measurement and comparison data. At the end of this short 9-week period, slightly stronger literacy performance gains were observed in the iPad settings. In a second study, a much longer period of three years of data sets were analyzed before and after the 1:1 iPad implementation. The implementation occurred in waves of distribution. In December of 2011, all of the district's Kindergarten classrooms received 1:1 iPad access for the remainder of the year and for all school years following. All grade one students received their iPad access at the beginning of the 2012 school year, and grade two students received 1:1 access at the beginning of the 2013 school year. Data was assessed utilizing information from The Children's Progress (2009) Academic Assessment (CPAA) and Observation Survey of Early Literacy Achievement (OSELA) for English Language Arts (ELA) and Math achievement.

In analyzing Math data for all three academic years and all three grade levels, the information revealed no evidence of gains in student performance related to iPad implementation for any of the Math subtests. Minimal gains in ELA subtests were observed for Kindergarten students during the iPad implementation period, providing some indication of iPad effectiveness in increasing students' Phonemic Awareness at the Kindergarten level. There were no differences observed for grades one and two in terms of iPad use vs. non-iPad use.

Donovan, Green, and Hartley, (2010) conducted a one-year study that also concluded in technology increasing off-task classroom behavior. This case study occurred during the first year of a one-to-one laptop initiative in 7th grade classrooms in a southwestern United States middle school. During this study, three groups were identified based on the amount of technology use within the classroom. Group A used technology frequently in their student-centered homework assignments, modes of communicating with each other and the teacher, and in their assessments. Group B used technology occasionally during their class time with some homework assignments based on technology but most assignments were content based rather than project-based like Group A. In drastic contrast was Group C which rarely utilized technology throughout their day.

It was found that although all students in every group were given access to a device for the entire school year, the students in Group B showed the most off-task behavior. This study contradicts the idea that increased access to technology leads to increased student engagement.

Gaffney, Smarkola, and Wurst (2008), found differing results in relation to scores, but similar results in relation to the distraction factor. Their study analyzed three cohorts of honors business students. The first cohort of 27 students did not participate in the 1:1 laptop initiative. Cohort two, with 27 students, and cohort three, with 33 students, both participated in the 1:1 initiative. Students in cohort two and three were using laptop technology throughout all of their classes. Upon graduating, it was found that the laptop users had a slightly higher overall mean GPA score, and had very slight increases in the mean GPA in writing courses. The students were also given a survey of questions regarding their satisfaction with using technology in their classes. While several students appreciated the ability to look up information immediately, they also found they could become distracted with non-class related tasks, resulting in the loss of learning time and opportunities.

Hur and Oh (2012) designed a study involving one randomly selected 7th grade classroom to serve as the experimental group. All 40 students within this classroom received a laptop to use in school and at home for three years. The teachers of these 40 students developed laptop lessons that required students involvement and interaction.

This study was trying to identify if technology increased test scores and student engagement. It was found that the experimental group did not have increased test scores compared to their peers that did not have laptops. It was also found that while student engagement increased at the beginning of the laptop initiative, engagement decreased over time.

CHAPTER III: DISCUSSION AND CONCLUSION

Summary of the Literature

All schools and educators are in a constant mindset to better the learning opportunities for students. In this day and age, where technology is a part of our everyday lives, technology in the classroom is viewed as a tool that leads to positive results and therefore technology initiatives continue to increase year after year. A review of the literature identifies many benefits to integrating technology into the classroom. For the purpose of this paper, technology integration and initiatives is the idea that technology is infused in the curriculum of general content areas in education in order to allow students the opportunity to utilize technology while learning, problem-solving, and demonstrating mastery of concepts within content areas, but also learning and enhancing technology skills.

This paper sought to identify the impact technology has in the K-12 classroom. As with many educational tools, test scores often come up as a way to measure the impact of the educational tool being studied. In terms of technology initiatives in the K-12 classroom, several studies show that these initiatives have a positive impact on test scores (Chandra & Watters, 2012; Dunleavy & Heinecke, 2008; Grimes & Warschauer, 2008; Gulek & Demirtas, 2005; Hwang, Wu, & Chen, 2012; Kposowa & Valdez, 2013; Rosen & Beck-Hill, 2012; Suhr et. al., 2010; Sung & Hwang, 2013; Zheng et. al., 2014). When students use technology, it offers different opportunities to learn material that a traditional teaching method may not be able to provide. With technology comes unlimited possibilities to research and problem-solve, deepening the understanding of concepts, which can lead to increased test scores and student achievement.

Student engagement and motivation to learn is an ongoing goal of classroom teachers as they look to enhance their curriculum and learning activities. According to several studies, technology integration can build engagement and motivation (Bebell et. al., 2014; Clarkson, & Burraston, 2014; Dawson et. al., 2008; Hwang et. al., 2012; Moos & Honkomp, 2011; Mouza, 2008; Smith, 2014; Suhr et. al., 2010; Sung & Hwang, 2013).

Not all students learn in the same way nor at the same pace. Differentiation is key to helping students find success in the classroom. As many studies point out, technology can be a tool to help classroom teachers differentiate instruction (Clariana, 2009; Liu et. al., 2014; Milman et. al., 2014; Rosen & Beck-Hill, 2012; Zheng et. al., 2014), specifically by reducing teacher-centered instruction to allow for more one-on-one time (Clariana, 2009; Rosen & Beck-Hill, 2012) or students working at their own pace (Clariana, 2009; Rosen & Beck-Hill, 2012; Zheng et. al., 2014).

The last area discussed in this paper is 21st Century skills. As students enter higher education and the workforce, more and more careers involve technology of some kind. To better prepare future generations, technology infused curriculum can lead to more opportunities to learn the skills many employers look for in their employees. Several studies (Lei & Zhao, 2008; Shapely et. al., 2011; Spektor-Levy & Granot-Gilat, 2012) all identified technology initiatives were valuable in learning and developing technology based skills and 21st Century skills.

In order to maximize technology initiatives in the classroom, studies find that professional development for teachers is key. Ekanayake and Wishart (2015) and Inan and Lowther (2010) implied that professional development had the greatest impact on teachers readiness to implement technology into their curriculum. Storz and Hoffman

(2013) found that teachers were frustrated and felt unprepared when they lacked the necessary professional development and training to implement technology. Even with findings to support success in student achievement linked to technology integration, Zheng et. al., (2014) found more professional development was desired from teachers in order to continue to feel confident in their ability to embed technology within curriculum.

Not all research supports the positive impacts of technology in the classroom. Several studies indicate that technology did not increase test scores (Bebell & Pedulla, 2015; Fried, 2008; Hur & Oh, 2012), nor does increased technology in the classroom lead to more engaged learners (Donovan et. al., 2010; Fried, 2008; Gaffney et. al., 2008).

Limitations of the Research

The first limitation of the research is that many of the studies utilized were small in nature. This pertains to either a small number of participants within the study or a short amount of time that the study took place. With limited participants and short time frames, the data becomes less precise, questioning the true validity, especially the validity of technology in correlation to increased student achievement. Another limitation pertains to using multiple teachers within the experimental and control groups. It is very difficult to measure or identify concrete evidence to reflect with 100% accuracy that technology is the variable that increases student achievement. Other variables, such as teaching style, teacher-student relationship, and learning tools utilized, could also lead to an increase or decrease in student achievement, thus making the technology variable more difficult to measure.

Research was limited to K-12 classrooms with studies older than 2005. While science classrooms were a focus, there is limited research in the science field because of the lack of longitudinal data as science achievement is not measured annually from state testing. Therefore, math and ELA achievement became a focus to better understand how technology may impact other core areas. Research was also limited to public schools and did not include online school systems. The majority of research also focused on schools within the United States.

One other limitation in the research involving technology in the classroom is recognizing that technology is ever changing. As technology changes, it becomes more difficult to identify if technology is linked to results or if the technology utilized is out of date and given an opportunity for newer tools, study results would be different. This also includes technology usage in relation to time and the type of technology used. Several studies are not able to indicate the amount of time that technology was in use or the type of specific technology that was being utilized. This indicates other variables that need to be addressed to more accurately identify if technology does have a significant impact on student achievement.

Implications for Future Research

With these limitations, opportunities for future research are identified. Studies that involve more students, over longer periods of time, would better reflect accurate data. Research designed to specifically identify the online tools, apps, and technology based teaching strategies used in learning could more accurately reflect if a link to an increase in student achievement because of technology use actually exists. Using the same teacher in the experimental group and the control group could eliminate one variable, providing a more accurate picture of technology initiatives and how implementation impacts student achievement, student motivation and engagement, and the enhancement of 21st Century skills.

Professional Application

Technology in the classroom is an ever changing entity with endless opportunities, but one that has sparked much controversy in regards to the academic outcomes and results linked to technology use. The literature regarding technology use in K-12 classrooms identifies positive correlations between technology use and academic outcomes, increased motivation and engagement, opportunities for differentiation and learning 21st Century Skills, correlations that educators should recognize. Technology is another resource that teachers can add to their professional toolbox. Like many of our teacher resources, technology should not be used as the only source of delivering content or learning about subject matter. As research shows, experimental groups did not utilize technology 100% of the time, but rather had technology infused into the curriculum to enhance their learning opportunities. As educators, it is important that we embed technology appropriately into our subject matter and not use technology just to say we used it, nor should we rely solely on technology to help our students learn.

As educators, technology can be used to engage and motivate students in our classrooms. With most teacher tools, you will find students are motivated and engaged by different tasks. As an example, some students are motivated and engaged in taking notes, others in reading aloud, public speaking, or writing papers. Technology is no different and while many students may find technology to be motivational, not all students will agree. I would not use the same technology based assignment, website, or app for every chapter or learning segment in my class, as students would soon find the task to be mundane and repetitive, thus losing out on any motivation and engagement technology integration may have within my curriculum.

Research supports the relationship between technology integration offering opportunities for students to learn or enhance their 21st Century skills. As an educator, I find this correlation very important as I prepare students for the learning opportunities they will encounter for years to come. Learning how to communicate, work as a team, problem solve, and research are some of the 21st Century skills that students will not only encounter during their educational path, but also skills that many careers rely on. By not infusing technology into my curriculum, I feel that I am not preparing my students for skills that may be required of them in their future. While I will not be able to teach them every technological skill, providing them different opportunities to work with or trouble shoot also provides them to e opportunity to build confidence in their ability to tackle any task that is asked of them.

In regards to professional development, school districts and administrators can find a significant amount of research to support the fact that teachers need opportunities to develop their own technological skills and also opportunities to learn how to use technology specifically for their content. While teachers can search for ideas and support online, this can be very time consuming and frustrating, leading to teachers developing a poor attitude towards technology integration resulting in limited integration within the curriculum. School districts need to support their teachers in order to develop a positive attitude towards technology integration and realize that technology integration does not happen quickly and needs to be supported with teacher learning opportunities several times throughout the school year.

Conclusion

There is no denying that technology is a significant part of our lives. With advances in technology, comes the need for students to be able to adapt to this ever changing environment, utilizing technology in order to communicate, research, develop, design, and problem-solve. From an educational standpoint, more and more schools are implementing technology into their curriculum to better serve the learners of today and the workforce of tomorrow. This might come in the form of increasing student achievement, providing more engaging and motivational tasks and learning opportunities, providing teachers with more opportunities to differentiate instruction, thus leading to more success for all students, and finally, increasing the 21st Century skills of students. These skills are necessary as student move on to higher education or enter the workforce.

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Appendix

Appendix A

2003–04 Cumulative Grade Point Averages by Grade

Grade	Laptop	Non-laptop
6	3.50	3.13
7	3.28	2.94
8	3.23	3.07

Appendix B

2003-04 End-of-Course Grades by Subject, Grade, and Program

English Language Arts

End of Course Letter Grade	Grade 6 Laptop program	Grade 6 Non-laptop	Grade 7 Laptop program	Grade 7 Non-laptop	Grade 8 Laptop program	Grade 8 Non-laptop
A	50%	38%	39%	23%	36%	39%
B	42%	32%	45%	33%	54%	40%
C	7%	21%	11%	28%	10%	17%
D	1%	6%	3%	9%	0%	3%
F	0%	3%	2%	7%	0%	1%

Mathematics

End of Course Letter Grade	Grade 6 Laptop program	Grade 6 Non-laptop	Grade 7 Laptop program	Grade 7 Non-laptop	Grade 8 Laptop program	Grade 8 Non-laptop
A	40%	13%	37%	30%	24%	23%
B	41%	31%	38%	32%	36%	29%
C	14%	20%	18%	21%	20%	28%
D	2%	6%	5%	8%	20%	11%
F	3%	10%	2%	9%	0%	9%

Appendix C

2004 STAR California Standards Tests in English-Language Arts and Mathematics Results: Percent of Students Scoring Proficient or Advanced

		English Language Arts	Mathematics
Grade 6	Laptop	80%	86%
Grade 6	Non-Laptop	68%	66%
Grade 7	Laptop	83%	73%
Grade 7	Non-Laptop	64%	57%
Grade 8	Laptop	76%	58%
Grade 8	Non-Laptop	56%	49%

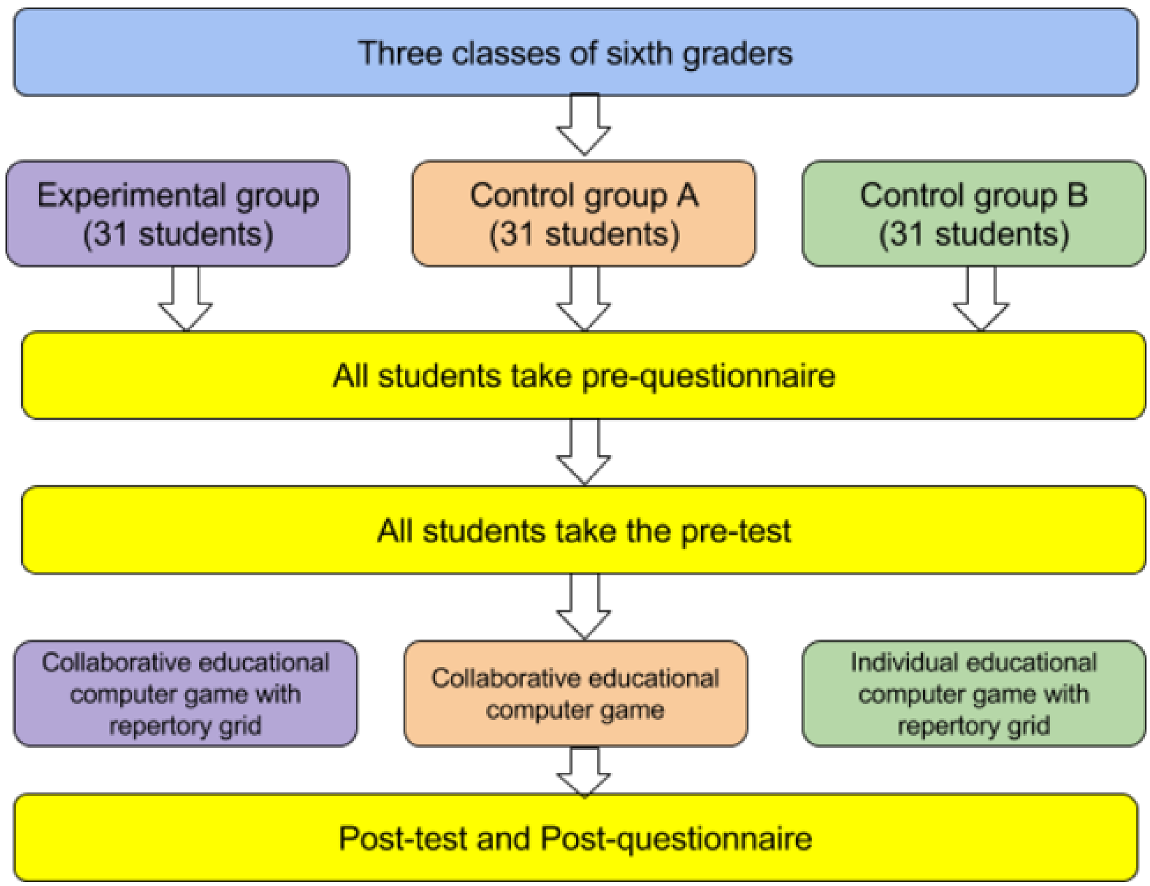
Appendix D

Descriptive data and the ANCOVA results of the learning achievement post-test for the three groups.

Variable	Group	N (number of participants)	Mean	Standard Deviation	Adjusted Mean
Post-Test	Experimental group	31	57.26	16.87	59.37
	Control group A	31	43.07	14.24	41.56
	Control group B	31	43.07	14.47	42.50

Appendix E

Experimental design for the learning activities



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