Clicker Use as an Instructional Strategy: Effects on Student Engagement and Achievement in a College-Level Digital Literacy Course

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ABSTRACT

This study sought to determine the impact of clicker use as an instructional strategy on student engagement and achievement in a college-level digital literacy course taught in face-to-face classroom settings. This was also an attempt to explore students' learning experiences and attitudes toward instruction utilizing clicker technology-based strategies. This study was conducted in a public college with an open-access admission policy in the rural South. The college has a significant racially and ethnically diverse student population. The students' levels of preparation to enter college are just as diverse, and there is a large number of learning support students. This course, under study, does not have any prerequisite, allowing learning support students to enroll in this course along with everyone else, causing a challenge to teach this course effectively.

Eight classes were selected where students were already pre-registered, resulting in convenience sampling. This study used quasi-experimental control group time series design. Concentration was more focused on the internal validity of this study rather than the generalizability of its findings over the student population at a different institution that may be vastly different. Data collection continued throughout the duration of a semester. Students' academic achievement was measured using a series of assessments. Students' learning experiences and attitudes toward learning were measured using data, collected through survey instruments. Descriptive statistics, reliability analysis, effect size, *t*-test of independent samples, and multivariate analysis of variance (MANOVA) were used for data analysis. Content analysis technique was used to identify trends and themes in qualitative data collected through open-ended survey items.

Findings of this study revealed that the academic achievement of students in the group that was taught with extensive use of clicker technology was higher than the students in the group that was taught using traditional methods. It also revealed that the students who were taught with extensive use of clicker technology reported that they had substantially positive learning experiences. Furthermore, the results revealed that the students who were taught using instructional strategies focused on extensive use of clicker technology demonstrated a more positive attitude toward learning than students who were taught using traditional methods. Overall, the results suggested that frequent feedback through clicker technology is more effective in circumstances where improved understanding of the current topic is essential to establish a good foundation for the next learning experience. Future research can be done to explore this suggestion in further details.

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DEDICATION

To my wife Nazmoon, and my two sons: Nafiz and Asif. Thank you from the bottom of my heart for allowing me the time away from you to pursue this endeavor.

Chapter I

INTRODUCTION

Instructional methodologies have changed very little in recent decades. Computer technologies, however, have transformed modern-day communications, collaborations, and research. The development of the effective use of technological tools to connect teaching with enhanced learning has been far slower in comparison (Brewer, 2004). The number of computers used in academic institutions from K-12 through higher education has been on the rise since late 1990s. At the same time, there has been a steady increase in support for the assimilation of technology in classrooms as well. However, there is a huge discrepancy between the level of technology use expected of educators to increase student learning and comprehension, and the actual use and assimilation of technology to achieve that goal (Brewer, 2004).

Using technology for course management or content delivery does not impact student learning since it does not promote engagement or interaction of students with course materials (Brewer, 2004). The use of technology in the classroom has to be inventive, creative, and fitting for the adopted pedagogical approach (Brewer, 2004; Judson & Sawada, 2002). The purpose of the use of technology in the classroom should be to enhance the ability of students to achieve higher levels of learning and comprehension through deeper understanding of concepts and mastery of skills (Edutopia, 2008).

Raines and Arnsparger (2010) pointed out that this millennial generation of college students grew up in smaller families where they were the center of attention and were surrounded by digital media. Their environment has shaped their expectations, and technology plays a very large role in their everyday lives. These students prefer to participate in an active learning process and to use technology to enhance learning (Mangold, 2007). The necessary initiative is to engage them in their own learning process in order to achieve higher levels of comprehension through the aid of technology with which they already feel comfortable (Raines & Arnsparger, 2010).

There are studies that clearly suggest that Student Response Systems are a viable instructional tool that encourages students to actively participate in the learning process (Beuckman, Rebello, & Zollman, 2007; Masikunis, Panayiotidis, & Burke, 2009). Student Response Systems, more generally known as clickers, are small hand-held transmitters that generally use radio frequency to transmit wireless signals. A computer, equipped with required hardware and software, often connected to a projector, receives and records the signals transmitted from the clickers and processes them, allowing the option to store the data to perform a multitude of additional analyses at a later time (Banks, 2006; Skiba, 2006). Shaffer and Collura (2009) reported that the use of Student Response Systems as a teaching tool made the learning process for their students more interactive, more engaging, and more entertaining.

Marti (2009) suggested that positive learning outcomes are directly associated with active participation and engagement of the student in the learning process. Marti believes the more the students can be actively engaged in their own learning process the better the chance of their success — thus, positively affecting the retention, progression, and graduation rates of the institution.

Purpose of the Study

An educational institution is like a social system that has an inherent design and a unique culture that may have evolved over time (Green, 2000). Best practices borrowed from one institution with its own unique design and culture do not always bring about the same results elsewhere. Both instructors and administrators can immensely benefit from having access to local knowledge and tools in order to forge the most appropriate tried and tested pedagogical approach to maximize instructional effectiveness in terms of student satisfaction and learning achievement for their institutions (Parker, 2006).

Learning needs for this millennial generation of students have to be matched by the use of technology tools that can aid in engaging and empowering these students. In its National Educational Technology Plan 2010, the Office of Educational Technology of the U.S. Department of Education (2010) called for “engaging and empowering learning experiences for all learners” (p. 8) largely through the use of technology. The plan’s model asks that we “focus what and how we teach to match what people need to know and how they learn it best” (p. 8).

Effectively tapping into the technologies in which students are already immerged has clear potential (Tapscott, 2008). Tapscott believes it levels the field for communications with students who are significantly more racially and ethnically diverse than their parents’ generation, as their educational needs are different from those of their parents.

The purpose of this study is to examine the impact of clicker-technology-aided classroom instruction on student engagement, achievement, and course-level retention in a college-level digital literacy course by comparing a group that used traditional instructional strategies with one that used clicker-technology-aided instructional strategies. The digital literacy course, itself being a technology course, already employs few technology tools for teaching and learning purposes. The sections of the course selected for the study will be taught in face-to-face classroom settings. This digital literacy course has the largest enrollment of any course in the institution where the study will be conducted.

Clicker technology used in classroom teaching allows instructors to ask questions and collect and analyze responses that provide real-time feedback to create interactivity between a presenter and the audience. These systems were introduced in the television industry in the 1960s, in business in the 1970s, and finally in education in the 1980s (Beatty, 2004). This study will use clickers, and associated hardware and software from the TurningPoint Technology Company.

One of the strengths of clicker technology is generating question-answer sessions. The question-answer method to promote critical thinking through discussion and learning has been in practice as a teaching tool dating back to the time of Socrates over four hundred years BC. The fundamental objective is to learn as a group through dialogue. The Socratic Method is still widely used and valued in classroom instruction to actively engage students in their learning process (Bereiter & Scardamlia, 1992).

Conceptual Framework

The conceptual framework for this study is firmly grounded in the constructivist learning theory. Constructivist theory examines specifically how people learn. Among others, John Dewey has clearly voiced the core idea of the theory that learners individually construct knowledge for themselves. Hein (1991) proclaimed that learners individually construct the meaning of what they learn and that “constructing meaning is learning” (p. 1). “There is no knowledge independent of the meaning attributed to experience (constructed) by the learner, or community of learners” (p. 1). Hein also noted that this core idea of constructivist learning theory is “widely accepted today by educators, curriculum developers and cognitive psychologists” (p. 1). Clicker technology actively engages students in their own learning process helping them in constructing their own understanding of the topic.

Dangle and Guyton (2003) stressed that active participation and engagement in the learning process enhance the acquisition of knowledge by promoting assimilation of new concepts into the existing body of knowledge. When student response systems are used to engage students in individual and collective learning process, a higher level of knowledge acquisition takes place enhancing comprehension and knowledge retention for the learners (Guthrie & Carlin, 2004).

Actively engaging students in their own learning process has proven to be a critical component of successful achievement in college-level coursework within many disciplines (Beuckman, Rebello, & Zollman, 2007; Masikunis, Panayiotidis, & Burke, 2009; Revell & McCurry, 2010; Shaffer & Collura, 2009). Benefits of technology-aided instruction are both theoretically and empirically grounded. Abdallah (2008), Brewer

(2004), and Skiba (2006) claimed that clicker-technology-aided instruction has demonstrated a significant positive effect on student achievement, and one of the proven technological means to actively engage students in the classroom that enhances their learning and comprehension of the subject matter is the use of Student Response Systems.

Christenbury (2010) stressed that "good teaching comes not from a recipe, but from consistently putting student needs first" (p. 46). Christenbury believed teaching methods have to be engaging; student needs have to be the top priority; teachers have to employ a variety of instructional strategies that make the subject interesting and reach out to students with their various learning styles and personalities. Technology-aided instruction, or reflective teaching using technology, has the clear potential to aid in enhancing the level of student learning and comprehension (Abdallah, 2008). Over two decades ago, Kulik and Kulik (1991) concluded from their meta-analysis of 254 controlled studies of students from K-12 through higher education that technology-aided instruction had a clear advantage over traditional methods of classroom instruction.

Technologies are increasingly making the world flatter every day. Technologies have transformed the way people communicate, collaborate, and learn – young and old alike (Friedman, 2007). But the effective use of technological tools in classroom instruction, which connects teaching with learning, has not made significant progress (Brewer, 2004). Increased student achievement can only be insured through the use of high-leverage technological tools and the teacher's increased ability to incorporate them in classroom instruction (Green, 2000).

Unlike the generation before, the learning needs for this millennial generation of students have to be matched by the use of technology tools that can engage and empower these students. In its National Educational Technology Plan 2010, the Office of Educational Technology of the U.S. Department of Education calls for “engaging and empowering learning experiences for all learners” (p. 8) largely through the use of technology.

Ensuring the best learning experience for an increasingly diverse student body in an open-access institution in the rural South has always been a challenge. Instructors are pressured to improve student retention and graduation through maximizing student satisfaction and learning achievement. Despite the diverse social, economic, ethnic, or secondary school backgrounds may be, they are the elite members of this millennial generation. They all are open to the use of technology (Prensky, 2001). The students sitting on the borderline of completing the course or dropping out might as well hinge on the slight nudge they need to boost their interest through active engagement in classroom. If students find the class more engaging, more interactive, and more interesting, they may not only perform better in class, but a higher number of them may actually be willing to stay in the class and complete it, potentially reducing the course-level dropout rate. Personal response systems have a proven track record of engaging students in classroom (Shaffer & Collura, 2009; Skiba, 2006).

Statement of the Problem

After reviewing studies conducted in the last thirty years on classroom use of clickers in science classes, Judson and Sawada (2002) concluded that clickers do make the classroom interactive. They contend, that the learning and comprehension could only be marginally higher through the mere use of clickers. They suggest that the pedagogical approach adopted by the instructor and the presentation of the course content to include the use of clickers have to be redesigned in order to achieve a significant improvement in student engagement, learning and achievement. Beuckman, Rebello, and Zollman (2007) also emphasized that redesigning the pedagogy for the course is essential to maximize the potential of clicker technology.

Acree (2010) conducted a study using clickers as an instructional strategy. Acree did not, however, redesign her course content or modify the pedagogical approach in her study. Instead, Acree only used clickers to measure student responses in class. As Judson and Sawada suggested, Acree's passive use of clickers made the classroom somewhat interactive, but Acree did not achieve any statistically significant improvements in any of the achievement areas measured.

There have been many studies involving the use of clickers in classrooms. However, as in the case of Acree (2010), in many of these studies, clickers only contributed to increasing interactivity in the classroom. According to Judson and Sawada (2002) and Beuckman, Rebello, and Zollman (2007), the degree of achievement in increased comprehension and knowledge retention is largely and directly proportional to the extent of redesigned pedagogical approach of instruction. While there are some well-funded studies such as that of Watkins and Sabella (2008) at Chicago State University and well-organized studies such as Shaffer and Collura (2009) at Ohio State University that produced significant improvement in student achievement, there are far too many studies similar to Acree (2010) at San Juan College that did not adopt a redesigned pedagogical approach that is integrated with the clicker technology itself and did not see significant improvement in student achievements as a result. Even though there are some well-organized and well-executed studies of technology-aided instruction using clickers that produced promising improvements, there are few successful studies conducted in rural South community colleges nor can the findings of successful studies from elsewhere be generalized to a rural South community college setting. When “retention and graduation” are the ultimate mission, an institution must attempt to find every possible way to engage students in their learning process to enhance higher levels of achievement towards that mission.

This study will implement the recommendations of Judson and Sawada (2002) and Beuckman, Rebello, and Zollman (2007)). There will be eight different class sections of the Digital Literacy course selected for this study and taught by two different instructors. Of the eight sections, four will be selected for the experimental group in this proposed study and will adopt redesigned clicker-technology-aided pedagogical approaches and instructional strategies. For this study, instructional strategies will be designed and developed to seamlessly integrate with clicker technology to be applied as the treatment in all four sections of the treatment group.

Definition of Terms

The following list of terms has been defined to address their specific use and meaning as they apply to this study.

- *Achievement* – Merriam-Webster’s dictionary (2013) defines achievement as “result gained by effort.” In the context of student achievement in the classroom, according to Hawaii Department of Education, that definition would translate to “knowledge and/or skill a person has acquired, usually as a result of classroom instruction” (Hawaii DOE, 1999).

- *Clicker* – A hand-held remote device that students use in a class to submit their responses to questions presented by the instructor. It is also known under other names such as Student Response System, Personal Response System, and Audience Response System (Skiba, 2006).
- *Clicker technology* - The integrated system that includes both hardware and software used to develop questions, and collect student responses, analyze and report the responses in real time (Skiba, 2006).
- *Control group* - In a comparative research design, this is a group of subjects that is very similar to the experimental group who receives no intervention, just the standard treatment, thus serving as comparison group when the factor(s) being studied are assessed (Fraenkel & Wallen, 2009).
- *Experimental group* - In a comparative research design, is a group of subjects who receive intervention or treatment to assess the effects of the intervention or treatment on the subjects (Fraenkel & Wallen, 2009).
- *Student learning experience* - Refers to the aspects such as how comfortable students felt using clicker technology, to what degree clickers helped them to concentrate on course content or engage in learning activities, the overall effectiveness of its use, its perceived potential, etc.
- *Student attitude about learning* - Refers to the aspects such as how students felt about the use of technology-based instructional strategies, their appropriateness and effectiveness, levels of overall student satisfaction, how

welcoming students would be for additional technology-based instructional strategies in other classes, etc.

- *Traditional methods of instruction* - Refers to, for this study, teaching students in a face-to-face classroom setting, using lectures with or without the use of projector, using hands-on exercise on computers, and using a training and testing software platform called Skill Assessment Manager (SAM).

Research Questions

Three research questions were investigated in this study:

1. How does student achievement differ between a group of students who were taught a college-level digital literacy course with heavy use of clicker technology and a group of students who were taught using traditional methods?
2. What are the learning experiences of students who were taught a college-level digital literacy course with heavy use of clicker technology?
3. How do instructional strategies focused on enhanced use of clicker technology influence students' attitude about learning?

Methodology

This study was conducted in a public college with an open-access admission policy in the rural South. The college has a significant racially and ethnically diverse student population. The students' levels of preparation to enter college are just as diverse, and there is a large number of learning support students. Learning support students are those who do not have high school completion-level competencies in math and/or English (reading/writing). The college traditionally experiences a high course-level as well as a college-level dropout rate and low retention and graduation rates.

This study intended to investigate how course-level student retention differ between a group of students who were taught a college-level digital literacy course with heavy use of clicker technology and a group of students who were taught using traditional methods. Data were collected throughout the duration of the study as well. However, it became very obvious during pre-analysis, that there was not enough data to conduct a meaningful analysis and a much larger study sample is needed to make any inference on course-level (or college-level) retention. Thus, that objective was dropped from the study.

This study used quasi-experimental control group time series design. In this design, the dependent variable is interrupted (usually near the middle) by manipulating the independent variable. The researcher records repeated measurements or observations under different conditions throughout the entire duration of the study both before and after the treatment is applied (Fraenkel & Wallen, 2009; Leedy & Ormrod, 2009). This design can reveal the causal effects of the treatment not only between the beginning and ending of the course but can also provide insights on the progression of the effects of treatment throughout the duration of the course (Gottman, McFall, & Barnett, 1969). Repeated measures of the same sample tend to make the experiment more efficient by keeping the variability in check. This increases the validity of the findings and allows for a smaller than usual sample size (Shuttleworth, 2009). Wagner, Soumerai, Zhang, and Ross-Degnan (2002) described control group time series design as one of the strongest design approaches in quasi-experimental research design.

For Research Question 1, student achievement was the dependent variable, and the use of clicker-technology-aided instructional strategies was the independent variable, or the treatment. For Research Question 2, student learning experiences were the dependent variables, and again the use of clicker-technology-aided instructional strategies was the independent variable. For Research Question 3, student attitudes toward learning were the dependent variables, and traditional and clicker-technology-aided instructional strategies was the independent variables.

The student body of a college in the rural South was the general population from which the sample was selected. In this educational institution setting, it was practically impossible to select a true random sample for the study. Therefore, this study employed convenience sampling – groups of students conveniently available for the study in different sections of the class (Fraenkel & Wallen, 2009). Data collection continued throughout the duration of a semester, using survey instruments as well as interviews. The repeated measure process was expected to minimize the effect of student absences on a given day when an assessment was conducted. The Statistical Package for the Social Sciences (SPSS) software was used to analyze quantitative data.

This study employed several methods of data analysis. Descriptive statistics was used to describe the basic features of the data and to form the basis of the analysis. The *t* test assessed whether the means of the traditional group and the treatment group were statistically different from each other (Trochim, 2006). Multiple Analysis of variance (MANOVA) was used to test the significance of group differences as it analyzed variations between and within each groups (Field, 2009). Content analysis technique was used to identify trends and themes in qualitative data analysis (Fraenkel & Wallen, 2009).

Significance of the Study

The field of technology has developed tremendously in recent years. There are many tools available for use in technology-aided instruction to meet various learning styles of learners. It is the responsibility of instructors and leaders in education to incorporate technology into classroom instruction to enhance student learning, achievement, retention, and graduation.

Green (2000) noted that an educational institution is a social system that has an inherent design and a unique culture that evolves over time. Green submitted that best practices borrowed from one institution with its own unique design, culture, and mission does not always bring about the same results elsewhere. The designs, the cultures, the missions, and the philosophies of K-12 institutions differ from those of community colleges. Similarly, the designs, the cultures, the missions, and the philosophies of community colleges differ from those of senior colleges and research universities. Even within the same group of institutions, there are varieties of factors making each of the member institutions unique. The scope of quasi-experimental research findings has limited scope of generalizability as well (Fraenkel & Wallen, 2009). Engagement, achievement, and retention issues of a college in the rural South hardly resemble the same issues at other institutions (Green, 2000).

Both instructors and administrators can immensely benefit from having access to the local knowledge and tools in order to forge the most appropriate tried and tested pedagogical approach to maximize instructional effectiveness in terms of student satisfaction and learning achievement for their institutions (Parker, 2006). This study attempted to aid in developing that local knowledge that might be applicable to the specific institution, and investigating the effectiveness of the use of clicker-technology-aided instructions as one additional tool. Finally, findings of this study were intended to enrich the existing general knowledge body on the effectiveness of clickers in engaging students to achieve higher levels of learning and achievement in an environment with large number of learning support students.

Limitations

Action research assists in practical problem solving and helps expand scientific knowledge (Hult & Lennung, 1980). It is a reflective and progressive process of problem solving. An action research study or a quasi-experimental research study such as this one, in most cases, is done to improve and become more effective in the practitioner's work environment. From that perspective, external validity for such studies is a confusing issue that needs a balanced consideration (Hult & Lennung, 1980). External validity is one of the fundamental attributes of true experimental design since it addresses the scope of generalizability of findings over the larger population from which the study sample was initially drawn, and it requires random sampling where every student has equal opportunity to be selected for the study (Fraenkel & Wallen, 2009). Since true random sampling is practically impossible for this type of study in an academic institution, this study used convenience sampling instead, limiting the scope of external validity. In this case, the principle of proximal similarity can be substituted for external validity (Campbell, 1986).

For this study, eight classes were selected where students were already pre-registered, resulting in a quasi-experimental design with convenience sampling rather than a true experimental design with random sampling. Thus, concentration was more focused on the internal validity of this study rather than the generalizability of its findings over the student population at a different institution that may be vastly different.

Organization of the Study

This dissertation was divided into five chapters. Chapter 1 provided a broad overview of the stated problem of the study, purpose of the study, the theoretical and conceptual framework, methodology, significance of the study, and its limitations. Chapter 2 will include a broad literature review on technology and student achievement, clicker technology, student retention, experience with technology use, and the effect of technology on attitude. Chapter 3 will provide detailed methodology used for this study. Chapter 4 will discuss the findings of the study. Finally, Chapter 5 will summarize previous chapters, draw conclusions of the study, and provide recommendations for future directions of research in this area.

Chapter II

REVIEW OF THE LITERATURE

This chapter offers an overview of the teaching and learning tools used in classroom environment since the colonial era. The chapter also discusses research on student achievement, factors that influence student achievement, how student achievement is measured, and how clicker technology, in particular, influences student engagement and achievement. In addition, the chapter describes research on student retention in the context of community colleges. Finally, the chapter explores the experiences of others using clicker technology in classroom instruction as well as how utilizing technology-based strategies influence students' attitude about learning.

Overview of Teaching and Learning Tools

On September 15, the New York Time Magazine (2010) chronicled the progression of "Learning Machines" that aided in teaching and learning throughout the recent history of formal education. It stated that in the colonial era, use of Wooden Paddles with printed lessons was popular. Around 1870, the Magic Lantern that projected images printed on glass plates, was introduced in classrooms. The Magazine stated that school slate and chalk board were introduced around 1890 and were widely used in America's school systems. In the late 19th century, mass-produced paper and pencil gradually replaced the school slates. In 1905, a three-dimensional viewing device called the Stereoscope was introduced. By 1925, filmstrip projectors, similar to the ones used in motion pictures, made their debut as a teaching and learning tool. Thomas Edison was so impressed he thought the filmstrip projectors had the potential to make textbooks obsolete. According to the Magazine, with the advent of radio, New York City, in 1925, was the first to broadcast educational programs to school students. In 1930, overhead projectors were introduced and schools followed the example of U.S. military and quickly adopted them as a teaching aid. The Magazine also reported that a host of other inventions, one after another, steadily made their way into the reserve of teaching and learning tools. Some of those included the Language-Lab Headset in 1950 for audio drills, the Reading Accelerator in 1957 to improve reading efficiency, the Skinner Teaching Machine in 1957 to allow students to proceed at their own pace, educational television in 1958, which had in excess of 50 educational programming channels throughout the country, photocopier in 1959, videocassette recorder in 1965, filmstrip viewer in 1965 that personalized benefits of filmstrip projector, the hand-held calculator in 1972, personal computers in late 1970s, student response systems (aka Clickers) in 1980s, Smart Board in 1991, World Wide Web in 1993, and iPads in 2010.

Over recent history, many different types of teaching and learning tools have evolved. However, the teaching methodologies and integration of technology-based teaching and learning tools in classroom instruction have not kept up with the rapid pace of technological evolution (Brewer, 2004). Brewer submitted that “the real power of technology to enhance student learning is underutilized” (p. 1034).

Factors Influencing Student Achievement

Merriam-Webster (2013) online dictionary defines achievement as “result gained by effort.” In the context of student achievement in the classroom, that definition would translate to “knowledge and/or skill a person has acquired, usually as a result of classroom instruction” (Hawaii DOE, 1999). Hawaii DOE described classroom instruction as pre-planned and largely structured to help students gain that desired result, and classroom achievement as a gain in knowledge and skills, which often are contrasted with a gain in aptitude or cognitive power.

Academic achievement for students can be influenced by a variety of individual factors or any combination of them. Brixey (2007) reported that school climate and culture can influence classroom achievement of a student. Brixley stated, “Leadership in an effective school begins with a highly competent principal who exhibits transformational, instructional, and managerial leadership skills” (p. 3). Brixley felt when school professionals did not have adequate training to carry out their responsibilities, organizational performance would undoubtedly suffer. He believed quality teaching was a precursor to effective learning and achievement. “In order to address student achievement, one must first address the assumptions one holds regarding the abilities of students who represent various diversities” (p. 3). Brixley concluded that leadership in an institution was one of the most important forces that help shape the culture and climate for instructional practices.

Fletcher (1994) reported that parental and peer behaviors can affect classroom achievement of a student, yet, the effect may be different for different group of students. Fletcher posits, specific aspects of student experiences in the family and peer group indicate that family organization, parental warmth, parental involvement in education-related practices and peer influence affect academic achievement. Fletcher noted that “influences on achievement may operate differently for adolescents from ethnic minority groups" (p. 1). For example, Dornbusch, Ritter and Steinberg (1991), Gottfredson (1981) and Mickelson (1990) suggested that although a combination of such variables like parental education, socioeconomic status, and family structure are a good predictor of academic achievement for students from mainstream populations, the same has not been an equally effective predictor for academic achievement of African American students (as cited in Gonzales, Cauce, Friedman, & Mason, 1996). Even with parallel demographic backgrounds, academic preparations, and enrollment characteristics, first-generation college students being exposed to same set of influences, compared to their counter-parts, are less likely to attain the same academic achievements (Cunningham, 2009). Interestingly, the same notion could hold true for instructors. After exposing classroom instructors to Classroom Organization and Management training to improve student success, the student achievement may be significant in some subject areas and not in others (Gulbrandson, 2008).

Students have different learning styles as they have diversities and personalities. Hoeffner (2010) reported that individual learning style information can be useful to a student in classroom achievement. In his study, Hoeffner revealed that one out of every two students found the learning styles information helpful and they used the information to change how they studied.

Vu (2009) stated that classroom characteristics and teacher-student relations may influence student achievement in classroom and the social environment maintained in a classroom helps to develop behavioral, social, and academic skills of school-aged children. "Classroom characteristics, such as class composition, student and teacher characteristics, student interactions with peers and teachers, classroom values, and classroom beliefs all influence student academic development" (p. 1). Vu suggested that positive teacher-student relations motivate teachers to go extra miles to help students and provide the best possible classroom environment to facilitate positive academic achievement.

Lowther, Ross, and Morrison (2003) conveyed that ease of access to resources, especially technology resources, may influence classroom achievement of a student. They believed when students have adequate access to resources, their learning behavior can change and so can the teaching strategies for classroom instructors. Consequently, computers can be a gateway to access a large amount of knowledge and provide a means to practice skills. Lowther, Ross, and Morrison suggested, in a class with each student having a laptop computer, as opposed to a class with only few computers for all students, the teaching strategy and methodology can be drastically different, and so can student achievements.

Web-based streaming applications may have strong potential to influence academic achievement (Reed, 2003; Sherry, Bilig, & Daniel, 2001). The Web-Based Education Commission, in their report submitted to the President and the Congress of the United States, suggested making "powerful new Internet resources, especially broadband access, widely and equitably available and affordable for all learners" (Kerrey & Isakson, 2000). Reed (2003) reported that use of standards-based video content, powered by web-based streaming applications, has a proven record of positively influencing student achievement. Internet-based lessons allow students to assume more control over the content making the learning process proactive. However, as promising as the streaming technology may be, Reed lists the following barriers for successful use of this teaching and learning tool:

1. Bandwidth: downloading video streamed clips may easily overload available bandwidth. Many schools may not have adequate available bandwidth to deliver dependable quality streaming simultaneously to a large number of students.
2. Content issues: the content must meet the highest standards of educational excellence. It must also be cleared for digital rights. The Web-Based Education Commission recommends continuing and expanding efforts to digitize a high quality educational material that is also compatible with copyright laws.
3. Teacher training: professional development for instructors and leaders in education is the necessary precondition for effective use of technology in classroom. Teachers has to be trained on how to incorporate streaming content in their lesson plans, the methodology involved, and the ways students can make the best use of them.
4. Security issues: As students become more savvy users, challenges to enforce security increases as well. Proper administrative tools can be integrated with video streaming strategy to assure blockage of inappropriate content.
5. Funding: All initiatives must face the inevitable issue of sustainable funding with focus on eliminating digital divide and provide equal opportunity to access and use technology for all.

The degree of active engagement of the learners in their own learning process may influence the level of learning achievement. Marti (2009) suggested that the more the students can be actively engaged in their own learning process, the better the chance of their success and achievement. Marti believed positive learning outcomes were directly associated with active participation and engagement. Be it the personality of the instructor, nature of the content being learned, the instructional technology in use, or instructional strategy in practice, the level of learning will be largely influenced by the degree of learner engagement in their own learning process. When the classroom is made more interesting, more interactive, and more engaging, the students achieve at a higher level (Shaffer & Collura, 2009). Student engagement is generally considered to be among the better predictors of learning (Carini, Kuh, & Klein, 2004).

Measurements of Student Achievement

Student achievement refers to a gain in knowledge and skills acquired by a student, usually as a result of classroom instruction (Hawaii DOE, 1999). Measuring student achievement throughout the course can be accomplished in many ways, depending on the nature of the content, as well as the objectives of the course (Blackboard, 2006). One of the most common tools used to measure student achievement is standardized tests. When the same test is administered in the same way to all students, in any testing situation, it is a standardized test. Standardized tests tend to measure learner performance against each other and a predetermined standard (Scholastic, 2013; wiseGEEK, 2013). Homework, class participation, and papers are also considered traditional methods for measuring student achievement. Portfolios, projects, presentations and skill demonstrations are alternative ways for students to prove their understanding and mastery of course materials (Blackboard, 2006).

While the use of standardized tests is common, a collaborative report of Scholastic and the Bill & Melinda Gates Foundation (Mayer & Phillips, 2010) revealed that only six percent of K-12 teachers think that state-required standardized tests are absolutely essential in measuring student academic achievement. They found that formative ongoing assessment during the course is what 54% of K-12 teachers think is the most important in measuring student academic achievement with class participation is the second most important (47%) in measuring student academic achievement.

Technology in the Classroom

Since the beginning, there has been a consistent effort to make the process of teaching and learning more effective for both the teacher and the learner, since it is the key to raising standards (Smith, 2007). From the text-printed wooden paddle of colonial era to current day iPads, learning machines have evolved significantly (*New York Times Magazine*, 2010). In the last three decades advances in computer technology have transformed how we learn, work, communicate, collaborate, and even entertain ourselves. Brewer (2004) reported that although integration of technology-based teaching and learning tools in classroom instruction had not kept up with the rapid advances of technology, still a variety of technology could be found in elementary, secondary and college classrooms across the globe.

Gray, Thomas, and Lewis (2010) at the National Center for Educational Statistics reported in Educational Technology in U.S. Public Schools: Fall 2008 that 100% of U.S. public schools have Internet access. At the time, of the entire public school student population, the student to computer ratio was roughly three to one. Of all computers in public schools, 91% were used for instructional purposes, with the rest being used for administrative and other areas. Of these instructional computers, 98% of them had Internet access, and 15% of them were less than one year old. This report suggested that an increasing number of schools have full-time technology specialists whose only responsibility is technology support and technology integration in classroom instruction. Ninety percent public schools reported that they had local expertise to restore network services in less than eight hours when school network went down; 22% reported the network restoration time to be less than one hour. Of all public schools, 97% had LCD or DLP overhead projectors, 73% had interactive white boards, and 93% had digital cameras for classroom use. However, the report revealed, percentage of teachers "sufficiently trained in technology usage" was 12% lower in schools with high poverty concentration compared to schools with low poverty concentration. The difference was 11% for teachers "sufficiently trained to integrate technology into classroom instruction" for those two groups.

As technology has advanced over the years as an instructional tool, it also has become a medium for education itself. Computer Projector and PowerPoint Presentation (Fedisson & Braidic, 2007), World Wide Web (Sherry, Bilig, & Daniel, 2001), Learning Management System (Powell, 2005), Interactive White Board (Paoletti, 2004), Streaming video (Reed, 2003), Wiki (Teng, 2012), Student Response System (Abdallah, 2008), Multimedia (Foti & Ring, 2008), or even Smartphones (Parnell & Bartlett, 2012) are routinely being used for teaching and learning purposes in all developed nations. The selection of the technology in the classroom, however, rests with school district or the classroom instructor depending on the suitability of the technology for the content and the availability of the technology at the institution (Kotrlik & Redmann, 2009).

Technology tools can aid both students and instructors in classroom instruction (Green, 2000). Green suggested that increased student achievement can only be insured through the use of high-leverage technological tools, and the teacher's increased ability to incorporate them in classroom instruction.

Student Engagement and Technology

The central idea of constructivist learning theory is that learners individually construct knowledge for themselves (Hein, 1991). In other words, learners construct meaning for themselves of what they learn. The level of learning achievement is largely determined by the degree of learner engagement in their own learning process (Marti, 2009). When the classroom is more interesting, interactive, and engaging, the students achieve at a higher level (Shaffer & Collura, 2009). Student engagement is generally considered to be among the better predictors of learning (Carini, Kuh, & Klein, 2004). Actively engaging students in their own learning process has been shown to be a critical component of successful achievement within a variety of disciplines (Beuckman, Rebello, & Zollman, 2007; Masikunis, Panayiotidis, & Burke, 2009; Revell & McCurry, 2010; Shaffer & Collura, 2009). Technology plays a critical role in engaging students in their learning process. Effectively tapping into the technologies that students are already immerged in has clear potential to enhance student success and achievement (Tapscott, 2008).

Inclusion of technology tools in classroom instruction can make a difference (Kulik & Kulik, 1991). Kulik and Kulik concluded from their meta-analysis of 254 controlled studies of students from K-12 through higher education that technology-aided instruction had a clear advantage to engage students in learning activities over traditional methods of classroom instruction.

The increasing diversities observed in classrooms necessitate a common medium that levels the ground for everyone equally and equitably. Mangold (2007) reported that this millennial generation of students grew up surrounded by digital media and technology plays a very large role in their everyday lives. Raines and Arnsparger (2010) pointed out that these students prefer to participate in active learning processes and their choice of medium to engage is technology.

Clicker Technology in Student Engagement and Achievement

Introduced in the 1960s, the clicker is a small hand-held transmitter that generally use radio frequency (in its current generation) to transmit wireless signals. This system was introduced in the television industry in the 1960s, in businesses in the 1970s, and finally in education in the 1980s (Beatty, 2004). Skiba (2006) described the clicker technology setting as a computer, equipped with required hardware and software, often connected to a projector, receive and record the signals from clicker-keypads and process them in real time. Skiba noted that the software also allow the option to store the collected data to perform a multitude of additional analysis and reporting at a later time. Clicker technology used in classroom teaching allows instructors to ask questions and collect and analyze answers that provide real-time feedback to create interactivity between a presenter and audience (Skiba, 2006). The question-answer method to promote learner engagement and critical thinking through discussion and reinforcement has been in practice as a teaching tool dating back to the time of Socrates over four hundred years BC (Bereiter & Scardamlia, 1992).

Active participation and engagement in the learning process enhance the acquisition of knowledge by assimilating new concepts into the existing knowledge body (Dangle & Guyton, 2003). Use of clickers engages students in individual and collective learning process, and promotes higher level of knowledge acquisition enhancing comprehension and knowledge retention for the learners (Guthrie & Carlin, 2004).

With the advent of explosive technological growth, a steady and consistent shift has been occurring in moving away from chalk-and-talk lecture approach to more technology-aided participatory approach of classroom instruction that promote student engagement (Lightner, Bober, & Willi, 2007). One of the technology tools, widely used in participatory approach throughout K-12 and higher education, is clickers. Clickers aid in student participation in improving conceptual understanding, and in immediate and accurate problem diagnosis resulting in correction of misconceptions (Cutts, Kennedy, Mitchell, & Draper, 2007).

Participatory practice in classroom instruction using clickers to engage students in their own learning process has been found to be a critical component of successful achievement in K-12 through college-level coursework within many disciplines. Brewer (2004) conducted a study on the effect of real-time assessment of student learning and understanding in her large enrollment introductory Biology class using clickers at University of Montana. Brewer developed a set of questions where students had to choose between correct answer and popular misconceptions. After one or two breakout sessions, more than 90% of students chose the correct answer with high confidence

Brewer found that with instant feedback, she was able to pace her instruction and make sure students grasped the correct interpretation before moving on to the next topic. Moreover, she claimed that the students' improved understanding of the current topic established a better foundation for the next learning experience.

Beuckman, Rebello and Zollman (2007) adopted clickers in their Physics classes with large enrollments at Kansas State University. They observed significant improvement in student engagement in class and better student achievement using clickers. To adopt clicker technology they redesigned the pedagogy for the course. They demonstrated that using clickers to engage students improved learning outcomes, and student grades.

Masikunis, Panayiotidis and Burke (2009) conducted a study using the clicker system in courses of their Business and Management program at Kingston University in the United Kingdom as a measure of innovative teaching in their very large classes that had as many as 500 students. They reported a substantial increase in the mean scores across the board for those classes.

Shaffer and Collura (2009) conducted a study using clickers in their Introductory Psychology course at Ohio State University. As a result, they discovered that students rated their lectures as more interactive, and more entertaining. Students in the class taught using clickers also performed significantly better on exam questions compared to another group of students who did not use the clickers.

Revell and McCurry (2010) conducted a study using clickers in two Nursing courses at University of Massachusetts. Clicker technology enabled them to bridge the distance between teachers and students through active engagement and collaborative learning in classroom. The researchers perceived clicker technology to be “effective in engaging students, fostering critical thinking, and improving learning outcomes in both the large and small classes” (p. 274).

Dunham (2011) conducted a study at Columbia County School System in Georgia on 7th grade Math students taught using clicker technology. Students were evaluated on teacher-made assessments, 4 units from the textbook, and the Math portion of the Georgia Criterion-Reference Competency Test (CRCT). She observed significant improvement in the performance of students from classes that were taught using clickers in pre- and post-unit test scores as well as the CRCT Math scores.

Skiba (2006) taught Nursing classes using clickers. She highlighted two instructional values in using clickers in classroom:

- Using clickers students are not fearful of providing incorrect answers. They are encouraged to think through the questions and submit their answers anonymously.
- It allows instructor to be able to ask students multi-answer questions efficiently which would not be feasible otherwise.

Skiba also lists some instructional best practices that can be made easy to practice through the use of clickers in classroom:

- Best-practice: Encourage active learning – through quizzing assigned reading, pre-testing class, reviewing for tests, etc.
- Best-practice: Encourage student-teacher contact – through forming learning community, increasing personal contacts, etc.

- Best-practice: Encourages cooperation – fostering a teaching technique called *Think, Pair, Share* through students interaction, collaboration, group activity, etc.
- Best-practice: Provides prompt feedback – provides frequent reading of student progress on course content as individual as well as a class allowing timely corrective measures when necessary.

Woelk (2008) presented a taxonomy of clicker use and accurately distinguished between two major categories for which clickers are generally used in classroom instruction.

1. *"I Am"* category – this category enables instructors to assess students for their current level of understanding of the content, or student disposition. This category relates to the following:
    - *I am here* – Taking and honoring attendance
    - *I am prepared* – Quizzing students on assigned reading
    - *I am interested* – Polling common knowledge to create initial interest among students
2. *"I Do"* category – this category enables instructors to probe learning progress of students. Students to answer questions correctly in this category require active engagement in the subject matter which translates to progress in learning. This category relates to the following:
    - *I learn* – Conducting on-the-spot assessments that provide immediate feedback to students and instructors
    - *I understand* – Promoting critical thinking and active learning

- *I apply* – Incorporating problem-based learning (Woelk, 2008)

Instructors who use clickers in classroom instruction observe different levels of benefits and achievements ranging from "simple attendance check to promoting critical thinking and in-depth learning" (Woelk, 2008, p. 1400). There are issues that transcend through clicker use in variety of subjects and settings such as Psychology vs. Biology, lecture vs. lab, undergraduate vs. graduate, and small class size vs. large class size. Sevian & Robinson (2011) suggested that regardless of the circumstance, "clickers are most effective when their use is transparently integrated with the content. In other words, clicker use should not disrupt the lesson, but rather should sustain the flow of the class" (p. 15). The best way to achieve this goal is to use clickers throughout the class period by leading "into and out of clicker questions fluidly" (Sevian & Robinson, 2011, p. 16).

While there is research showing strong evidence of improvements in student learning and achievements through the use of clicker technology in classroom instruction (Beuckman, Rebello & Zollman, 2007; Brewer, 2004; Dunham, 2011; Shaffer & Collura, 2009), there are some studies that point to no statistically significant improvements in student success (Acree, 2010; Crossgrove & Curran, 2008; Strasser, 2010). Yet, other studies report rather interesting outcome as in case of Watkins and Sabella (2008). Watkins and Sabella conducted a study in introductory Physics class at Chicago State University examining the effectiveness of clickers in promoting learning. For the study, funded by National Science Foundation, they created a bank of Clicker Question Sequences. They found that the use of clickers made the class more dynamic as learning environment, and they observed a significant improvement in student engagement and student performance during class Question and Answer (Q&A) sessions. Interestingly, when asked the same or similar questions in a test, they found that the students did not perform significantly better anymore. Watkins and Sabella attributed the outcome as that of a knowledge retention issue. They claimed that the students did learn at an enhanced level because of their active engagement through the use of clickers as demonstrated during the class Q&A sessions, but how they could hold on to that knowledge (a knowledge retention issue) is a separate research topic.

There are several possible reasons why use of clicker technology may not produce significantly improved student success. Judson and Sawada (2002) conducted a meta-study of the classroom use of clickers in science classes. They reviewed literature from the past thirty three years. They found that the clickers alone may make the classroom interactive, but it is the pedagogical approach adopted by the classroom instructors that made the difference. Judson and Sawada suggested that instructors must change their role in classroom and redesign the course content to include the use of clickers as teaching tool to achieve significant improvement in student learning.

A study conducted by Acree (2010) did not include a modified pedagogical approach and did not observe statistically significant difference in student achievements. In Acree's study, students in treatment group answered questions using clickers whereas students in control group answered the same questions by raising hands. As Judson and Sawada (2002) suggested, instructor role and pedagogical approach have to be modified to go with the adoption of clicker technology. That may explain why studies like Acree (2010) does not achieve significantly positive outcome.

"The biggest challenge with clickers or personal response devices is figuring out how to integrate them into the heart of the lesson rather than tagging them on at the end"

(Derringer, 2011). Sevian and Robinson (2011) stressed that to make adoption of clicker technology work successfully, it takes commitment of time and effort. Sevian and Robinson (2011) pointed out that aspect to be the critical reason why more classroom instructors do not adopt clickers and courses poorly and inadequately developed do not produce desired results. There is only so much time in a work day, and there are always something else waiting to get attention. Sevian and Robinson continued stating that learning a new technology and at the same time revising the teaching approach to incorporate it requires a significant time commitment. The most important factor in successful use of clickers to promote student learning and consume the largest amount of time, is designing good questions. "Good questions must be well thought out and specifically address a pedagogical objective of the course (Beatty et al. 2006; Skinner, 2009)" (p. 17). Furthermore, the use of these questions should be "transparently integrated with the content" (Sevian & Robinson, 2011, p. 15).

"Learning by Playing" is a generally accepted concept in this day and age (Gray, 2013). Gray pointed out that the idea was based on the fact that active engagement was vital precondition for active learning. Gray, a research psychologist, suggested that people learn best when they are playing, not working. Learning achievement is the ultimate goal for students in a classroom. But the learning achievement must be experienced as an intrinsic part of student engagement. When student engagement is fostered, learning will naturally take place. Therefore, the adopted pedagogical approach is a critical determinant of the success of adopted clicker technology (Gray, 2013).

Siddharth (2009) reported that clicker studies that report no statistically significant improvements may have been carried out in where small sample sizes were the norm. Study results may become statistically insignificant solely for inadequate sample size even if there were observed improvements. Siddharth noted that the sample size depends on the confidence interval and confidence level. The lower the confidence interval required, the higher is the sample size needed. At least 95% confidence level is expected to claim the outcome statistically significant. Of course 99% confidence level would require an even larger size sample. Fortunately, minimum sample size can be calculated ahead of time. “If you want to generalize the findings of your research on a small sample to a whole population, your sample size should at least be of a size that could meet the significance level, given the expected effects” (Siddharth, 2009, para. 3).

Clicker Technology and Attitude

Elliott-Yeary (2012) submitted that to this millennial generation of students, use of technology comes “as natural as breathing.” They use technological gadgets in everyday lives as they are consistently surrounded by them. Their digital environment has shaped their attitude to be readily accepting when it comes to the use of technology (Raines & Arnsparger, 2010). They report that students feel comfortable with, and welcome the use of technology.

In general, research studies reveal that students have positive attitude about clicker use during instruction since it makes the class more interesting, engaging, and entertaining (Duncan, 2006; Shaffer & Collura, 2009). On the other hand, students tend to have unfavorable feeling when they have to pay extra for clickers on the top of primary textbooks (Zhu, 2007). Zhu pointed out that students had unfavorable feeling when technical glitches occurred too frequently while using them. Furthermore, Zhu noted that students had unfavorable feeling when clickers were used solely for taking attendance, or when clickers were used to collect answers to questions but students were not awarded any corresponding point reward for them.

Chapter III

RESEARCH DESIGN AND METHODOLOGY

In this chapter, an overview of the problem and purpose of this research study is presented. The chapter also presents the research questions that this study attempted to answer. In addition, the chapter describes the general population of the study and selection of sample, as well as data collection methods and instruments used. Finally, the chapter maps out how the collected data were analyzed and what type of statistical methods were employed to draw inferences.

Problem and Purposes Overview

Ensuring the best learning experience for all students in an open-access institution in the rural South has always been a challenge. These colleges have very limited screening processes for admissions. Students come with diverse social, economic, ethnic, and secondary school backgrounds. Best practices borrowed from one institution with its own unique design and culture does not bring about the same results in another institution with its own inherent design and its own unique culture (Green, 2000). Both instructors and administrators can immensely benefit from having access to the *local* best practices in terms of knowledge and tools in order to forge the most appropriate tried and tested pedagogical approach to maximize instructional effectiveness in terms of student satisfaction and learning achievement (Parker, 2006). Regardless of how diverse the student backgrounds are, however, there is one thing that tends to level the field: the use of technology (Lowther, Ross, & Morrison, 2003). This generation of students is consistently surrounded by digital media. Their tech-laden everyday life has shaped their attitude to enthusiastically be open to further use of technology. Consequently, this study is an attempt to explore whether the improved effectiveness of technology-aided classroom instruction in student achievement, in a face-to-face classroom setting, is significant, compared to traditional instruction. This study is also an attempt to explore students' learning experiences and attitudes toward instruction utilizing technology-based strategies.

Research Questions

Three research questions were investigated in this study, using the data collected over a one-semester period through the use of multiple instruments (assessment, survey, observation log, and interview):

1. How does student achievement differ between a group of students who were taught a college-level digital literacy course with extensive use of clicker technology and a group of students who were taught using traditional methods?
2. What are the learning experiences of students who were taught a college-level digital literacy course with extensive use of clicker technology?
3. How do instructional strategies focused on extensive use of clicker technology influence students' attitudes about learning?

Research Methods and Procedures

The central purpose of the study was to examine the impact of clicker-technology-aided classroom instruction on student achievement in a college-level digital literacy course by comparing a group that used traditional instructional strategies with one that used clicker-technology-aided instructional strategies. Thus, student achievement was the dependent variable, and the use of clicker-technology-aided instructional strategies was the independent variable, or the treatment. Quasi-experimental control group time series research design was used in this study.

Quasi-experimental control group time series research design "involves repeated measurements or observations over a period of time both before and after treatment" (Fraenkel & Wallen, 2009, p. 272). In other words, the dependent variable is interrupted (usually near the middle) by introducing the independent variable (Leedy & Ormrod, 2009). In Figure 1, O_i represents the series of observations or measurements applied to both control and treatment groups, and X represents the treatment applied only to the treatment group.

Figure 1

A Basic Control Group Time-Series Design

O_1	O_2	O_3	X	O_4	O_5	O_6
O_1	O_2	O_3		O_4	O_5	O_6

This study design informs of the causal effects of the treatment not only between before and after the treatment was applied but also provides insights on the progression of the effects of treatment throughout its duration (Gottman, McFall, & Barnett, 1969). Trochim (2006) suggested that showing "if treatment is applied, there is an effect" is not enough since there could be other factors beside the treatment that may cause the effect. Therefore, it is necessary to show that "if treatment is applied, there is an effect, and if treatment is not applied, there is no effect." To demonstrate that proposition, one of the two groups received the treatment (treatment group), and the other group did not (control group). Figure 1 shows the study design reflecting that proposition. Wagner, Soumerai, Zhang, and Ross-Degnan (2002) described control group time series design as one of the strongest approaches in quasi-experimental research design.

Participants

The study sample was selected from the general student population of a college in the rural South. The college enrollment in the semester when the study was conducted was 3,226 students – 2,190 of them were full-time and 1,036 of them were part-time. Of all enrolled students, there were 2,566 (79.5%) White, 424 (13.1%) Black, 145 (4.5%) Hispanic, 29 (0.9%) Asian, and 16 (0.5%) American Indian or Alaskan Natives. There were 1,753(54.3%) male and 1,473 (45.7%) female students. All students in the study sample, except one, were enrolled full-time, carrying an average of 13.8 credit hours. Table 1 shows how the study sample compares to the general student population in terms of ethnicity and gender.

Table 1

Demographics of Population and Study Sample Compared

	All Students	Study Sample
Total count	3,226	153
Ethnicity		
White	2,566 (79.5%)	127 (83.0%)
Asian	29 (0.9%)	1 (0.7%)
Black	424 (13.1%)	11 (7.2%)
Hispanic	145 (4.5%)	8 (5.2%)
American Indian or Alaskan Native	16 (0.5%)	4 (2.6%)
Gender		
Male	1,753(54.3%)	80 (52.3%)
Female	1,473 (45.7%)	73 (47.7%)

The average age of all students was 20.3 years compared to the average age of 18.7 years for the students in the study sample. Similarly, the average high school graduation Grade Point Average (GPA) of all students was 2.7 compared to the average high school graduation GPA of students in the study sample of 3.0. The average of current semester load for all students was 11.6 credit hours compared to the average of current semester load for the students in the study sample of 13.8. There were 913 students who were required to take at least one learning support course in the given semester, representing 28.3% of the total number of enrolled students. There were 60 students in the study sample who were required to take at least one learning support course in the same semester, representing 39.2% of students in the study sample. Table 2 shows how the student population compares with the study sample.

Table 2

Ethnicity and Gender of All Enrolled Students

	All Students	Study Sample
Total count	3,226	153
Average age	20.3	18.7
HS GPA	2.7	3.0
Current semester load	11.6	13.8
Number of LS students	913 (28.3%)	60 (39.2%)

The digital literacy course, the focus of this study, is part of the general education core curriculum and appears on the list of required or optional courses for almost all majors offered by the college. This course does not have any prerequisite, and thus almost all students registered in this course are freshmen. Learning support students are also allowed in this course. The college offers 25 to 30 different sections of this course every semester. This is the largest-enrollment class for the college. Students who want to sign up for this course have equal opportunities to self-select any particular section they choose, as long as the section is not already closed at its maximum size limit.

In an educational institution setting, it is practically impossible to select a true random sample for a study such as this one. Therefore, this study used convenience sampling – groups of students conveniently available for the study in different sections of the class (Fraenkel & Wallen, 2009). There were two instructors teaching eight sections of this class under the study. Each section had approximately 20 students. The total sample was 153 students, with 79 students in the control group and another 74 students in the treatment group.

Procedures

The study of the clicker technology used in the digital literacy course was carried throughout the length of a semester. The course covers essentials of computer concepts and fundamentals of major computer applications. The sections of the course selected for the study were taught in face-to-face classroom settings. The digital literacy course, itself being a technology-related course, did make use of some technology tools for teaching and learning purposes. Therefore, even the traditional method of instruction for this course in this study used lectures with a projector, hands-on exercises on computers, and a training and testing software application, Skill Assessment Manager (SAM). All assessments were administered using SAM and had two components: objective questions to test understanding of concepts and hands-on task-related questions to test mastery of skills. Each assessment had at least 50 test items or questions. Wollack, Cohen, and Wells (2003) suggested that the length of an assessment affects its reliability to produce accurate reflection of learner skills and abilities. Moderately long assessments tend to be more reliable than shorter assessments. Similarly, moderately difficult assessments tend to be more reliable than very easy or very difficult assessments. A sample assessment is found in Appendix A.

The instructional strategies were the same for both the control and treatment groups at the beginning of the semester. There were five assessments during the duration of the course in the form of unit tests. Both instructors participating in the study contributed to the development of the assessments. Of the five assessments, three were administered before clicker-technology-aided instructional strategies are introduced to the treatment group towards the middle part of the semester. Once the clicker-technology-aided instructional strategies were implemented with the treatment group, they continued through the remainder of the course. After the treatment was introduced, two more assessments were administered.

Clicker-technology-aided instructional strategies made use of clicker-questions integrated seamlessly with pedagogical objectives to enhance student engagement and learning. Once the treatment was initiated, all major content topic discussions in the treatment-group sessions were followed by clicker questions embedded in a PowerPoint presentation used to manage and sequence the topics of discussion. The questions addressed understanding of the topic as well as the common misconceptions. Students submitted their answers to the projector-displayed question using their clicker-keypads. Students were allowed time to think through the question before they submitted their answers. The anonymous process of answering questions was expected to relieve students from the fear of embarrassment, thus enhancing participation (Cunningham, 2009). The clicker-software instantly generated a bar chart using student response data. The green colored bar informed students of the correct answer to the question. The instant feedback was used to pace the instructor's presentation and assure students grasped the correct interpretation of the current topic before moving on to the next. In the event that student responses indicated, through the bar chart, that the current topic needed further discussion, the instructor did so by using a different example or using a different approach. Both instructors participating in the study agreed to use 70% correct student responses as the cut off level to move forward to the next learning topic. That means that if less than 70% of the students answered the projector-displayed question correctly, the topic of discussion would be revisited. All such protocols were discussed between the participating instructors and agreed upon before the course started. For all critical topics, there was a backup clicker-question to ask the students once the repeat-explanation of the topic was concluded. For example, the instructor just finished explaining how cell addresses used in a spreadsheet formula change when copied from one location to another depending on the relative or absolute reference to the cell. At this point, the instructor displayed a question on the projector screen that focused on the understanding of cell addressing in spreadsheet application. Student responses collected through clickers and bar charts showed the levels of student understanding of the concept. Since clicker-technology enabled the instructor to assure 100% student participation, the chart provided invaluable information for the instructor to decide on the course of action in real time. In the event that clicker responses demonstrated that a large number of students did not quite grasp the concept of cell addressing yet, the instructor explained again the use of various types of cell addressing, presumably using a different scenario with a different formula. At this point, the instructor had the option to use the backup question to poll the class again. The repeat-explanation reinforced by the backup clicker-question improved students' understanding of the current topic and established a better foundation for the next learning experience as a result (Brewer, 2004).

Once the treatment was introduced, class attendance for all students in the treatment group was not taken by calling student names. Instead, at the beginning of every class meeting a small quiz of five to seven questions were administered to record student performance as well as attendance. These quiz-questions provided a general review for critical topics covered in the previous class meeting.

All of the clicker-questions used in the treatment group were also used for class discussions and test reviews as well as made available online to students in the control group to make sure that students from both groups had exposure to the same course content.

Skill Assessment Manager (SAM)

SAM is one of the leading training and assessment instruments in the nation for digital literacy and microcomputer applications, published and marketed by Course Technology publishing company, a subsidiary of Cengage. The reliability of SAM as an instrument have been thoroughly investigated by the development team and insured by Course Technology. SAM has been in use since 1997. Over a thousand secondary and post-secondary institutions in the United States use SAM and over 75,000 students access SAM on a daily basis (Cerys, 2011). SAM provides a variety of student assessment options including objective questions to measure understanding of concepts, hands-on questions to measure proficiency of individual skills, and project-based questions to measure ability to put together a solution using a set of individual skills. SAM also works very well as a training and practice tool (Cerys, 2011). Both of the instructors participating in this study have been trained on SAM by a professional trainer from Course Technology Company, and each has many years of working experience with SAM. Students from both the control and treatment groups were trained to use training and testing features of SAM by their respective instructors.

Data Collection and Instrumentation

Data were collected throughout the fall 2012 semester. For Research Question 1, only quantitative data were collected through a series of assessments using SAM. For

Research Questions 2 and 3, both quantitative and qualitative data were collected. Quantitative data were collected through survey instruments using Likert-scale items. Qualitative data were collected through survey instruments using open-ended questions, interviews, and the Instructor's Log (Appendix E). The Student Learning Experience survey (Appendix B) and the Student Attitude Toward Learning survey (Appendix C and D) were conducted toward the very end of the semester when students in the treatment group had experienced the maximum exposure to the treatment.

There were five practice tests in SAM that students were required to complete outside the class within the given deadlines – multiple attempts were allowed in these practice tests until students attained a predetermined level of achievement. There were at least five proctored in-class timed tests (assessments) in SAM, including objective questions to measure understanding of concepts and hands-on questions to measure mastery of acquired skills. There were four project-based homework assignments in SAM for students to complete individually. SAM project-based assessments have a built-in plagiarism detection feature that informs instructors if one student submits another student's work. The two instructors participating in the study were in agreement on the content of the assessments in SAM.

The entire course was broken into five units; each of them about three weeks in duration. At the end of each unit, there was an assessment using SAM for that unit. The control and treatment groups used the same assessments in SAM. There were three assessments administered before treatment was introduced. The treatment was introduced near the middle of the semester. The data collected from these three before-treatment assessments helped determine how closely statistically equivalent the control and the treatment groups were. Once the treatment was applied, two more assessments were administered.

Background data were collected from the college enrollment database on race, gender, age, high school GPA, number of learning support course(s), current semester enrollment load, placement test scores, and standardized scores (SAT/ACT) to study the demographics of the student population and the participating sample. Personnel in Enrollment Services stripped all identifying information from all of these student records before handing them over to be used in the study.

Student Experience and Attitude Surveys

The Student Learning Experience survey and Student Attitude Toward Learning survey were developed by the instructor to collect both quantitative and qualitative data for Research Questions 2 and 3. The instruments were used in a pilot action research study during spring 2011 semester. The pilot study was conducted as a class project with15 students in the control group and 15 students in the treatment group. Based on the results, experience, and student feedback obtained from the pilot study, some adjustments were made to the instruments for data collection in this study. Furthermore, the internal reliability of the instruments was determined by calculating the Cronbach’s alpha values. Any Cronbach’s alpha value of .7 or larger is acceptable. As the value increases from .7, the indication of internal consistency gets stronger (Fraenkel & Wallen, 2009). To assess the degree of internal consistency among the survey items, Cronbach's alpha (a measure of internal consistency) was calculated. The calculated value for the Learning Experience survey items was .99, and the calculated value for the Attitude Toward Learning survey items was .98.

The survey instruments contain Likert-scale items to collect quantitative data and open-ended questions to collect qualitative data. The Student Learning Experience survey was used to collect data from the students in the treatment group only. However, there were two separate survey instruments to collect data on student attitude toward learning: one administered to the students in the control group and one administered to the students in the treatment group. All three of these surveys were conducted toward the end of the semester. The full text of the Student Learning Experience survey instrument is found in Appendix B, and the full text of the Student Attitude Toward Learning survey instruments for control and treatment groups are found in Appendix C and Appendix D respectively.

Interviews

Seidman (2006) described interviewing as the process of collecting people's stories of experience and insights. Seidman stated that "stories are a way of knowing" (p. 7). To conduct individual interviews of selected students, a purposive sampling was used. This sample represented the identified low, mid, and high achievers in each of the class sections under study. In purposive sampling researchers use their personal judgment to select the sample that they believe, based on available information, will provide the data they seek (Fraenkel & Wallen, 2009). Instructor observation, classroom participation, and assessment results were used as part of the selection criteria. To achieve the greatest possible benefit, the student interviews were conducted after the experience and attitude surveys were completed and partially analyzed, so that more in-depth information could be gained using more appropriate questions than would have been possible if the questions were designed beforehand. Participants were told that no identifying information would be recorded, the interview would only be used to collect relevant data, and all records would be destroyed subsequently.

Instructor's Log

The Instructor's Log served as a qualitative instrument to collect thoughts and observations throughout the semester while interacting with students in the classroom. The Instructor's Log was used for qualitative data for Research Question 2. Just as the Student Experience and Attitude Survey instruments were used in the pilot study, the Instructor's Log was used in the same pilot study during the spring 2011 semester to test the usability aspects of the instrument.

Instructors recorded information about student behavior in the classroom, such as listening to the instructor, following directions, responding to questions, and overall body language. If there was any observed difference from what was typical or expected in the classroom, the nature of the source, the topic of discussion, and the associated teaching strategies were noted.

Data Analysis

For this study descriptive statistics were used to describe the basic features of the data and to form the basis of the analysis. The t test of independent samples was used to determine whether the means of the control group and the treatment group were statistically different from each other (Trochim, 2006). A t test is appropriate when the independent variable is defined as having two categories and the dependent variable is quantitative (Mertler & Vannatta, 2005). The independent means t test is used when comparing the means of two different or independent groups (Fraenkel & Wallen, 2009). This test determined whether students in the treatment group performed better academically than those in the control group. Multivariate Analysis of Variance (MANOVA) was used to determine any differences between the groups on the attitude survey. MANOVA incorporates two or more dependent variables in the same analysis, thus permitting a more powerful test of differences among means (Fraenkel & Wallen, 2009). A statistical significance level, alpha level or the *p*-value, of .05 will be used for this study ($p < .05$), which is generally accepted for moderate statistical significance (Hinkle, Wiersma, & Jurs, 2003).

For Research Question 1, descriptive statistics and independent-means *t* tests were used. For Research Question 2, only descriptive statistics was used to address all Likert-scale survey items. For Research Question 3, descriptive statistics and MANOVA were used to address all Likert-scale survey items on both survey instruments. SPSS software was used to analyze all quantitative data. Qualitative data collected through open-ended survey questions for Research Questions 2 and 3, interviews, and the Instructor's Logs were analyzed for trends and themes using content analysis techniques.

Permission to conduct the research was secured from Valdosta State University Institutional Review Board. Since this research was going to be conducted in an established or commonly accepted educational setting, involving normal educational practices such as comparing instructional strategies, the Institutional Review Board granted an exemption from oversight (see Appendix E).

Chapter IV

ANALYSIS OF DATA

Introduction

The purpose of this study was to investigate the effect of clicker-technology-aided classroom instruction and associated pedagogical strategies in terms of 1) student achievement, 2) student learning experience, and 3) student attitude toward learning. A high-enrollment college-level digital literacy course was used to form a control group of students that used traditional instructional strategies and a treatment group that used clicker-technology-aided instruction and associated pedagogical strategies. The purpose of this chapter is to present the analysis of the data related to each of those three study objectives (research questions).

To measure student achievement, data were collected using a quasi-experimental control group time series research design. A series of five assessments were used in the form of data collection instruments – three of them administered before the introduction of treatment and the other two administered after the introduction of treatment. These assessments were developed to measure students' conceptual understanding and skill mastery. The assessments before the introduction of treatment helped establish the statistical equivalence between the control and the treatment groups before the treatment was applied. The assessments after the introduction of treatment helped determine any difference in student achievement between control and treatment groups. To measure student learning experience, data were collected using a survey instrument (Appendix B). Similarly, to measure student attitude toward learning, data were collected using two survey instruments – one for the control group (Appendix C), and one for the treatment group (Appendix D). Included in the latter two surveys were a set of attitude measuring items that were common for both control and treatment groups. Except for one open-ended item in each survey instrument, all other survey items used the same five-point Likert scale options for user input. All surveys were conducted towards the very end of the semester, coinciding with the end of the application of treatment.

Data Analysis Methods

To analyze all quantitative data collected, descriptive statistics, comparison of means for independent samples (*t* test), and multivariate analysis of variance (MANOVA) were used. To analyze all qualitative data collected through open-ended questions embedded in survey instruments, interviews, and the Instructor's Log, trends and themes were studied using content analysis techniques. Analyzing qualitative data essentially involves analyzing and synthesizing information acquired from various sources into coherent description of what the researcher has perceived or exposed (Creswell, 2009).

Participant Demographics

Excluding the students who withdrew from the class formally, the control group had 79 students in total while the treatment group had 74 students. The average age of students in the control group was 18.9 years and the average age of students in the treatment group was 18.4 years. The average course load of students in the control group was 13.7 credit hours and the average course load of students in the treatment group was

13.9 credit hours, while the average course load for all full-time students in the college for the same semester was 13.6 credit hours. The high school graduation GPA for students in both groups was exactly the same at 3.0. In the control group, 37% of the students had at least one learning support course to take, while 42% of the students in the treatment group had at least one learning support course to take. The majority of the students were White – 86% in the control group and 80% in the treatment group. Black, Hispanic, Asian, and American Indian or Alaskan Native made up the rest of the participants, each representing a small percentage. Table 3 shows the characteristic that differed the most between the treatment and control groups was the ratio of male and female students.

Table 3

Characteristics of Student Groups Compared

	Control Group	Treatment Group
Total count	79	74
Average age	18.9	18.4
Current semester load	13.7	13.9
HS GPA	3.0	3.0
Learning Support students	29 (37%)	31 (42%)
Ethnicity		
White	68 (86%)	59 (80%)
Asian	0 (0%)	1 (1%)
Black	5 (6%)	6 (8%)
Hispanic	5 (6%)	3 (4%)
American Indian or Alaskan Native	1 (1%)	3 (4%)
Gender		
Male	36 (46%)	44 (59%)
Female	43 (54%)	30 (41%)

Pre-Analysis Data Screening

To ensure quality of the study outcomes, the data were prescreened before conducting the actual analysis. Missing data, outliers, and normality distribution issues were addressed. There were five assessments in total – three of them before the introduction of treatment and two of them after the introduction of treatment. Students who missed more than one assessment before the introduction of treatment were dropped from the data analysis. Similarly, students who missed any assessment after the introduction of treatment were dropped from the data analysis as well. There were eight students in total who had essentially abandoned the course at various points in the semester for unknown reasons. They remained on the official course rosters, but were excluded from the study. One student was dropped from the study for missing more than one assessment before the introduction of treatment. An additional 10 students were dropped from the study for missing at least one assessment after introduction of the treatment. In total, 19 students were dropped from the study during pre-analysis data screening. As a result, the total number of students in the study sample came down from 153 students to 134 students – 74 students in the control group and 59 students in the treatment group.

The descriptive statistics for each assessment are shown in Table 4. None of the test scores appeared to be particularly out of range. As such, there was no student dropped from the study because of an outlier score. To determine normality of score distribution for each of the assessments, Skewness and Kurtosis coefficients were used. The most desired value for Skewness and Kurtosis is zero (Field, 2009). However, the Skewness and Kurtosis values in the range of ±1 are accepted as normal (Cunningham, 2009). Out of 20 different Skewness and Kurtosis coefficients obtained, only one (Kurtosis value of Control group in Assessment 1), was slightly out of normal range. Since the variation was very small, the distribution of all assessment scores for both control and treatment groups were considered normal in terms of symmetry and peakedness.

For the qualitative data, irrelevant responses were discarded. Examples would be "You Rock" and "I am glad the semester is over." A very limited number of students (N = 14) actually responded to the open-ended questions embedded in the survey instruments.

Table 4

Descriptive Statistics for Assessment Scores

Groups	*n*	*M*	*SD*	Skewness	Kurtosis
Assessment 1					
Control	74	76.51	10.96	.03	-1.05
Experimental	58	75.48	10.87	.27	-.68
Assessment 2					
Control	73	85.03	9.52	-.90	.77
Experimental	58	86.62	7.27	-.55	-.44
Assessment 3					
Control	74	89.58	7.83	-.81	.57
Experimental	58	87.40	8.41	-.50	-.22
Assessment 4					
Control	74	72.64	10.47	.10	-.51
Experimental	59	79.49	12.14	-.53	-.43
Assessment 5					
Control	74	77.16	9.88	-.35	.84
Experimental	59	79.14	10.54	-.52	.54

Research Question 1 Results

The first research question of the study addressed the effects of the use of clicker technology and associated pedagogical strategies in classroom instruction measured in terms of student achievement. Measuring the effectiveness of the use of clicker technology and associated pedagogical strategies was the central objective of this study.

Research Question 1 – How does student achievement differ between a group of students who were taught a college-level digital literacy course with extensive use of clicker technology and a group of students who were taught using traditional methods?

After prescreening of data, 74 student records out of 79 in the control group and 59 student records out of 74 in the treatment group were included in the analysis. In absence of a true random sampling, to increase the validity and integrity of the study, it was vitally important to establish the statistical equivalence of the control and treatment groups. To that effect, in the first half of the semester, the same three assessments were administered to all students in both the control and the treatment groups. With that, enough data were accumulated to establish a point of reference for comparing student achievements in the following assessments after the treatment was introduced.

Pre-Treatment Comparisons. A *t* test for independent samples was conducted for each of the three pre-treatment assessments. Table 5 shows the descriptive statistics for those tests.

Table 5

Descriptive Statistics for Assessments 1, 2, and 3

	Groups	*n*	*M*	*SD*
Assessment 1	Control	74	76.51	10.96
	Treatment	58	75.48	10.87
Assessment 2	Control	73	85.03	9.52
	Treatment	58	86.62	7.27
Assessment 3	Control	74	89.58	7.83
	Treatment	58	87.40	8.41

Since a *t* test assumes equality of variances in the population samples, Levene's test was used to assess the homogeneity of variances (homoscedasticity). Table 6 shows the results of the tests in terms of *F* statistic and corresponding significance (*p* value). None of those *p* values (.82, .15, and .52) are less than the established alpha level ($\alpha = .05$). Thus, the null hypothesis of "population sample variances are equal" cannot be rejected. Therefore, groups for each *t* test met the assumption of equal variances.

Table 6

Levene's Test Results for Assessments 1, 2, and 3

	Levene's Test for Equality of Variances	
	F	*p*
Assessment 1	.05	.82
Assessment 2	2.13	.15
Assessment 3	.41	.52

Table 7 shows the results of a *t* test for independent samples for all three pre-treatment assessments. On Assessment 1, the *t* test revealed no statistically significant difference between the mean score of students in the control group (*M* = 76.51, *SD* = 10.96) and the mean score of students in the treatment group (*M* = 75.48, *SD* = 10.87), $t(130) = 0.54$, $p = .59$, $\alpha = .05$. Cohen's effect size ($d = 0.09$) suggested very little practical significance. Similarly, on Assessment 2, the *t* test revealed no statistically significant difference between the mean score of students in the control group (*M* = 85.03, *SD* = 9.52) and the mean score of students in the treatment group (*M* = 86.62, *SD* = 7.27), $t(129) = -1.05$, $p = .29$, $\alpha = .05$. Cohen's effect size ($d = 0.19$) suggested little practical significance. Finally, on Assessment 3, the *t* test again revealed no statistically significant difference between the mean score of students in the control group (*M* = 89.58, *SD* = 7.83) and the mean score of students in the treatment group (*M* = 87.40, *SD* = 8.41), $t(130) = 1.54$, $p = .13$, $\alpha = .05$. Cohen's effect size ($d = 0.27$) suggested small-size practical significance. Thus, the analysis of these assessments established the statistical equivalence of the two groups under observation.

Table 7

Independent Samples Test for Assessments 1, 2, and 3

	t test for Equality of Means		
	t	*df*	*p* (2-tailed)
Assessment 1	.54	130	.59
Assessment 2	-1.05	129	.29
Assessment 3	1.54	130	.13

Post-Treatment Comparisons. After introduction of the treatment, in the form of using clicker technology and associated pedagogical strategies in classroom instruction, two more assessments were conducted. Although the students in the control group did not receive the treatment, they received the same assessments as their peers in the treatment group. Table 8 shows the descriptive statistics for those two assessments.

Table 8

Descriptive Statistics for Assessments 4 and 5

	Group	*n*	*M*	*SD*
Assessment 4	Control	74	72.64	10.47
	Treatment	59	79.49	12.14
Assessment 5	Control	73	77.16	9.88
	Treatment	59	79.14	10.54

Since a *t* test assumes equality of variances in the population samples, again, Levene's test was used to assess the homogeneity of variances (homoscedasticity). Table 9 shows the results of the tests in terms of *F* statistic and corresponding significance (p value). Neither of those p values (.24 and .62) are less than the established alpha level ($\alpha = .05$). Thus, the null hypothesis of "population sample variances are equal" cannot be rejected. Therefore, groups for each *t* test met the assumption of equal variances.

Table 9

Levene's Test Results for Assessments 4 and 5

	Levene's Test for Equality of Variances	
	F	*p*
Assessment 4	1.39	.24
Assessment 5	.24	.62

Table 10 shows the results of a *t* test for independent samples for both post-treatment assessments. On Assessment 4, the *t* test revealed a statistically significant difference between the mean score of students in the control group (M = 72.64, SD = 10.47) and the mean score of students in the treatment group (M = 79.49, SD = 12.14), $t(131) = -3.50$, $p = .001$, $\alpha = .05$. Cohen's effect size (d = 0.60) suggested moderate to high practical significance.

Table 10

Independent Samples Test for Assessment 4 and 5

	t test for Equality of Means		
	t	*df*	*p* (2-tailed)
Assessment 4	-3.50	131	.001
Assessment 5	-1.11	131	.269

However, on Assessment 5, the *t* test revealed no statistically significant difference between the mean score of students in the control group (M = 77.16, SD = 9.88) and the mean score of students in the treatment group (M = 79.14, SD = 10.54), $t(131) = -1.11$, $p = .27$, $\alpha = .05$. Cohen's effect size (d = 0.19) suggested very small practical significance. Even though the mean score was about two points higher in the treatment group than the control group, the difference was not statistically significant. Possible explanations are discussed in Chapter 5.

Research Question 2 Results

The second research question of the study addressed the learning experiences of students in the treatment group using clicker-technology and associated pedagogical strategies in classroom instruction.

Research Question 2 – What are the learning experiences of students who were taught a college-level digital literacy course with extensive use of clicker technology?

Student Learning Experience Survey. The survey instrument (Appendix B) used to collect data for this research question had 16 items. Fifteen of those items used a five-point Likert scale for user input. The numeric values used in each of the 15 Likert-scale survey items were: 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, and 1 = Strongly Disagree. Survey items 11 and 13 were reverse-coded – meaning more disagreement conveyed more positive response. There was also one open-ended question seeking qualitative input from users, addressing anything they might have to say that had not been addressed by the Likert-scale items.

Sixty-four students from the treatment group completed the survey. The treatment group originally started with 73 students. During pre-analysis data screening, 14 student records were dropped from the study for reasons such as missing one of the post-treatment assessments or excessive absences. The final number of student records that were analyzed for research question 1 was 59. However, since the survey instrument did not ask for any identifying information, it was not possible to separate which five students out of the 64 survey respondents were not included in analysis for research question 1. Thus, all 64 responses were processed. The survey items were printed on two sides of a single sheet of paper – 12 items on the front side and four items on the back side. Four students did not answer survey items on the back page. Table 11 shows the descriptive statistics for the learning experience survey results for students in the treatment group.

Table 11

Descriptive Statistics for Learning Experience Survey of Treatment Group

	Survey Items	*n*	*M*	*SD*
Q1.	I have had positive experiences with the use of technology.	64	4.19	0.73
Q2.	I felt comfortable and enjoyed using clicker-technology in this class.	64	4.19	0.64
Q3.	I had prior experience with using clicker-technology.	64	3.89	1.26
Q4.	I was more engaged while clicker-technology was used in class.	64	3.72	0.93
Q5.	The use of clicker-technology helped me better concentrate on course content.	64	3.58	0.89
Q6.	The use of clicker-technology increased my motivation to come to class.	63	3.14	0.86
Q7.	The use of clicker-technology helped me learn and understand course content better.	64	3.53	0.78
Q8.	The use of clicker-technology better prepared me for exams.	64	3.72	0.88
Q9.	It was beneficial for me to see how other students answered the questions.	63	3.67	0.93
Q10.	The clicker-questions, instant feedback, and repeat-explanation helped me with knowledge retention.	64	4.05	0.72
Q11.	I randomly answered questions to secure participation credit without thinking through the questions.	64	2.00	1.07
Q12.	The instructor made effective use of clicker-technology.	64	3.83	1.00
Q13.	I would have learned more in this class if clicker-technology was not used.	60	2.25	0.87
Q14.	The clicker-technology worked reliably.	60	4.13	0. 60
Q15.	Use of clicker-technology kept me from drifting away to Facebook, cell phone, or iPod use.	60	3.53	1.17

Note. Numeric values used in Likert-scale survey items: 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, and 1 = Strongly Disagree.

In general (Appendix B2), student learning experience with the clicker-technology and associated pedagogical strategies was positive. Table 11 shows the descriptive statistics for the learning experience survey of the students in the treatment group. A large number of students reported that they felt comfortable and enjoyed using clicker-technology in this class ($M = 4.19$). They also reported that use of clicker technology helped them engage in learning activities ($M = 3.72$), and learn and understand course content better ($M = 3.53$). Furthermore, clicker-questions, instant feedback, and repeat-explanation helped them with knowledge retention ($M = 4.05$), and subsequently helping them in exams (M = 3.72).

While clicker technology helped some students to engage in learning activities, it did not keep some others from drifting away to Facebook, cell phone, or iPod use ($M = 3.53$). Furthermore, some students reported that they randomly answered questions to secure participation credit without thinking through the questions (reverse-coded, $M = 2.0$).

The majority of the students, however, had had a positive experience with general use of technology ($M = 4.19$) and had prior experience with use of clicker technology before they came to this class ($M = 3.89$), although this was the item with the most variation in student responses ($SD = 1.26$). They also reported that clicker technology worked reliably for them ($M = 4.13$) and the instructor made effective use of clicker technology in this class ($M = 3.83$).

Two survey instruments (Appendix B and Appendix D) were distributed on the same day among students towards the end of the class. The instructor stepped out of the room for students to fill out the forms and place them back in an envelope placed on the instructor's desk. Even though it was stressed to write comments for the open-ended survey items at the end of each instrument, very few students actually took the time to do it. There weren't enough data to run a formal qualitative analysis on them. However, through those few comments, one theme that came across was that students liked the use of clicker technology in classroom instruction. Here are a few comments to support that theme:

1) "I think it catches the students' attention."
2) "The clicker technology is a very good and useful idea. It helps me to review previous material in class."
3) "It shows the correct answer."
4) "Best help for test."

Instructor's Log Data. The Instructor's Log also supports the assertion that students liked the use of clicker technology. Students became more punctual, since at the beginning of class, clicker-review of the previous day's work also served as the class attendance. When student responses indicated that a certain topic needed to be repeated, students were anxious to make sure that that particular question would be excluded from their grade. One of the instructors wrote in the Log, "The mood of the class was like roller coaster! When they answered a question correctly, they were happy. When they answered a question wrong, their mood reflected that."

Interview Data. To conduct focus group interview of selected students, a purposive sample was used. This sample identified low, mid, and high achievers from multiple sections within the treatment group. To achieve the highest possible benefits, the focus group interviews were scheduled to be conducted after the learning experience survey was completed and at least partially analyzed so that more in-depth information could be gained using more appropriate questions than would be possible if the questions were designed beforehand. However, since the learning experience survey was not done until the very end of the semester, student participation became a challenge as students became busier preparing for their finals. Thus, only one focus group interview took place.

The informal interview with the purposive sample of seven students reaffirmed what the larger student group already has expressed in the learner experience survey.

- They liked the use of clicker technology.
- They were glad that they did not have to purchase the clicker (it was provided).
- It helped them most in reviewing materials to prepare for tests.
- It helped them stand corrected in real time, if they made a wrong selection.
- It was far better to use a clicker to respond anonymously than to speak up in class.
- They liked the peer discussions some clicker-questions initiated.

Research Question 3 Results

The third research question of the study addressed how student attitude about learning was influenced by the extensive use of clicker technology and associated pedagogical strategies in classroom instruction.

Research Question 3 – How do instructional strategies focused on extensive use of clicker technology influence students' attitudes about learning?

Two survey instruments were used to collect data for this research question – one for the control group with 12 survey items (Appendix C) and the other for the treatment group with 16 survey items (Appendix D). The control group survey instrument included 11 items that addressed general attitudes about learning. The treatment group survey instrument also included the same 11 items. These common items were used to measure how the general attitudes about learning of students in the treatment group, having been influenced by the extensive use of clicker technology, differed from the general attitudes about learning of students in the control group without that influence. The treatment group survey instrument also included an additional four clicker-specific items that addressed attitudes about learning influenced by exposure to clicker technology in particular. All of these items used the same five-point Likert-scale options for user input. The numeric values used in each of the Likert-scale survey items were: 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, and 1 = Strongly Disagree. The survey instrument included one open-ended question seeking qualitative input from users addressing anything they might have to say that had not been addressed by the Likert-scale items.

Seventy-five students from the control group completed the survey. The control group originally started with 79 students. During pre-analysis data screening, five student records were dropped from the study for reasons such as missing out multiple assessments. The final number of student records from the control group that were analyzed for research question 1, was 74. However, since the survey instrument did not ask for any identifying information, it was not possible to separate which student out of the 75 survey respondents was not included in analysis for research question 1. Thus, all 75 records were processed. Similarly, 63 records from the treatment group were processed.

The common set of survey items were used to measure how the general attitude about learning of students in the treatment group, having been influenced by the extensive use of clicker technology, differed from the general attitude about learning of students in the control group without that influence. A multivariate analysis of variance (MANOVA) test was conducted with one independent variable with two groups, and 11 dependent variables. Since some of the survey items enquired about somewhat related issues, it was suspected that correlation could exist among them and, therefore, MANOVA would produce more reliable results than a series of *t*-tests.

MANOVA results revealed an overall significant difference between the two groups on the attitudes probed by this survey, Wilk's $\Lambda = .43$, $F(11, 126) = 15.51$, $p < .001$, partial $\eta^2 = .58$. Cohen (1988) interpreted η^2 effect sizes of .14 or greater as large. That means the difference between the two groups on the attitudes probed by this survey did exist, and with such a large effect size it should be easily observed. Table 12 shows the descriptive statistics of both groups for the attitude about learning survey.

Univariate tests for responses to the items in the attitude about learning survey indicated significant differences between control and treatment groups for items 1, 3, 4, 5 6, 7, 8, and 9. The differences for items 1, 3, 4, 5, 8 and 9 were statistically significant even at $\alpha = .01$ level. The differences for items 6 and 7 were statistically significant at $\alpha = .05$ level. Table 13 presents a summary of the univariate test results.

Table 12

Attitude Toward Learning Survey Results

		Groups	*n*	*M*	*SD*
Q1	I enjoyed the class.	Control	75	4.12	.72
		Treatment	63	4.48	.67
Q2	I am comfortable using various technologies.	Control	75	4.27	.72
		Treatment	63	4.41	.80
Q3	Use of technology can improve classes at [college name].	Control	75	4.12	.90
		Treatment	63	4.57	.59
Q4	I liked the instructional strategies employed by the instructor.	Control	75	4.15	.85
		Treatment	63	4.52	.56
Q5	Use of clicker-technology is an effective means for instruction.	Control	75	3.36	.69
		Treatment	63	3.78	.75
Q6	Technology can enhance student engagement.	Control	75	4.04	.85
		Treatment	63	4.33	.67
Q7	Technology can enhance student learning.	Control	75	4.21	.72
		Treatment	63	4.48	.67
Q8	Use of technology-based instructional tools can positively influence student retention.	Control	75	3.87	1.03
		Treatment	63	4.32	.82
Q9	I understood the course materials adequately.	Control	75	3.83	.92
		Treatment	63	4.30	.64
Q10	The concepts/skills that I learned in this course will be useful in other classes or at work.	Control	75	4.23	.80
		Treatment	63	4.38	.58
Q11	I fit in with other students in the class.	Control	75	3.95	1.04
		Treatment	63	3.92	.85

Note. Numeric values used in Likert-scale survey items: 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, and 1 = Strongly Disagree.

Table 13

Univariate ANOVA Results for Attitude about Learning Survey

	SS	*df*	*MS*	*F*	*p*	η^2
Q1	4.34	1	4.34	9.00	.003	.06
Q2	.73	1	.73	1.27	.261	.01
Q3	6.98	1	6.98	11.67	.001	.08
Q4	1.70	1	1.70	3.41	.003	.06
Q5	5.98	1	5.98	11.58	.001	.08
Q6	2.95	1	2.95	4.95	.028	.04
Q7	2.37	1	2.37	4.85	.029	.03
Q8	6.96	1	6.96	7.87	.006	.06
Q9	7.72	1	7.72	11.93	.001	.08
Q10	.99	1	.99	1.98	.162	.01
Q11	.02	1	.02	.03	.874	.00
Error						
Q1	65.63	136	.48			
Q2	77.94	136	.57			
Q3	81.35	136	.60			
Q4	67.90	136	.50			
Q5	70.17	136	.52			
Q6	80.88	136	.60			
Q7	66.30	136	.49			
Q8	120.32	136	.89			
Q9	88.02	136	.65			
Q10	68.23	136	.50			
Q11	124.39	136	.92			

Item 1 ("I enjoyed the class") responses showed that students in the treatment group ($M = 4.48$) enjoyed the class more than did those in the control group ($M = 4.12$), $F(1,136) = 9.00$, $p = .003$, partial $\eta^2 = .06$. According to Cohen's (1988) interpretation the effect size implied medium practical significance. Item 3 ("Use of technology can improve classes") responses revealed that students in the treatment group ($M = 4.57$) believed at a much higher level than those in the control group that the use of technology can improve classes ($M = 4.12$), $F(1,136) = 11.67$, $p = .001$, partial $\eta^2 = .08$. The effect size implied medium practical significance. Similarly, item 4 ("I liked the instructional strategies employed by the instructor") responses showed that students in the treatment group ($M = 4.52$) liked the instructional strategies employed by the instructor in classroom instruction more than did those in the control group ($M = 4.15$), $F(1,136) = 3.41$, $p = .003$, partial $\eta^2 = .06$. Again, the effect size implied medium practical significance. Finally, item 5 ("Use of clicker-technology is an effective means for instruction") responses revealed that students in the treatment group ($M = 3.78$) believed at a higher level than those in the control group that the use of clicker-technology is an effective means for instruction ($M = 3.36$), $F(1,136) = 11.58$, $p = .001$, partial $\eta^2 = .08$. The effect size implied medium practical significance. Item 9 responses showed that students in the treatment group ($M = 4.30$) reported at a higher level than those in the control group that they understood the course materials adequately ($M = 3.83$), $F(1,136) = 11.93$, $p = .001$, partial $\eta^2 = .08$. This effect size also implied medium practical significance.

Item 2 ("I am comfortable using various technologies") responses showed that students in the treatment group ($M = 4.41$) agreed marginally more than those in the control group (M = 4.27), $F(1,136) = 1.27$, $p = .26$, partial $\eta^2 = .01$. Item 10 ("The concepts/skills that I learned in this course will be useful in other classes or at work") responses also showed that students in the treatment group (M = 4.40) agreed marginally more than those in the control group (M = 4.23), $F(1,136) = 1.98$, $p = .16$, partial $\eta^2 = .01$. Finally, item 11 ("I fit in with other students in the class") responses demonstrated that students in the treatment group (M = 3.92) agreed at a marginally lower level than those in the control group (M = 3.95), $F(1,136) = .03$, $p = .87$, partial $\eta^2 = .00$. This last item also had the highest variation in student responses (SD = 1.04). The effect sizes of items 2, 10 and 11 implied small to no practical significances. That means the students in the treatment group and the control group did not have significantly different levels of attitudes about learning on those items.

As mentioned earlier, the survey instrument for the treatment group (Appendix D) used to collect data for this research question had four additional items with five-point Likert-scale options for user input. Table 14 shows the descriptive statistics for those items.

Table 14

Statistics for Attitude about Learning Survey Items Specific to Students in Treatment Group

	Survey Items	*n*	*M*	*SD*
Q12.	Due to the use of clicker-technology, I have learned more in this class compared to other classes.	64	3.47	0.84
Q13.	If I had to recommend between this class taught using clicker-technology and a similar class taught without clicker-technology, I would recommend this class.	59	3.92	0.84
Q14.	I enjoyed this class taught using clicker-technology.	59	4.03	0.79
Q15.	I wish more classes were taught using clicker-technology.	59	3.97	0.93

Note. Numeric values used in Likert-scale survey items: 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, and 1 = Strongly Disagree.

Quite a few students felt that they had learned more because of the use of clicker technology in the classroom ($M = 3.47$). A large number of students reported they would recommend similarly taught classes to others ($M = 3.92$), and they also wished more classes were taught this way ($M = 3.97$). Finally, a large number of students ($M = 4.03$) conveyed that they actually enjoyed the class taught using clicker technology.

Even though it was stressed for students to write comments for the open-ended survey items at the end of each instrument, very few students actually took the time to do so. There weren't enough data to run a formal qualitative analysis for these submissions. The open-ended question ("Provide any additional comments in the space below") sought qualitative input from users, addressing anything they might had to say that had not been addressed by the Likert-scale items. However, through those few comments, one theme that came across was that students were appreciative that their instructor took the time to prepare the clicker-lessons and develop associated instructional strategies. Here are a few comments to support that theme:

1) “I enjoy interactive class, the more hands on, the better. It is just how I learn.”
2) “Please add clicker technology to more classes. It’s a very good way to study and learn material covered in class.”
3) “It depends on the instructor as to how he or she uses clickers. Some classes would be hindered while others would benefit from it. For example, comp/math/science class would probably benefit from multiple choice questions over an English class talking about Julius Caesar.”

Chapter V

FINDINGS, CONCLUSIONS, AND IMPLICATIONS

This chapter presents an overview of the study, a summary of findings, implications for practice, and considerations for future research. It summarizes the existing literature on how clicker-technology-aided classroom instruction can impact academic achievement. The chapter reviews the purpose of the study and research methodology including data collection and analysis. The chapter continues with a review of findings and conclusions drawn from the data. Finally, implications for practice and future research are discussed.

Overview of the Study

The challenge of ensuring the best learning experience for an increasingly diverse student body in an open-access post-secondary institution is a difficult one. Historically, these open-access institutions, most of them being community colleges, have no admission restrictions or enrollment limits (Roman, 2007). In absence of a credible screening process for admissions, students come with various levels of preparedness from secondary schools. A large number of these students lack the required skill-levels in basic computation, composition, and reading to successfully complete post-secondary coursework. Thus, they are required to take at least one or more learning support or remedial course to develop those required skills and competencies. A digital literacy course, the focus of this study, is part of the general education core curriculum and appears on the list of required or optional courses for almost all majors offered by most post-secondary institutions. This course does not have prerequisites, thus almost all students registered in this course are entry-level freshmen. Learning support students are allowed in this course which makes it a challenge to ensure the best learning experience for all students in the class because the student preparedness-levels are so varied.

This lack of basic computation, composition, and reading skills makes it difficult for instructors to improve student retention, and progress towards graduation. Therefore, instructors must develop creative ways to reach out to students of all levels, through the means available to develop competency, and level the field for learning. For this millennial generation of students, technology is considered one of the most promising tools to accomplish that goal.

This study was guided by the following research questions:

1. How does student achievement differ between a group of students who were taught a college-level digital literacy course with heavy use of clicker technology and a group of students who were taught using traditional methods?
2. What are the learning experiences of students who were taught a college-level digital literacy course with heavy use of clicker technology?
3. How do instructional strategies focused on enhanced use of clicker technology influence students' attitude about learning?

Purpose of the Study

The purpose of this study was to examine the impact of clicker-technology-aided classroom instruction on student engagement and achievement in a college-level digital literacy course. This study was also an attempt to explore the impact on student learning experiences and students' attitudes toward instruction utilizing technology-based strategies.

In recent decades, an unprecedented growth has occurred in technological developments that have transformed every aspect of our lives. Technology has changed the way we communicate, collaborate, or conduct research. In the same time frame, however, classroom instructional methodologies have changed very little. The number of computers used in academic institutions from K-12 through higher education has been on the rise since 1990s. There has been a steady increase in support for the assimilation of technology in classrooms as well. However, the development of the effective use of technological tools to connect teaching with enhanced learning has been far slower in comparison (Brewer, 2004).

The use of technology in the classroom has to be inventive, creative, and fitting for the adopted pedagogical approach (Judson & Sawada, 2002; Brewer, 2004). The purpose of the use of technology in the classroom should be to enhance the ability of students to achieve higher levels of learning and comprehension (Edutopia, 2008). If technology-aided tools can make the class more engaging, more interactive, and more interesting, students may not only perform better in class, but a higher number of them may actually be willing to stay in the class and complete it, potentially reducing the course-level dropout rate. Personal response systems have a proven track record of engaging students in classroom (Skiba, 2006; Shaffer & Collura, 2009).

Marc Prensky (2001), who coined the phrases "Digital Natives" and "Digital Immigrants" wrote, "Our students have changed radically. Today's students are no longer the people our educational system was designed to teach" (p.1). This is the first generation of students who grew up surrounded with technological toys and tools of the digital age (Prensky, 2001). They think and process information differently than their parents and prefers to participate in an active learning process and to use technology to enhance learning (Mangold, 2007). There are studies that clearly suggest that clicker technology is a viable instructional tool that encourages students to actively participate in the learning process (Masikunis, Panayiotidis, & Burke, 2009; Beuckman, Rebello, & Zollman, 2007). Marti (2009) suggests that positive learning outcomes are directly associated with active participation and engagement of the student in the learning process. Marti believes the more the students can be actively engaged in their own learning process the better the chance of their success — thus, positively affecting the retention, progression, and graduation rates of the institution.

Conceptual Framework

The conceptual framework for this study is firmly grounded in the constructivist learning theory. Among others, John Dewey has clearly voiced the core idea of the theory that learners individually construct knowledge for themselves. Clicker technology actively engages students in their own learning process helping them in constructing their own understanding of the topic. Dangle and Guyton (2003) stressed that active participation and engagement in the learning process enhance the acquisition of knowledge by promoting assimilation of new concepts into the existing body of knowledge. When clicker technology is used to engage students in individual and collective learning process, a higher level of knowledge acquisition takes place enhancing comprehension and knowledge retention for the learners (Guthrie & Curlin, 2004).

Actively engaging students in their own learning process has proven to be a critical component of successful achievement in college-level coursework within many disciplines (Beuckman, Rebello, & Zollman, 2007; Masikunis, Panayiotidis, & Burke, 2009; Shaffer & Collura, 2009; Revell & McCurry, 2010). Benefits of technology-aided instruction are both theoretically and empirically grounded. Abdallah (2008), Brewer (2004), and Skiba (2006) claimed that clicker-technology-aided instruction has demonstrated a significant positive effect on student achievement, and it is one of the proven technological means to actively engage students in the classroom that enhances their learning and comprehension of the subject matter.

Technologies are increasingly making the world flatter every day. Technologies have transformed the way people communicate, collaborate, and learn – young and old alike (Friedman, 2007). What is needed is, the effective use of technological tools in classroom instruction which connects teaching with learning (Brewer, 2004). Increased student achievement can only be insured through the use of high-leverage technological tools and the teacher's increased ability to incorporate them in classroom instruction (Green, 2000).

Related Literature

Since the beginning there has been a consistent effort to make the process of teaching and learning more effective for both the teacher and the learner, since it is the key to raising standards (Smith, 2007). It has been documented in numerous researches that technology-aided instruction, or reflective teaching using technology, has the clear potential to aid in enhancing the level of student learning and comprehension (Abdallah, 2008). Over two decades ago, Kulik and Kulik (1991) concluded from their meta-analysis of 254 controlled studies of students from K-12 through higher education that technology-aided instruction had a clear advantage over traditional methods of classroom instruction. Even in the National Educational Technology Plan 2010, the Office of Educational Technology of the U.S. Department of Education calls for "engaging and empowering learning experiences for all learners" (p. 8) largely through the use of technology.

There are many research studies where participatory practice in classroom instruction using clicker-technology produced enhanced levels of academic achievements in a variety of subject areas. Brewer (2004) conducted a study on the effect of real-time assessment of student learning and comprehension in her large enrollment introductory Biology class using clickers at University of Montana. Brewer developed a set of questions where students had to choose between correct answer and popular misconceptions. Brewer found that with instant feedback, she was able to pace her instruction and make sure students grasped the correct interpretation before moving on to the next topic. Moreover, she claimed that the students' improved understanding of the current topic established a better foundation for the next learning experience. Beuckman, Rebello, and Zollman (2007) adopted clickers in their Physics classes with large enrollments at Kansas State University. They reported significant improvement in student engagement in class and better academic achievement using clickers. To adopt clickers technology they redesigned the pedagogy for the course. They demonstrated that using clickers to engage students improved learning outcomes, and student grades. Masikunis, Panayiotidis, and Burke, (2009) conducted a study using the clicker system in courses of their Business and Management program at Kingston University in the UK as a measure of innovative teaching in their very large classes that had as many as 500 students. They reported a substantial increase in the mean scores across the board for those classes. Shaffer and Collura (2009) conducted a study using clickers in their Introductory Psychology course at Ohio State University. As a result, they discovered that students rated their lectures as more interactive, more interesting, and more entertaining. Students in the class taught using clickers also performed significantly better on exam questions compared to another group of students who did not use the clickers. Dunham (2011) conducted a study at Columbia County School System in Georgia on 7th grade Math students taught using clicker technology. Students were evaluated on teacher-made assessments, 4 units from textbook, and the Math portion of the Georgia Criterion-Reference Competency Test (CRCT). She observed significant improved performance of students from classes taught using clickers in pre- and post-unit test scores as well as the CRCT Math scores. Skiba (2006) teaches Nursing classes at the University of Colorado using clickers. She highlights two instructional values in using clickers in classroom:

- Using clickers students are not fearful of providing incorrect answers. They are encouraged to think through the questions and submit their answers anonymously.
- It allows instructor to be able to ask students multi-answer questions efficiently which would not be feasible otherwise.

While there are research showing strong evidence of improvements in student learning and achievements through the use of clicker technology in classroom instruction, there are some studies that point to no statistically significant improvements in student success (Crossgrove & Curran, 2008; Strasser, 2010; Acree, 2010). Yet, there are studies that reports rather interesting outcome as in case of Watkins and Sabella (2008). Watkins and Sabella, researchers at Chicago State University, conducted a study, funded by National Science Foundation, in introductory Physics class examining the effectiveness of clickers in promoting learning. The researchers found that the use of clickers made the class more dynamic as learning environment, and they also observed a significant improvement in student engagement and student performance during class Question and Answer (Q&A) sessions. However, interestingly enough, when asked the same or similar questions in a test, they found that the students did not perform significantly better anymore. The researchers attributed the outcome as that of a knowledge retention issue. They claimed that the students did learn at an enhanced level because of their active engagement through the use of clickers as demonstrated during the class Q&A sessions, but how they could hold on to that knowledge (a knowledge retention issue) is another research topic.

Methodology

The study sample was selected from the general student population of a college in the rural South. The college enrollment in the semester when the study was conducted was 3,226 students – 68% of them were full-time and 32% of them were part-time. Of all students enrolled, there were 80% White, 13% Black, 5% Hispanic, 1% Asian, and less than 1% American Indian or Alaskan Natives. The percentages of male and female students were 54 and 46 respectively. In addition, the average age of all students was 20.3 years, their high school graduation GPA was 2.7, and their current semester load was 11.6 credit hours. Furthermore, 28.3% of all students were required to take at least one learning support course.

All students in the selected study sample, except one, were enrolled full-time. The average age of all students in the study sample was 18.7 years, their average high school graduation GPA was 3.0, and their average current semester load was 13.8 credit hours. Likewise, of all students in the study sample 39.2% were required to take at least one learning support course. The students in this study sample were already pre-registered in the selected sections of the course resulting convenience sampling rather than random sampling as required for true experimental design. Thus, a quasi-experimental time series research design was used in this study.

In absence of a true random sampling, it was essential to establish the statistical equivalence of the control and treatment groups before introducing treatment. To that effect, three pre-treatment assessments were administered to all students in both the control and the treatment groups. Then, two post-treatment assessments were administered to all students in both the control and the treatment groups to observe the potential effect of treatment.

Descriptive statistics was used to describe the basic features of the data and to form the basis of the analysis. The *t* test of independent samples was used to determine whether the means of the control group and the treatment group were statistically different from each other. Multivariate Analysis of Variance (MANOVA) was used to determine any differences between the groups with suspected correlation among dependent variables. SPSS software was be used to analyze all quantitative data. Qualitative data collected through open-ended survey questions, interviews, and Instructor's Log was analyzed for trends and themes using content analysis techniques.

Discussion

The results of the first research question revealed that the academic achievement of students in the group that was taught with extensive use of clicker technology was higher than the achievement of the students in the group that was taught using traditional methods. Clicker-technology-aided classroom instruction had a positive effect here. The analysis of the first post-treatment assessment revealed that there was a statistically significant difference between the mean score of students in the control group and the mean score of students in the treatment group. In addition, the Cohen's effect size (*d*) also suggested moderate to high significance in the difference of the two means. However, the analysis of the second post-treatment assessment revealed that there was no statistically significant difference between the mean score of students in the control group and the mean score of students in the treatment group. Similarly, Cohen's effect size (*d*) also suggested small practical significance.

To try to understand this disparity between the results for the two assessments during the intervention period may involve considering the differences in the topics covered by those assessments and how the students engaged with that content. Assessment 4 covered what the students were to learn about Microsoft Excel. For that unit of the course, the students had to process numbers, manipulate cell addressing, use functions, construct formulas, create various types of charts, etc. The unit involved more than learning a procedure such as changing document margins. A moderate degree of understanding of spreadsheet features was necessary. If a student did not grasp the way cell addressing features worked, that student could not effectively construct formulas to be copied across a range of cells. With the instant feedback from clicker technology, the instructors were able to pace instruction and make sure students grasped the content before moving on to the next topic. Thus, the improved understanding of the current topic established a better foundation for the next learning experience for students. When the topic of classroom instruction is not very easy to grasp, when distinguishing misconception from correct interpretation is not very obvious, or when improved understanding of the current topic is essential to establish a good foundation for the next learning experience, frequent feedback through clicker technology is invaluable (Brewer, 2004). After conducting a similar study in Kingston University at UK, Masikunis, Panayiotidis, and Burke (2009) concluded that clicker-technology-aided interactive lectures driven by educational ends can enhance student learning and comprehension.

The content for Assessment 5 was a brief coverage of Microsoft Access. In this unit of the course students had to learn basic concepts and terms, create simple database tables, enter and edit records, create a simple query and a simple form, use navigation, modify field formats, modify table structures, specify primary key, etc. This unit was largely about learning procedures. It did not involve database features such as normalization, enforcing data integrity, complex query design, or Sequential Query Language (SQL), features that require in-depth understanding of procedures as well as concepts. Database normalization, for example, would have required understanding of how to organize the data fields in a number of small tables to minimize redundancy. It would have required an understanding of defining relationships between those tables to enforce referential integrity. It would also have required an understanding of the concept of data isolation to enhance database maintenance. Thus, to build up the skills and concepts needed to understand how to normalize a database, a step-by-step process involving frequent feedback would have been necessary. However, the procedure of creating a simple query was independent of the procedure for creating a simple form. Similarly, specifying primary key for a table was independent of the procedure for editing a record, or modifying a table structure. In this unit briefly covering Microsoft Access, there was not much of the building upon understanding in a step-by-step approach that was necessary in the Excel unit. Therefore, frequent feedback was not as necessary or as critical in this unit as it was in the Excel unit. Judson and Sawada (2002) emphasized that use of clicker technology would not produce substantial improvement unless the course content could be seamlessly adopted into clicker-technology-based pedagogical approaches. Basics of Microsoft Access did not fit that model.

The results for the second research question revealed that the students who were taught with extensive use of clicker technology reported that they had substantially positive learning experiences. It should not be surprising to find that the higher academic performance by the treatment group revealed by Research Question 1 was accompanied by enjoyment and appreciation for the learning experience. It was evident that use of clicker technology as an instructional tool contributed to the positive learning experiences. Shaffer and Collura (2009) also found that the use of clicker technology in classroom instruction made the learning process more interactive, more engaging, and more entertaining for students, contributing to positive learning experiences and improved academic success. It was also evident from the results in the present study that positive learning experiences were directly associated with active participation and engagement of the students in the learning process. Evidence for these associations came from all of the data collection methods used with this research question: Likert-scale survey items, open-ended survey questions, instructor's log entries, and focus-group interviews. Marti (2009) noted that the more the students can be actively engaged in their own learning process the better the chance they will have academic success and positive learning experiences.

The results for the third research question revealed that the students who were taught using instructional strategies focused on extensive use of clicker technology demonstrated a more positive attitude about learning than students who were taught using traditional methods. Analysis of student responses revealed that students in the treatment group enjoyed the class more than those in the control group. It appears that the clicker-technology-aided classroom instruction significantly influenced student opinion on how much they enjoyed the class. Consistently, students in the treatment group believed at a much higher level than those students in the control group that the use of technology could improve classes, that the use of clicker-technology was an effective means for aiding in instruction, and that they liked the instructional strategies employed by the instructor. These students' first-hand exposure to technology-aided instruction most likely shaped their favorable attitude towards the potential of technology use in classroom instruction. Furthermore, these students reported at a higher level than those in the control group that they understood the course materials adequately. This finding was especially important since it corroborates the *t* test achievement results for Research Question 1. It was evident that instructional technology, and especially clicker technology used along with appropriate instructional strategies, not only resulted in better achievement, as seen in the Research Question 1 results, but also in students' perceptions of better learning. It appears that clicker-technology-aided instruction promoted student engagement, which is one of the established prerequisites to academic achievement (Dangle & Guyton, 2003). The anonymous nature of clicker responses assured participation from all students. Clicker-review short quizzes that also served as attendance encouraged students to read the textbook as well as arrive on time to class. It was easy for students to see the direct and indirect benefits of the use of clicker technology, which ultimately shaped their opinions. Skiba (2006) reported in her study that when using clickers students were not fearful of providing incorrect answers. They were encouraged to think through the questions and submit their answers anonymously. She also submitted that use of clicker technology encouraged active learning, student-teacher contact, and cooperation, and provided prompt feedback on students' level of comprehension. These benefits resulted in positive experiences, attitudes, and academic success (Brewer, 2004; Shaffer & Collura, 2009).

Analysis of student responses also revealed that there were only marginal differences of opinion between the groups on the comfort level of using various technologies, on the potential of the concepts/skills learned in this class to be of use in another setting, and how they individually fit in with others in the class. These results were not surprising, since the responses to these items were not expected to be significantly influenced by exposure to the clicker-technology-aided classroom instruction. This millennial generation of college students grew up being exposed to technology around them. Their environment has shaped their experience, and technology plays a very large role in their everyday lives (Raines & Arnsparger, 2010). They feel comfortable using technology in general. The technological concepts and skills learned in one course could always be useful in another setting. These items would probably receive similar responses if asked in a different course, since the items did not pertain directly to the use of clicker technology in this course.

The survey items 12 through 15 were specific to the clicker-technology-aided classroom instruction and therefore were asked only of the treatment group. The combined mean for student responses to those survey items was 3.85, indicating a substantially positive attitude about learning influenced by clicker-technology-aided classroom instruction. These findings are consistent with the findings addressing Research Question 2, where the combined mean for student responses to those survey items was 3.78. Based on these findings, the students in this group had both positive experiences with and positive opinions about the clicker-technology-aided classroom instruction.

The Implications

The study results were supported with some other reported studies that report significant achievements attributed to clicker-technology-aided classroom instruction (Brewer, 2004; Masikunis, Panayiotidis, & Burke, 2009; Dunham, 2011). The first post-treatment assessment (Assessment 4) supported that assertion.

Students with such highly positive experience with general use of technology, such high rate of prior experience with use of clicker technology, and such high percentage of students being able to make technology work reliably for them may be the clear indication of a new generation of students who are much more technologically savvy than any generation of students before. That in itself is a compelling reason why more technology-aided instruction should be used in classroom to enhance academic achievement.

In this study, 91% of students agreed that clicker-technology worked reliably for them, while 83% of students agreed that clicker-questions, instant feedback, and repeat-explanation helped them with knowledge retention. Also, 81% of students reported that they had prior experience with using clicker-technology and 87% of students agreed that they felt comfortable and enjoyed using clicker-technology in class. The mean scores of the treatment group in the post-treatment assessments were seven points higher in Assessment 4 and two points higher in Assessment 5 than the mean scores of the control group. However, the two-point difference of the mean scores between the two groups for the second post-treatment assessment was not large enough to be statistically significant for the given sample size, suggesting a possible misconception between student perception of how much more they were learning and the reality.

Effectiveness of the use of clicker technology in classroom heavily relies on the degree of transparent integration of clicker technology and course content. Since it may require developing some experience to harness the full potential, instructors may ease into clicker use slowly without having to commit significant time and resource at one time. Clicker technology can be used without clickers as well; any computer connected to the Internet or any smartphone can be used instead, eliminating a major cost component. There is no downside making a class engaging and interactive for learners, no matter at what degree that is.

Clicker technology is a teaching tool – an instructional aid. It cannot replace student responsibilities such as reading textbook, doing homework, or taking class notes. Similarly, improper use of it may mute its effectiveness as well.

The Limitations

This study used convenience sampling and thus, a quasi-experimental research design. In absence of a true experimental research design with random sampling, the generalizability of the findings of this study has been compromised. The selected study sample size was a limitation as well.

The instructors were not experienced clicker technology users. Studies suggested that the degree of achievement in increased comprehension and knowledge retention through clicker-technology-aided classroom instruction is largely and directly proportional to the extent of redesigned pedagogical approach of instruction (Judson & Sawada, 2002; Beuckman, Rebello, & Zollman, 2007). Redesigning the pedagogy for the course is essential to maximize the potential of clicker technology. Yet, "the biggest challenge with clickers or personal response devices is figuring out how to integrate them into the heart of the lesson rather than tagging them on at the end" (Derringer, 2011). To make adoption of clicker technology work successfully, it takes commitment of time and effort. Even though the instructors committed their time and effort, it was possible that they lacked in skills to develop most effective clicker lessons.

This study used classes largely with incoming freshmen students where 39% of them were also required to take at least one learning support course. Clicker-technology-aided classroom instruction in a different setting such as a senior-level course could have produced different outcome.

The instructors were not experienced researchers. Scheduling student interviews at the very end of the semester, close to the finals, caused poor participation. An experienced researcher could have foreseen that. There were very few comments submitted by students through the open-ended survey items. To assure increased student input, the open-ended survey items could be addressed differently, such as including specific prompts to write down their views on strength, weakness, etc. There were well-concerted efforts to split class sections into the control and the experimental groups. Out of two 8:00 a.m. classes and two 11:00 a.m. classes, one was selected from each time slot for each group. However, all class sections were not symmetric like that. There may also have been bias on the part of the instructors that they were not aware of, such as working extra hard to produce results.

Suggestions for Future Research

This study could be repeated as an expanded research study with much larger study sample. Multiple participating instructors trained in the use of clicker technology could join in. The research could be done using different types courses (Mathematics versus Ethics), different levels of courses (introductory versus advanced), as well as different sizes of classes (small versus large). Similarly, this research could be done at different levels of institutions such as junior college, research university, private college, public college, etc. Since redesigning the pedagogy for the course being used in the study is essential to maximize the potential of clicker technology, it would be wise to have clicker lessons developed and tried for a while before conducting the actual study. That would minimize weakness of research findings attributed by the poorly developed and ineffective clicker-lessons and/or lack of experience of the researcher(s). Finally, this research could be done to study the effect of clicker-technology-aided instructional strategies specifically on learning support and non-learning support student groups.

Summary

The results of the first research question demonstrated that the academic achievement of students in the group that was taught with extensive use of clicker technology was higher than the students in the group that was taught using traditional methods. The results for the second research question revealed that the students who were taught with extensive use of clicker technology had a substantially positive learning experience. Also, the results of the third research question revealed that the students who were taught using instructional strategies focused on extensive use of clicker technology had their attitude about learning more positively influenced than students who were taught using traditional methods.

A large number of students with such highly positive experience with general use of technology, such high rate of prior experience with use of clicker technology, and such high percentage of students being able to make technology work reliably for them may be the clear indication of a new generation of students who are much more technologically savvy than any generation of students before. That in itself is a compelling reason why more technology-aided instruction should be used in classroom to enhance academic achievement. Moreover, if clicker-questions, instant feedback, and repeat-explanation help students with knowledge retention, as large number of students reported that it actually did, then that reason alone may justify the use of clicker-technology-aided classroom instruction. After all, the fundamental objective of classroom instruction is learning, and longer the knowledge can be retained the better.

This study informed how use of clicker-technology-based instruction and associated pedagogical strategies can improve academic achievement and learning experience for students in this institution. The uniqueness came from the diversity of students in social, economic, ethnic, and most importantly, high school preparedness levels. A very large number of students in the course selected for this study were learning support students. The findings of this study not only enabled the practitioners of this institution to perform their job better, that also was what this study added to the existing knowledge body on use of clicker technology in classroom instruction.

This technology can be adapted at all levels and in all subject areas ranging from K-12 through higher education. It appeared throughout the study that there was no significant downside using clicker technology in classroom instruction beside substantial commitment of efforts on the part of the instructors. Over time, even that may ease off. Using technology-aided classroom instruction to enhance the academic achievement of this generation of students is only common sense.

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APPENDIX A

Sample Assessment

(The actual test looks different. The actual test displays in Flash-based graphics window and shows only one question at a time.)

MS Word 2010: Skill Questions

Task Name	Task Instruction
1. Save a document with a new file name	Save the current, previously saved document as "MANUAL". (Do NOT use ALT-D.)
2. Move text	Move the selected text to the top of the document using drag-and-drop.
3. Display the ruler	Display the Ruler in the current document.
4. Enter a line break	Enter a line break at the insertion point.
5. Cut and paste text	Cut the selected text and place it at the top of the page in the bottom pane, below the split.
6. Use the Format Painter	Copy the formatting of the selected text and apply it to the word "PRINTERS". (Do NOT create a new style.)
7. Clear formatting	Remove all text formatting from the selected text. Do NOT remove text formats one at a time.
8. Create a bulleted list	Specify that the selected text will appear as a bulleted list using the default bullet.
9. Create a numbered list	Turn the selected list into a numbered list with the format 1), 2), 3), etc.
10. Indent the first line of a paragraph	Place a first line indent of .5 inches in the selected text.
11. Modify paragraph spacing	Remove the space after the selected paragraphs.
12. Indent paragraphs	Indent the selected paragraph one inch. (Do not click and drag.)
13. Display formatting marks	Display formatting marks in this document, including paragraph, space and page break.

14. Set a tab stop	Set a left-aligned tab at two inches.
15. Search for text	Search for the word "RULES" in this document.
16. Insert a page break	Insert a page break at the insertion point.
17. Insert a cover page	Insert a Built-in cover page in the document using the "Austere" style.
18. Create a table	Place a table with four columns and eight rows at the insertion point. Do NOT draw the table.
19. Insert a picture	Insert the graphic file named "LOGO" (NOT a clip art image) in the current document at the insertion point.
20. Insert clip art	Insert the ClipArt image named "PRINTERS".
21. Insert a SmartArt graphic	Insert a SmartArt graphic of an Inverted Pyramid.
22. Create a document header	Use the ribbon to insert a header using the style "ALPHABET". Type "MANUAL" in the title place holder. Close the header when done.
23. Insert page numbers	Insert a Page Number at the top of the page using the "Plain Number 1" format.
24. Create WordArt	At the insertion point insert the text "PRICE LIST" in WordArt style "Fill - None, Outline - Accent 2".
25. Insert the current date into a document	Automatically insert today's date to the document in the format "July 10, 2013" (Do NOT use the Insert Field command).
26. Insert a symbol	Without using the keyboard, insert the "TRADE MARK" symbol at the insertion point.
27. Change the page orientation	Change the orientation of the document to Landscape (horizontal).
28. Insert a section break	Add a section break at the insertion point. Specify that the section break will start the new section on the next

	page.
29. Create columns	Format the selected text as two evenly spaced columns.
30. Add a page border	Add a Box Page Border so it appears around the entire page of all pages in the document.
31. Create a footnote	Place a footnote at the insertion point that reads "SEE CARE AND USAGE MANUAL".
32. Apply a style to a picture	Apply the "Soft Edge Rectangle" style to the selected graphic.
33. Wrap text around a graphic	Specify that text will wrap to the top and bottom of the graphic.
34. Rotate a graphic	Rotate the selected graphic 90 degrees right. (Do NOT click and drag the graphic.)
35. Apply a table style	Apply the table "Light Shading - Accent 1" style to the selected table.
36. Insert a row in a table	Insert a new row above the selected row in this table.
37. Delete a table column	Delete the selected column from the displayed table.

Multiple Choice Questions

38. A _____ is a set of characters that uses the same typeface.

A . style
B . theme
C . font
D . format

39. A wavy _____ line appears if you type a word that is not in the dictionary at all.

A . green
B . red
C . blue
D . black

40. A Word feature that automatically inserts the dates and other regularly used items is called _______.

A . AutoCorrect
B . AutoComplete
C . the spelling checker
D . the grammar checker

41. After you finish typing a document, you need to ______ it carefully from start to finish.

A . print
B . view
C . proofread
D . save

42. Item 1 in the figure above is a ____.

A . word wrap symbol
B . nonprinting ScreenTip
C . paragraph mark
D . space mark

43. To select the entire document, press ___________.

A . Alt +A
B . Ctrl +A
C . Shift + A
D . Alt+Ctrl+A

44. A(n) _________ is an alphabetic list of all the books, magazines, Web sites, movies, and other works that you refer to in a research paper.

A . endnote
B . bibliography
C . citation
D . source

45. If you press the ____ keys, the insertion point moves to the end of the document.

A . Ctrl+Home
B . Ctrl+End
C . Shift+Home
D . Shift+End

46. With a ____ indent, all lines except the first line of the paragraph are indented from the left margin.

A . left
B . right
C . center
D . hanging

47. [Type the document title] is an example of ____.

A . a footer
B . a document task
C . a view label
D . placeholder text

48. A(n) ____ should not be included on a cover page.

A . title
B . author name
C . footer
D . summary

49. The Tab dialog box allows you to insert a ______, which is a row of dots between tabbed text.

A . leader
B . diamond leader
C . dot leader
D . comma leader

50. Pre-made images known as _____ are installed with Word and free for you to use in documents.

A . clip art
B . SmartArt
C . side art
D . art clips

APPENDIX B

Student Learning Experience Survey for Treatment Group

This survey is to explore your learning experience with the use of clicker-technology and the associated instructional strategies. You are not asked to provide any identifying information, and your input will remain anonymous. Please read the question items carefully, and mark your answer. Thank you for your input.

1. I have had positive experiences with the use of technology.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

2. I felt comfortable and enjoyed using clicker-technology in this class.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

3. I had prior experience with using clicker-technology.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

4. I was more engaged while clicker-technology was used in class.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

5. The use of clicker-technology helped me better concentrate on course content.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

6. The use of clicker-technology increased my motivation to come to class.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

7. The use of clicker-technology helped me learn and understand course content better.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

8. The use of clicker-technology better prepared me for exams.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

9. It was beneficial for me to see how other students answered the questions.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

10. The clicker-questions, instant feedback, and repeat-explanation helped me with knowledge retention.
    ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

11. I randomly answered questions to secure participation credit without thinking through the questions.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

12. The instructor made effective use of clicker-technology.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

13. I would have learned more in this class if clicker-technology was not used.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

14. The clicker-technology worked reliably.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

15. Use of clicker-technology kept me from drifting away to Facebook, cell phone, or iPod use.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

16. Provide any additional comments in the space below.

APPENDIX B2

Learning Experience Survey Results for Treatment Group

Learning Experience Survey Results of Students in Treatment Group

Survey Items	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Q1	38%	44%	19%	0%	0%
Q2	31%	56%	13%	0%	0%
Q3	38%	42%	0%	13%	8%
Q4	22%	39%	28%	11%	0%
Q5	20%	23%	50%	6%	0%
Q6	8%	19%	54%	17%	2%
Q7	13%	33%	50%	5%	0%
Q8	17%	48%	23%	11%	0%
Q9	21%	35%	37%	6%	2%
Q10	25%	58%	14%	3%	0%
Q11	5%	17%	0%	45%	33%
Q12	30%	36%	22%	13%	0%
Q13	0%	7%	30%	45%	18%
Q14	23%	68%	7%	2%	0%
Q15	23%	32%	27%	12%	7%

Items 11 and 13 are reverse-coded – more disagreement conveyed more positive response.

APPENDIX C

Student Attitude Towards Learning Survey for Traditional Group

This survey is to explore your attitude toward learning that may have been influenced with the use of clicker-technology and the associated instructional strategies. You are not asked to provide any identifying information, and your input will remain anonymous. Please read the question items carefully, and mark your answer. Thank you for your input.

1. I enjoyed the class.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

2. I am comfortable using various technologies.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

3. Use of technology can improve classes at [college name].
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

4. I liked the instructional strategies employed by the instructor.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

5. Use of clicker-technology is an effective means for instruction.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

6. Technology can enhance student engagement.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

7. Technology can enhance student learning.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

8. Use of technology-based instructional tools (such as PowerPoint slides, Clickers, Podcasts, SAM, etc.) can positively influence student retention.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

9. I understood the course materials adequately.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

10. The concepts/skills that I learned in this course will be useful in other classes or at work.
☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

11. I fit in with other students in the class.
☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

12. Provide any additional comments in the space below.

APPENDIX C2

Attitude Towards Learning Survey Results for Both Groups

Attitude Toward Learning Survey Results for Both Groups

Survey Items	Groups	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Q1	Control	33%	47%	20%	0%	0%
	Treatment	56%	33%	11%	0%	0%
Q2	Control	40%	40%	20%	0%	0%
	Treatment	61%	22%	17%	0%	0%
Q3	Control	40%	40%	13%	7%	0%
	Treatment	61%	33%	6%	0%	0%
Q4	Control	47%	47%	7%	0%	0%
	Treatment	50%	50%	0%	0%	0%
Q5	Control	7%	27%	60%	7%	0%
	Treatment	17%	39%	44%	0%	0%
Q6	Control	33%	47%	13%	7%	0%
	Treatment	44%	44%	11%	0%	0%
Q7	Control	33%	60%	0%	7%	0%
	Treatment	56%	33%	11%	0%	0%
Q8	Control	33%	40%	13%	13%	0%
	Treatment	50%	39%	6%	6%	0%
Q9	Control	27%	40%	33%	0%	0%
	Treatment	39%	50%	11%	0%	0%
Q10	Control	47%	33%	20%	0%	0%
	Treatment	44%	50%	6%	0%	0%
Q11	Control	33%	40%	20%	0%	7%
	Treatment	28%	39%	28%	6%	0%

APPENDIX D

Student Attitude Towards Learning Survey for Treatment Group

This survey is to explore your attitude toward learning that may have been influenced with the use of clicker-technology and the associated instructional strategies. You are not asked to provide any identifying information, and your input will remain anonymous. Please read the question items carefully, and mark your answer. Thank you for your input.

1. I enjoyed the class.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

2. I am comfortable using various technologies.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

3. Use of technology can improve classes at ABAC.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

4. I liked the instructional strategies employed by the instructor.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

5. Use of clicker-technology is an effective means for instruction.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

6. Technology can enhance student engagement.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

7. Technology can enhance student learning.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

8. Use of technology-based instructional tools (such as PowerPoint slides, Clickers, Podcasts, SAM, etc.) can positively influence student retention.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

9. I understood the course materials adequately.
   ☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

10. The concepts/skills that I learned in this course will be useful in other classes or at work.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

11. I fit in with other students in the class.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

12. Due to the use of clicker-technology, I have learned more in this class compared to other classes.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

13. If I had to recommend between this class taught using clicker-technology and a similar class taught without clicker-technology, I would recommend this class.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

14. I enjoyed this class taught using clicker-technology.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

15. I wish more classes were taught using clicker-technology.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

16. Provide any additional comments in the space below.

APPENDIX D2

Attitude Towards Learning Survey Results for Treatment Group

Student Attitude Towards Learning Survey Results for Treatment Group (Specific to the Use of Clicker Technology)

Survey Items	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Q12	17%	17%	61%	6%	0%
Q13	28%	28%	44%	0%	0%
Q14	33%	39%	28%	0%	0%
Q15	39%	17%	44%	0%	0%

APPENDIX E

VSU IRB Protocol Exemption Report

VALDOSTA STATE UNIVERSITY

Institutional Review Board (IRB)
for the Protection of Human Research Participants

PROTOCOL EXEMPTION REPORT

PROTOCOL NUMBER: IRB-02837-2012 **INVESTIGATOR:** Abul Sheikh

PROJECT TITLE: Technology-Aided Instruction: The Effects on Student Achievement and Course-Level Retention

DETERMINATION:

This research protocol is **exempt** from Institutional Review Board oversight under Exemption Category 1. You may begin your study immediately. If the nature of the research project changes such that exemption criteria may no longer apply, please consult with the IRB Administrator (irb@valdosta.edu) before continuing your research.

ADDITIONAL COMMENTS/SUGGESTIONS:

Although not a requirement for exemption, the following suggestions are offered by the IRB Administrator to enhance the protection of participants and/or strengthen the research proposal:

none

If you make any of these suggested changes to your protocol, please submit revisions so that IRB has a complete protocol on file.

Wilson Huang 8/1/12
Wilson Huang, IRB Chair Date

Thank you for submitting an IRB application.
Please direct questions to irb@valdosta.edu or 229-259-5045.

Form Revised: 05.04.2012