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The Impact of Computer-Aided Instruction on Student Achievement

Ernest Tolbert Jr.
Gardner-Webb University

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By
Ernest Tolbert Jr.

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Approval Page

This dissertation was submitted by Ernest Tolbert Jr. under the direction of the persons listed below. It was submitted to the Gardner-Webb University School of Education and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Gardner-Webb University.

Wendy Edney, Ed.D. Committee Chair	Date
Steven Bingham, Ed D. Committee Member	Date
James Epps, Ed D. Committee Member	Date
Jeffrey Rogers, Ph.D. Dean of the Gayle Bolt Price School of Graduate Studies	Date

Abstract

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This dissertation was designed to examine the impact of computer-aided instruction (CAI) on student achievement in a business education course and examine student perceptions of the CAI of use, Programmed Logic for Automated Teaching Operations (P.L.A.T.O.). Students not achieving to their highest potential was a problem. The study compared a classroom where only traditional instruction was used to a classroom where traditional instruction and supplemental CAI were used. The results of the study were based on two sets of tests for one unit of study within the course and an evaluation survey of P.L.A.T.O.

The study was to include 56 participants in ninth to twelfth grade placed into two classes of equal numbers (n=28). The control class received the traditional classroom instruction and 20 minutes daily of supplemental traditional instruction. The experimental class received traditional instruction and 20 minutes daily of supplemental CAI from P.L.A.T.O. The experimental group participated in the student evaluation survey to gauge their perceptions of P.L.A.T.O.

Independent *t* tests were used to analyze the pre and postunit tests for both groups of students. The survey data were analyzed using a chi-square test to examine the significant differences in the number of people agreeing or disagreeing about feelings.

An analysis of the data revealed no significant difference between the two forms of instruction. The student perception surveys indicated there was no statistically significant difference in the feelings about the CAI. Overall, the students' perceptions of P.L.A.T.O. were more neutral and negative than positive. Based on the study results, continued research should be done on the impact of CAI in comparison to traditional instruction.

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Chapter 1: Introduction

Nature of the Problem

An American philosopher, psychologist, and education reformist, John Dewey, state in the early 1900s, "If we teach today as we taught yesterday we rob our children of tomorrow" (Dewey, 1916, p. 167). Studies have indicated that an up-to-date method of teaching, computer-aided instruction (CAI), can be a valuable supplementary aid used to improve student achievement. "The need for improvement of student achievement has been the focus of many plans in education for many years" (Patterson, 2005, p. 4). "Teachers are challenged daily by students who don't seem interested in learning" (Muir, 2000, p. 1). The need to improve all student achievement warranted the necessity to research and thus develop a possible method of improving student achievement through improving student motivation. "The more the student is motivated to learn, the more involvement there will be in the learning process" ("The Underachieving Student," 2002, para. 1). Motivating students through the use of computer technology is one strategy often utilized in education.

The use of computer technology to supplement traditional instruction is not a recent development. Computer-based teaching and learning produced positive effects in the classroom. Students seemed to be motivated by learning through this medium (Forcier, 1999). Educational technology had a large impact on student achievement ("The Underachieving Student," 2002). Traynor (2003) argued that CAI programs increase student learning by increasing motivation. Muir (2000) believed strongly in the push for change in educational learning through technology.

> If we are serious about educating every child we must venture to absorb every child in meaningful, engaged learning. Regardless of whether we want children

> to learn to be learners, or whether there are specific content and skills we value and want students to learn, we must use teaching strategies that more closely match how our students learn. (Muir, 2000, p. 10)

Students were disenchanted with the educational programs of today being provided around the world (Brooks-Young, 2010). Educators needed to rethink the way they taught based on the changes in technology that contributed to 21st century culture (Coates, 2007). Prensky (2010), American writer, speaker, and inventor of the term "Digital Native," believed that by teaching students in the manner in which they have grown up learning, students would be motivated to learn and thus an increase in student academic achievement would occur. The United States Government authorized the promotion of school reform in a purpose statement of the No Child Left Behind Act (NCLB) which read, "This purpose can be accomplished by . . . providing children an enriched and accelerated educational program, including the use of schoolwide programs or additional services that increase the amount and quality of instructional time" (United States Department of Education, 2010, p. 15). Traynor reported that many schools include CAI in their schoolwide programs to provide students opportunities to increase the quality of instruction. Boling, Martin, and Martin (2002) studied the effects of CAI on first-grade student vocabulary development and found that CAI was a motivating medium that enhanced good teaching. Boling et al. (2002) randomly divided 21 first-grade students at a mid-Atlantic elementary school into two groups. The control group used a book and tape to explore stories, while the experimental group used computerized storyboards. Both groups were given a pre and posttest in which the results provided a mean difference that demonstrated a larger gain for students in the experimental group (Boling et al., 2002). The researchers concluded that CAI had a positive influence on student interest, motivation, and learning.

Patterson (2005) established in his research that federal and state governments, along with educational institutions, are making efforts to introduce and integrate computers into schools. His study showed that “Classworks,” his CAI of study, increased student achievement in math and also positively impacted teacher attitudes about CAI. Patterson included 30 third-grade students and two teachers in his quasi-experimental study. He analyzed the mean scores of his 15-student control group versus his 15-student experimental group using a pretest and posttest. An independent *t* test was used to reveal that there was a statistically significant increase in student achievement for the experimental group in comparison to the control group. Patterson also surveyed the two teachers with a 3-question survey. The teachers were asked what they felt the advantages of using “Classworks” were, what they felt the disadvantages of using it were, and how they felt about the amount of time the CAI took in their instructional schedule over the 14-week research timeframe. Patterson noted that the teachers believed that the CAI was a good reinforcement tool, that it should only be used as a supplement to instruction, and that the time spent on “Classworks” was productive.

The increased efforts to integrate computers also amplified the efforts to use CAI to improve student achievement. The impact of CAI software, Programmed Logic for Automated Teaching Operations (P.L.A.T.O.), utilized in the classroom as a supplement to traditional instruction to improve the achievement of all students was determined. P.L.A.T.O. was considered the first CAI system ever developed, and the school district to be studied implemented its use throughout many of the schools and different classes. Teachers in the 21st century were more likely to teach students whose learning styles and preferences were a product of the technology that was available to them on a daily basis

(Coates, 2007). Through diligent research of P.L.A.T.O.'s impact on achievement and determined perceptions of P.L.A.T.O., student achievement and the CAI were evaluated.

Statement of the Problem

Students not achieving to their highest potential is a problem in most schools in America ("The Underachieving Student," 2002). What can teachers do to ensure that all children they taught achieved to their fullest potential and developed into successful learners? Many schools are integrating CAI into their curriculum in order to improve all student achievement (Patterson, 2005). More research is needed to validate the spending of funds toward implementing CAI as a possible way of increasing student achievement.

Review of the Literature

Research suggests that there is no conclusive answer to the impact of CAI on student achievement (Clark, 2001). Some studies showed improved learning and skill development, but others had no net gain (Clark, 2001). "There are more opportunities to study the effects of CBI on students because a greater proportion of students use computers in their classrooms" (Clark, 2001, p. 8). CAI was thought only to be successful in a supplementary role limited to mathematics and reading or language arts (Cherian, 2009). Various research studies on the subject of CAI were focused on the effects of CAI on math or reading (Boling et al., 2002; Brown, 2000; Clinkscales, 2002; Traynor, 2003). "It is not clear whether CAI can benefit students in other subjects" (Cherian, 2009, p. 24). Cherian (2009) recommended that states and school districts should implement and utilize technology to its fullest potential and CAI's impact on student achievement be researched.

Purpose of the Study

The purpose of this mixed-methods action-research study was to gain information about the use of CAI as a supplement to traditional instruction within a classroom to improve student achievement. The study examined the effect of CAI in comparison to the effect of traditional instruction of classroom teachers. By conducting the study, the impact of CAI on student achievement was evaluated. Student perceptions of the CAI software were also gathered and analyzed to determine overall perceptions of the CAI software at the one high school within the district of study.

Setting

There was a desire from the leaders in education from the district of study to utilize a CAI P.L.A.T.O. as a supplement to teaching in various departments or disciplines. Early within the 2012-2013 school year, the district provided professional development opportunities to many of the department leaders from the secondary education-level schools to educate them on the capabilities of the software and inform them of how to start using the district-funded technology software as a supplement within the classroom. The high school of study was an accredited public high school located in a small school district in a southeastern state. One of the school's core values was that all teachers and students must retool themselves through staff development and computer classes to meet the rapid change and use of technology in the classroom. The high school opened in fall 2006 and had been operating for 7 years as a relief school to the longstanding original high school. The school was located in a small but steadily growing town. The town had a population of nearly 35,000 people of which 47% were males and 53% were females. The median household income in the town was $60,665 versus $42, 442 for the state.

There were approximately 1,700 students enrolled in Grades 9 through 12 at the high school. The attendance rate during the 2013 school year was 96.7% with an annual dropout rate of 1.3%. A four-by-four block schedule was used for class instruction at all of the high schools within the district of study. The percentage of students eligible for a gifted and talented course was 31.7%, and 35.4% were enrolled in AP/IB programs. There were more than 200 courses that were offered based on the approved program of study or curriculum at the school. The majority of the courses offered were face-to-face, but a few core and elective courses were offered online.

The school district in the last 5 years performed well academically based on the district's rating. The district has attained a rating of excellent on the state report card for 5 years. The superintendent of the district stated that the rating was based on gains in student achievement. The last rating for the ESEA/Federal Accountability System further identifies the academic performance of the school district (see Appendix A).

The school's mission statement was to graduate students with the knowledge and skills to succeed in college and the workplace and to become lifelong learners who value and contribute positively to self, family, and community. The mayor of the town stated on the township website that the schools are among the best in the state and perform above national standards. In 2013, in the USNews.com website's rankings of the best schools in the state, the high school was ranked tenth academically of 223 high schools (Turbow, 2013). A core value listed for the school was that students learn in different ways and should be provided with a variety of instructional approaches to support their learning. In corresponding with Connie Crawley, Education Consultant, at the professional development on the instructional software P.L.A.T.O., provided by the school district of study, she noted that the software had not met with immediate use at the school.

P.L.A.T.O. was an answer to a pressing need for greater access to high-quality

> education. Initially funded by a number of grants that supported science and engineering education, including a National Science Foundation grant, P.L.A.T.O. became the first computer-assisted learning system. (White Paper, 2010, p. 3)

In the 1960s, P.L.A.T.O. addressed several key qualities that were still critical. The P.L.A.T.O. courseware development was committed to provide engaging graphics and animation, social learning technologies to support teacher/student interaction, rigorous curriculum and assessment components, and personalized learning strategies designed to increase motivation and achievement (White Paper, 2010, p. 3). In having these qualities, P.L.A.T.O. provided courses that engaged students and made learning relevant to their lives (Magidson, 1974). Magidson (1974) stated in his research that 13 of 14 students believed that P.L.A.T.O. was one of the most enjoyable educational experiences they have had (Magidson, 1974). The high school of study had been utilizing P.L.A.T.O. software in various ways to provide students with options to learning necessary curriculum in credit recovery and summer school programs for the last 2 years but not as a supplement within the classroom.

P.L.A.T.O. performed as an online learning platform that provided integrated data, assessment, reporting, curriculum, and course management features (White Paper, 2010). The courses fully used online learning technology. P.L.A.T.O. was technology-facilitated in the hopes of making learning easier and more valuable for students and teachers (White Paper, 2010). P.L.A.T.O. was an instructional approach to learning that could have been determined to affect achievement through experimental research on its use as a supplement to traditional teaching (Cherian, 2009).

Time for change or reform in education through changing strategies that were not satisfying all students was evident in the statistical data provided from the school of study’s Report Card. In 2013, 96% of the students at the high school were passing the necessary standardized test for graduation. The other 4% of students not passing the standardized test for graduation that measure math and English proficiency of high school students were at-risk students, Black, Hispanic, and disabled students. The test was used to measure student academic achievement on high school standards in accordance with the federal NCLB Act of 2001. The district of study believed strongly in improving student achievement of all students based on the district’s performance vision goal to have by 2020 all students graduating with the knowledge and skills necessary to compete successfully in the global economy. Patterson (2005) believed that in order to improve student achievement, schools were merging CAI into their curricula.

The school was considering merging P.L.A.T.O. into its curricula to insure the success of the 21st century learners being taught by instructors who currently are not utilizing P.L.A.T.O. in the classroom. Prensky (2010) stated that the traditional form of pedagogy, lecture, was not as effective with students today because they were changing as a result of their lives outside of the classroom which required an education that was more in line with the real world in which they live. Morgan (2006) stated that even though change seemed to be the right thing to do logically, people built dependency on that which had worked in the past and thus resisted innovation similar to incorporating CAI into traditional classrooms.

Research Questions

1. What was the impact of using P.L.A.T.O. CAI software in a high school introductory computer science course required for graduation, Integrated Business Applications (IBA), on student achievement on one of the four major unit tests for the course?

2. What were the students' perceptions of the CAI software P.L.A.T.O.?

Definitions of Major Concepts and Terms

Action research. Any systematic inquiry conducted by teachers, administrators, counselors, or others with a vested interest in the teaching and learning process or environment for the purpose of gathering information about how their particular schools operate, how they teach, and how their students learn (Mertler, 2006, p. 2).

Computer-aided instruction ("assisted" or CAI). Defined as the use of computers and software applications to teach concepts or skills.

P.L.A.T.O. (Programmed Logic for Automated Teaching Operations). The first computer-assisted learning system.

IBA (Integrated Business Applications). This course was designed to teach students software applications that are necessary to live and work in a technological society. The course is a state-mandated computer science unit required for graduation. The applications covered include word processing, database, spreadsheet, and presentation. Other content areas may include computer hardware, terminology, and concepts.

Organization of the Dissertation

Chapter 2 includes a literature review examining previous research that supported the need for this study. Specifically, the review of literature helped to answer questions about the impact of the supplemental CAI on student achievement with regard to student perception and achievement. In Chapter 2, the possible causes and contributors to the problem are described and the details of the study are utilized to examine the specific causes. A review of the related literature is presented in the areas of computer evolution, CAI, educational reform, generational learning styles, learning with technology, P.L.A.T.O., and the action research method. The review of literature concludes with the justification and rationale for this study. Chapter 3 describes in detail the methodology and methods utilized in this applied dissertation. Chapter 4 includes the results of statistics and open-ended survey questions as well as their analysis. Lastly, Chapter 5 analyzes and discusses the results, summarizes, and concludes the study with recommendations for future consideration.

Chapter 2: Review of the Related Literature

Introduction

"The education world has pursued new technology with an almost evangelical zeal and it is time to take a step back and give proper consideration to how we use it" (Moody & Bobic, 2011, p. 170). Research by Prensky (2010) established that digital technology was entering our classrooms at a rapid pace and could make our students' learning real, engaging, and useful for their future. Schools had been implementing, maintaining, and improving computer technology with the goal of increasing student achievement (Patterson, 2005). In efforts to improve all student achievement, Patterson (2005) recognized that more research was needed to validate implementing CAI as a possible method of improving student achievement.

The purpose of this study was to examine the impact of using CAI as a supplement to instruction. The use of computer technology to enhance traditional instruction was not a recent development. Computer-based teaching and learning produced positive effects in the classroom from the early days of implementation in the 1960s (Forcier, 1999). Students were motivated by learning utilizing computer-based teaching (Forcier, 1999). Research revealed that educational technology can have a positive impact on student achievement ("The Underachieving Student," 2002). The research of the impact of CAI on academic achievement as compared to the impact by traditional teaching methods was meager and, in some cases, not of good quality and, therefore, required more research on the topic (North Central Regional Laboratory, 2004). The results of the current study were used to analyze the achievement of students who used one form of CAI in particular, P.L.A.T.O., as the CAI of study. P.L.A.T.O. was one of the first CAI learning systems initiated at the University of Illinois in the early

1960s and developed by Control Data Corporation (White Paper, 2010). The software system was used for online learning to support educational attainment. The impact of CAI software on achievement was determined by the results of this study.

This literature review presented research about CAI. The beginnings of computers and their use were discussed to provide background for how education evolved with the introduction of the early computers in the classroom, the industrial age workforce, and now in the 21st century. The review also included research in the areas of CAI, educational reform, Generation Z, learning with technology, and a discussion about what the specific CAI of study, P.L.A.T.O., was, is, and may become for the ever-evolving technologically academic world. Information about computers and computer evolution helped to introduce CAI.

Computer Evolution

The 1940s marked the beginning of the modern computer with a punch card system which was large and slow. International Business Machines Corporations, IBM, initially developed one of the first computer systems in the 1960s that utilized minicomputers (Arnold, 2000). The use of computers in education began during the 1960s as the military and several universities created computers and computer systems to share information ("Computer-Assisted Instruction," 2013). Pennsylvania State University and the University of Alberta provided the early beginnings of CAI. P.L.A.T.O. began in the 1960s as one of the first CAI systems designed to offer various coursework (White Paper, 2010). It consisted of a mainframe computer that supported up to 1,000 terminals for individual students. P.L.A.T.O. was an online learning program that provided a wide range of courses designed to improve student achievement with engaging interactive content. It consisted of integrated assessments that included pretests that allow for omission of content already mastered and tests for assertion of concept mastery. By 1985, hundreds of P.L.A.T.O. systems were operating in the United States. One purpose for computers in classrooms was to provide students different methods to problem solve. Figure 1 exhibits the comprehensive look at computer evolution.

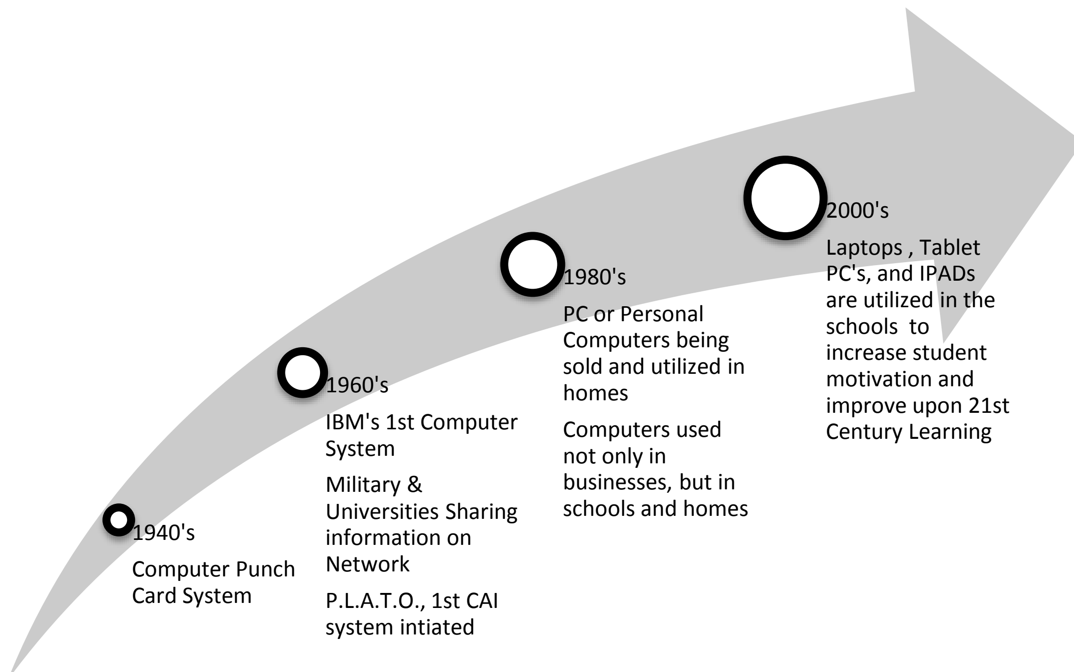

Figure 1. Evolution of the Computer. Illustration of a synthesis of the computer's evolution (White Paper, 2010).

“Instructional computers are basically used in one of two ways: either they provide a straightforward presentation of data or they fill a tutorial role in which the student is tested on comprehension” (“Computer-Assisted Instruction,” 2013, para. 2). With the radical change of computers, the change in the process of CAI or exploratory software programs that allow students opportunities to engage in problem-solving investigations that develop logical reasoning has developed (Clinkscales, 2002). The type of technology and educational tools developed to impact achievement are elaborated in the detailed discussion of CAI.

CAI

CAI was defined as the use of computers in education to teach and learn while providing instruction or remediation to test comprehension ("Computer-Aided Instruction," n.d.; "What is computer-assisted instruction," n.d.).

> The educational uses of computers that are considered to be computer-assisted instruction (CAI) or computer-based instruction (CBI) are those cases in which either instruction is presented through a computer program to a passive student, or the computer is the platform for an interactive and personalized learning environment. ("Computer-Assisted Instruction," 2013, para. 1)

CAI is offered in many main school subjects taught from preschool to professional school ("What is computer-assisted instruction," n.d.). An example of the uses of CAI was discussed in the study by SERİN (2011) on the effects of the computer-based instruction implemented with fourth-year primary school students. His study aimed to investigate the effects of CAI on the achievements and problem-solving skills of science and technology students. The study consisted of 52 students; 26 in a control group and 26 in an experimental group receiving the implementation of CAI. The experimental group received the CAI 3 hours a week during the 3-week research time period. After the 3 weeks of instruction, both groups were given an achievement test and a problem-solving inventory from which to collect data. A covariance analysis test was used to evaluate the efficacy of the process (SERİN, 2011). "Great emphasis is placed on the computer-based science and technology laboratories as well as ordinary science laboratories in the educational curricula of the developed countries" (SERİN, 2011, p. 1). The results of the study reveal that there was significant increase in the achievement of students who received CAI compared with those who did not.

Another example of where CAI was utilized in various major subject areas was in the study by Clinkscales (2002) that examined the effectiveness of CAI on mathematics. Test scores were used from two classes of Algebra I students in a high school in North Carolina. The study encompassed a control group that received traditional classroom instruction and an experimental group that received instruction from an online learning system called NovaNET. The participants included one class of 24 in the control group and one class of 25 in the experimental group. Both groups of math students were taught the unit of study for 2 weeks in 90-minute sessions. Clinkscales's study used a pretest and posttest for comparative purposes. The pretests given proved the assumption of normality because the data in the normal probability plot appeared straight in both normal probability plots and there were no outliers in both box plots. He used a 2-sample *t* test that produced a *t* statistic of -1.048 and a p value of 0.300 and thus failed to reject the null hypothesis which meant the means for the two groups for the pretest were not different. He conducted the same data analysis for the posttest utilizing the normal probability plots, box plots, and 2-sample *t* test. The *t* test provided a *t* statistic of 1.766 and p value of 0.082 and thus failed to reject the null hypothesis which meant the means for the two groups for the posttest were not different.

> Overall, the results suggest that there is no significant difference between the two methods of teaching. Both methods have positive features that bring the best out of instruction. It is recommended that continued research be done on computer-assisted instruction and comparing its methods with that of traditional instruction. (Clinkscales, 2002, p. 2)

The recommendation for continued research by Clinkscales was based on his conclusion that both methods of instruction had advantages beneficial to students, but more detailed research and analysis must be made to affirm whether CAI impacts student achievement. Based on the recommendation by Clinkscales, more research and analysis on CAI's impact on student achievement in other classes differing from the norm, math and English, was required. The current study on P.L.A.T.O. and its impact in a business education course differed from the consensus norm and helped to provide more detailed research. Along with being used in various subject areas, CAI was also used to teach students in different career areas.

Many different career areas use CAI to teach and train. One study by Lowe (2004) on effective CAI for adults investigated the need for using computers as a means of instructional delivery based on the growth of adult students in the workforce. In her findings, Lowe stated that there were some advantages for using the computer as a method of instructional delivery. She believed that the computer provided various advantages to learning that were not provided from traditional instruction. Some of these advantages were that computers provided consistency of content delivery; delivered training to remote locations; offered learning flexibility in controlling and pacing learning; provided opportunities for practice through simulation; and afforded greater retention (Lowe, 2004). When concluding her study, Lowe asked, "When you look at all the advantages of computer-based instruction, the question is why aren't more companies using this as their major delivery method?" (p. 3). CAI was also being used to assist today's workforce at higher learning institutions.

The Center for Computer-Assisted Legal Instruction provided law students from across the United States with access to CAI law school lessons to supplement their instruction for certain job duties. CAI has been used to teach many different employment areas. Nurses, jet engine mechanics, food service workers, and various other workers use

CAI in order to learn how to perform job functions (What is computer-assisted instruction, 2013). Even with all the different career areas that used CAI, there was a need to provide CAI for a field that covered much of the content used by the workforce, business. By conducting the study, CAI's impact on students in a business education class was influential to the many fields that business education fed into. Along with assisting today's workforce, CAI was also used to help students with different learning abilities and styles.

CAI was utilized to personalize learning for many students with physical and language limitations and who are learning disabled. Autism spectrum disorders (ASD) are developmental disabilities that researchers have suggested CAI may be used to offer reinforcement. Pennington (2010), an assistant professor of special education at the University of Louisville, believed that individuals with ASD might benefit from experience with CAI. Other researchers studied also believed that individuals with ASD had been shown to display fewer inappropriate behaviors during CAI than during traditional instruction (Pennington, 2010). Researchers like Pennington have provided data suggesting CAI had good potential for improving the lives of individuals with disabilities. "Supplementary instruction provided through tools such as CAI was seen as a feasible option to improve the performance of disadvantaged students" (Cherian, 2009, p. 5). In order to understand the full CAI potential, a much clearer breakdown of the definition of CAI was provided.

CAI was instructional software used sometimes to strictly present data or as tutorial programs. The software programs set-up as tutorial programs were defined clearly by a procedure. The procedure was as follows:

1. The student was asked a question by the computer.

2. The student typed an answer and received an immediate response to the answer.

3. If the answer was correct, the student was routed to more challenging problems.

4. If the answer was incorrect, the student was presented with alternative questions of a similar level of mastery for completion until mastery was obtained ("Computer-Assisted Instruction," 2013).

Math Blaster was a good example of the type of instructional software that allowed for skills to be reviewed and practiced or more time can be spent learning and understanding new concepts for those more skilled in basic mathematics. Clinkscales (2002) referenced Math Blaster in his research. Math Blaster was an arcade-style game that allowed the user to progress and ultimately win the game by answering questions dealing with math. The questions that were used in the game generally related number sense. Clinkscales established his belief that students who have better developed skills in the four basic operations of mathematics gained a better understanding of future mathematics topics. By students building a better understanding of the basics using CAI such as Math Blaster, they were able to proceed through new material with better understanding than those whose skills were not as developed (Clinkscales, 2002).

Another instructional software tool used today that was set up similar to the tutorial program procedure listed previously was NovaNET. "The NovaNET system is a computer-based, online learning system linking educators with progressive technology and proven teaching methods" (Clinkscales, 2002, p. 12). Educators used NovaNET to assist with teaching. NovaNET first tested the students with a placement test that allowed the CAI to create computer-based lessons, tutorials. Each student then proceeded at his/her own pace completing the tutorials and the various assessments that followed each tutorial. Students did have the option of completing specific units that covered a specific area needing improvement rather than only completing the tutorials. The advances in technology and software led to the conversion of courses from face-to-face instruction into web-based courses in order to teach the growing nontraditional students of today (Lowe, 2004).

A Call to Educational Reform

Brooks-Young (2010) further elaborated Dewey's idea of not robbing today's students of tomorrow with her discussion on teaching today's students with the tools that they were actually using and may use in the workplace. Brooks-Young stated in her study,

> Students who live in industrialized nations around the world are increasingly disenchanted with the education programs being provided. They view educators who use traditional teaching methods as being out-of-touch. They rankle at completing the same projects and assignments their parents and even grandparents did when they attended school. (p. 1)

Schools had for the most part been effective and efficient at preparing and educating students for the industrial era. In the new era of information and technology, educators needed to totally rethink the way they taught (Coates, 2007).

"As a society evolves in response to the changes in demographics, technology, and political forces that contribute to the development of 21st century culture, how we learn and what we need to learn will change as well" (Coates, 2007, p. 17). Learning began to be about a student-centered reform which differed from the teacher-centered paradigm. "Since the turn of the century, the challenges of globalization, information technology, international competition, and strong local developments have stimulated a new wave of educational reforms" (Cheng & Mok, 2008, p. 374). Over time in education, there has been a gradual shift from the traditional, teacher-centered instruction that came out of Bloom's Taxonomy to a more student-centered model of instruction. A paradigm shift occurred where learning began to be about the students and their mindset (Silva, Sabino, Adina, Lanuza, & Baluyot, 2011). Armstrong (2012), author and forecasting and marketing expert, believed that traditional education ignores or suppresses learner responsibility. Ignoring and suppressing learning responsibility was not the intent of traditional education when structured around concepts of the original Bloom's Taxonomy, but refinement for the future was necessary.

Bloom's Taxonomy for learning was refined over the decades. An adaptation of Bloom's work that reflected taxonomy more closely related to today's 21st century learning was developed and published by cognitive psychologist Dr. Lorin Anderson and educational psychologist Dr. David R. Krathwohl. Krathwohl's (2002) study stated,

> The original Taxonomy provided carefully developed definitions for each of the six major categories in the cognitive domain. The categories were Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation . . . . In the original Taxonomy, the Knowledge category embodied both noun and verb aspects . . . . This anomaly was eliminated in the revised Taxonomy by allowing these two aspects, the noun and verb, to form separate dimensions, the noun providing the basis for the Knowledge dimension and the verb forming the basis for the Cognitive Process dimension. (p. 1)

The Anderson-Krathwohl revision labeled the levels of Bloom's Taxonomy with verbs instead of nouns, changed Synthesis to Creating, and moved Creating up to the highest level (White Paper, 2010). In creating a more student-centered learning tool, CAI addressed the new terms that evolved from Bloom's Taxonomy (see Appendix B) which depicted the comparisons and contrasts of the six levels of learning. Theorists' works like Dewey, Piaget, Rogers, and Montessori led education to the move to student-centered learning. The student-centered paradigm shift occurred when learning was tailored to meet the needs of the individual student and where the focus of learning became how to learn, create, think, and develop as termed by Cheng and Mok (2008). Student-centered environments were ones in which students constructed their own personal meaning by taking what they learned and related it to what they already knew (Hannafin & Land, 1997). The students were the learners of the new generation called Generation Z which differed greatly from its predecessors.

Generation Z

Generations were defined as a group of individuals, most of whom were the same approximate age, having similar ideas, problems, attitudes, roughly differing from the next generation by 30 to 35 years of age. Ivanova and Smrikarov (2009) defined them as cohorts of people who were born in a certain date range and share a general cultural experience of the world. These cultural experiences were what defined Generation Z as people who were influenced by technologies such as the Internet, smart phones, and social networking sites. Their immediate predecessors included Generation X, individuals born between the mid-1960s and 1980 and Generation Y, individuals born between the mid-1980s and early 2000. Generation X was defined as those who were influenced by technologies such as cable television and video games ("Consumers of Tomorrow", 2011). Generation Y was defined as those who were influenced by technologies such as the Internet, email, and text messaging ("Consumers of Tomorrow," 2011). Having followed these two generations, the learners of Generation Z included students just entering high school born between 1996 and 2010. They were described as being technologically savvy, able to adapt to technology faster, more technology focused, and connected to the world via technology ("Consumers of Tomorrow," 2011).

Generation Z's unique makeup called for a reform in education that strongly addressed their specific learning styles. The students must have been constantly stimulated by technology, and if they were not, they became uninterested in the traditional grandfathered education (Jones, Jo, & Martin, 2007). "Deeply embedded in the culture of schooling is the notion that students should read, listen to, and absorb a large body of facts, concepts, procedures, theories, beliefs, and works of art and science that have accumulated over the centuries" (Collins & Halverson, 2009, p. 47). In many of the classrooms of today, students were taught as a whole class with the major focus being on the longstanding principles of learning being rooted in reading, writing, and arithmetic (Jones et al., 2007). The traditional methods of teaching emphasized direct in-class instruction that was categorized as teacher-centered (Brown, 2003). There were five main styles of teaching used in the classroom: expert, formal authority, personal model, facilitator, and delegator (Grasha, 1994). The Collins and Halverston (2009) study stated, "In the typical school, the teacher is an expert whose job is to transmit that expertise to students through lecture, recitation, drill, and practice" (p. 32). Twenty-first century learners did learn through traditional methods of teaching but to increase the achievement of all learners, technology had to play a role.

Prensky (2001) stated,

> Our students have changed radically. Today's students are no longer the people our educational system was designed to teach. Today's students - K through

> college – represent the first generations to grow up with this new technology. It is now clear that as a result of this ubiquitous environment and the sheer volume of their interaction with it, today's students think and process information fundamentally differently from their predecessors. (p. 1)

Prensky elaborated that today's students wanted to create using technology tools, work collaboratively with their peers, share class control, participate in decision making, and necessitate a relevant education. He believed that by teaching students in the manner in which they have grown up learning, students would be more inclined or motivated to learn and thus an increase in achievement would occur. CAI had been identified as a motivating resource and thus the current study on CAI was conducted to determine the impact of CAI on achievement with its implementation into subjects beyond the core. Prensky said, "My own preference for teaching Digital Natives is to invent computer games to do the job even for the most serious content. After all, it's an idiom with which most of them are totally familiar" (p. 4).

Bowen (2006) further added to the discussion about Generation Z with his belief that technology was the most powerful way to increase teaching and learning in the classroom. Bowen said, "Technology can give students more and better interaction with course content" (p. 1). By using new technology, student engagement outside of the classroom could have increased and allowed for more time in class for human interaction (Bowen, 2006). He said, "The best gift of new technologies is the ability to leave the tyranny of content online and focus class time on student learning" (Bowen, 2006, p. 4). With the use of computers in education came a change over time in the actual process of using computers in education.

Learning with Technology

SERİN (2011) stated that education evolved from learning *about* computers to learning *with* computers and to finally learning *through* computers.

1. Learning about computers involves the knowledge of computers at various levels such as knowing the uses of the computer and the names of the various parts, knowing how to use the keyboard and computer packages and so on (Owusu et al., 2010). According to Tabassum (2004), the knowledge of computers may be thought of as a continuum which ranges from skills in and awareness of computers at lower level to programming at higher level.
2. Learning with computers, students use computers as a tool in data acquisition, analysis, communication with other people, information retrieval and myriad other ways (Owusu et al., 2010). Learners use computers to get information and do their homework.
3. The term "learning through computers" involves the use of computer as an aid for the teacher to do his/her presentations, and/or to get the learners to practice and drill. Computers are used to enhance interactive activities, to provide immediate feedback, to facilitate the retention and to enable the learners at diverse levels to work at own their pace. (SERİN, 2011, p. 3)

Some researchers of computer technology believed that a great deal of research on computers and other technologies showed that they were no more effective at teaching students than teachers (Crismond, Howland, Jonassen, & Marra, 2010). Cherian (2009) argued that CAI was educationally effective but only successful in a supplementary role in core curriculum courses. The current mixed-methods action research study was needed to evaluate the statement that CAI was only successful in the core curriculum courses, because little to no research on CAI's impact had been done on noncore courses. Proof does exist that CAI used as a supplement was educationally effective in the core courses; but in studying CAI's impact in the current study, the lack of research in this area was addressed. The experts on the topic of meaningful learning with technology believed that technologies must be thought of as learning tools that students learned with and not from (Crismond et al., 2010). They advised, "If schools are to foster meaningful learning, then the ways that we use technologies in schools must change from technology-as-teacher to technology-as-partner in the learning process" (Crismond et al., 2010, p. 2). In order for students to learn with technology, technology had to fall under a particular set of assumptions (see Appendix C). Researchers of the previously mentioned technology assumptions believed strongly in providing learners with the technology that represented the world and challenged the students constructively. CAI had been often described as that particular type of technology that challenged while improving student learning based on each student's individual progress and level of comprehension. Schacter's (1999) review of four large-scale studies and 13 meta-analyses stated that "Computer Based Instruction (CBI), the most widely implemented and studied computer technology, moderately improves student learning" (Schacter, 1999, p. 330). CBI was just a broad term that referred to any kind of computer use in education such as CAI. McCombs (2000) had research that established that educational technology had been used to varying degrees in our nation's schools and that numerous studies existed demonstrating that educational technology when appropriately applied can enhance learning and achievement compared to traditional teaching methods. She believed that the benefits of educational technology cannot be adequately separated from other variables that impacted learning in the larger instructional context.

Some research indicated that the effect of computer technologies on student achievement was positive and negative. Kmitta and Davis (2004) stated, "In other words, computer technologies, in and of themselves, are not a panacea for improving student academic performance. Computer technologies have both positive and some negative correlations with student achievement" (p. 327). The research conducted by Kmitta and Davis was used to analyze the impact of educational technology. The study used recent literature reviews, studies, and survey research to synthesize the data in order to analyze the effect computers have in education. The study resulted in demonstrating that computers had an overall positive effect on student achievement and the school environment. The correlations between computer technologies and student achievement varied within the study from low to moderate with sizes ranging from .10 to .40.

Brown (2000) conducted a study of the effect of CAI on student achievement. Brown conducted a scientific study of the effect of CAI on mathematics achievement. The study was conducted in a large urban school district. Approximately 50% of the students in the school system were White, 42% of the students were Black, and 8% were other racial and ethnic groups. The study divided the students into two groups, an experimental group that used the CAI program and a control group of students who did not use the CAI.

The program was evaluated by comparing students' mathematic achievement scores on the State of North Carolina's required end-of-grade or end-of-course test. The study was conducted over a 2-year period between 1997 and 1999. The software was utilized before school began in the mornings. The majority of the CAI use occurred before the school day began when students were allowed access to the lab as soon as they arrived to school. The CAI program used was called FUNdamentallyMATH.

FUNdamentallyMATH received high performance reviews from evaluators in journals published by the National Council of Teachers of Mathematics (NCTM). Pretest and posttest scores on the state end-of-grade tests for the students were collected by the researcher.

Table 1 is a summary of the results from the eighth-grade FUNdamentallyMATH Algebra Study in terms of percentiles. The test group used the software. The control group did not. Confidence level meant the probability that the results were due to the software and not due to chance.

Table 1

1998 Eighth-Grade Algebra Study Results

All Students	No. Students	Percentile	
Test	54	62.28	Valid at the 99.5% confidence level.
Control	47	45.11	
African-American Students Only			
Test	16	64.19	Valid at the 98.4% confidence level.
Control	15	39.27	
Analysis of Test Group & Control Group by Ethnicity			
Test Group			
African-American	16	64.19	
White	31	61.19	
Control Group			
African-American	15	39.27	
White	29	47.87	
Female Students Only			
Test	32	58.97	Valid at the 95.9% confidence level
Control	25	41.04	
Females vs. Males			
Females – Test Group	32	58.97	
Males – Test Group	22	67.09	
Males – Conrol Group	22	49.68	

Note. Adapted from 1998 Eighth-Grade Algebra Study Results (www.fundamentallymath.com).

The results of the study revealed that students in the group who utilized the CAI scored higher than those students in the control group.

Another study done by Traynor (2003) compared the impact of CAI on different types of learners. The purpose of the study was to determine how CAI improved student performance among various types of students. The participants included 161 of 210 middle school students from different program types: regular education, special education, limited English proficient, and non-English proficient students. These students were placed in the computer-assisted instruction elective class that used CornerStone software. They completed a pretest for a capitalization subject area within the language arts course. After approximately 70 days of instruction utilizing the CornerStone to complete the capitalization subject area, the students were administered a posttest. A comparison of the pretest and posttest scores for all students was conducted and a comparison of different program types' pretest and posttest scores was done. A dependent *t* test was used in comparing all the students' pretest and posttest scores. In addition, an ANCOVA test was used to compare the gains among the different program types. The research concluded that by using CAI, there was improved student achievement. An experimental and control group was utilized to show the significant gains in pretest and posttest scores for those students of the experimental group provided the CAI in supplement to their traditional methods of learning. Similar to the study by Traynor, the study to be conducted used CAI P.L.A.T.O. as a supplement.

P.L.A.T.O.

Edmentum, formerly P.L.A.T.O., originated at the University of Illinois in the early 1960s (White Paper, 2010). Programmed Logic for Automated Teaching Operations forms the acronym P.L.A.T.O. There was a need then for greater access to high-quality education and P.L.A.T.O. became the first computer-assisted learning system. In the 1960s, P.L.A.T.O. addressed critical attributes of educators. Those attributes were that it provided engaging graphics and animation; social learning technologies to support teacher/student interaction; rigorous curriculum and assessment components; and personalized learning strategies designed to increase motivation and achievement. Today, P.L.A.T.O. provides rigorous web-based course offerings for education.

P.L.A.T.O. acted as an online learning platform that provided integrated data, assessment, reporting, curriculum, and course management features. The online platform had been expanded to provide course offerings in mathematics, science, social studies, and English. P.L.A.T.O. continued to develop online learning technologies that included reporting and data features, course management options with more personalized learning options, and student/teacher communications.

P.L.A.T.O. consisted of a courseware product, or educational software designed especially for classroom use as tutorials for students who provided full curriculum coverage that addressed at least 90 of the standards for each of the national standard sets for core courses and special courses. The courses fully used online learning technology. P.L.A.T.O. was not document-based but technology-facilitated in the hopes of making learning easier and more valuable for students and teachers (White Paper, 2010). Document-based applications were those that were primarily concerned with content documents. Technology-facilitated applications were those that consisted of the designs and environments that engaged learners. Crismond et al. (2010) believed that if technologies were used to nurture meaningful learning, they would not be used as delivery vehicles but as engagers and facilitators of thinking.

The courses within P.L.A.T.O. were designed to engage students and make learning relevant to their lives. Students were given the ability to learn independently in a self-paced way with no dependence on other students working simultaneously. The study on the impact of CAI P.L.A.T.O. on student achievement allowed teachers to create the desired student-centered learning environment. "For class-based learning, P.L.A.T.O. courseware provides teachers with resources (such as online discussions or blended classroom suggestions) to enhance the basic course interaction and learning" (White Paper, 2010, p. 4). Edmentum provided guidelines for using the courses for face-to-face and virtual modes. The learning was student-centered with guidance from the teacher, because the courseware enabled students to learn self-sufficiently. "There is no dependence on other students working simultaneously at the same customer site" (White Paper, 2010, p. 4). The courseware put the students' needs first and focused on each individual student's needs, abilities, interests, and learning style while placing the teacher in the role of facilitator of learning. The software allowed for the students to be active and responsible participants in their own learning,

P.L.A.T.O. supported personalized learning while allowing teachers to target learning options to specific students as a technology-based support for instruction. Pryor and Soloway (2000) stated, "It is only through the use of technology that education will progress into the needs of the twenty-first century workplace (p. 5). Student-centered classes were determined by what technology used, classroom control, and how students interacted with the technology (McPheeters, 2009). As an instructional technology, P.L.A.T.O. changed the traditional role of the teacher from that of lecturer to that of facilitator, creating a more student-centered learning environment tapping into 21st century learning.

P.L.A.T.O. used rigorous state and national standards which included the standards from NCTM, the National Council of Teachers of English (NCTE), and the Thomas B. Fordham Foundation index. With the adoption of the K-12 Common Core State Standards, states implemented new revised standards. Edmentum worked in a correlation process to plan the P.L.A.T.O. courseware to match and fit the standards. P.L.A.T.O. aligned readily with the reform acts engaged in by school districts and aligned the courseware accordingly.

P.L.A.T.O. Courseware

The P.L.A.T.O. courseware used a mastery-based model to set up the content for the courses and curriculum. The developers of the system began with the curriculum structure centered on learning objectives. Each learning module was focused on a single objective. The module was made up of an introduction to new material, a practice or application of new knowledge, and a demonstration of mastery of the objective. After completing a module, progression to the next module was attained. The actual breakdown for the P.L.A.T.O. courseware is depicted in Appendix D. The figure was a diagram that illustrated the overall makeup of the curriculum model based on the structure of P.L.A.T.O. The structure was made into units of material containing pretests, posttests, and end-of-semester tests for confirmation of mastery for broader levels of content.

A course, unit, and module structure was designed to group learning objectives into meaningful subsequences based on curriculum topics or themes (White Paper, 2010). The unit structure consisted of unit pretests, learning modules, unit activities, and unit posttests. The module structure consisted of tutorials, lesson activities, offline activities, application activities, and mastery tests. “Each online course within P.L.A.T.O. courseware’s offering includes multiple assessments designed to continuously check understanding, measure mastery, ensure knowledge retention, and predict preparedness for course exams" (White Paper, 2010, p. 8). The assessments included mastery tests, unit pretests, unit posttests, and end-of-semester tests. The mastery tests measured student's mastery of lesson objective and preparedness to move forward to the next learning objective. Unit pretests measured prior knowledge of unit objectives before students began lessons to allow students the ability to test out of lesson based on their demonstration of mastery. Unit posttests measured the students' understanding of the knowledge in each unit. The end-of-semester test measured mastery and retention of instruction from every lesson and unit for the semester.

Summary

Students were not achieving to their highest potential in school. Today's students had different learning styles that required a change in the approach to teaching and learning. Research by Bellanca and Brandt (2010) established that U.S. schools and students had not adjusted to the ever-changing world. The culminated research review lead one to question what the impact of using P.L.A.T.O. CAI software would be on student achievement and what would students' perceptions of P.L.A.T.O. be. In Chapter 3, the methodology of the quasi-experimental study is presented. The methodology consists of a discussion of the participants and their demographic information, the instruments used, and the procedures used in order to facilitate the study.

Chapter 3: Methodology

Introduction

The purpose of this mixed-methods action research study was to compare the impact of two types of instructional delivery, the traditional model of delivery and the traditional model of delivery supplemented with CAI on student achievement in two IBA classes as measured by statistical significance of scores on pre and postunit tests for one of the four major unit tests for the course. Also, student perceptions about the CAI supplement were gathered and analyzed to determine the level of improvement the students believed the supplement provided them and how motivated to learn it made them.

The research questions that were answered in this study were

1. What was the impact of using P.L.A.T.O. CAI software in a high school introductory computer science course required for graduation, IBA, on student achievement as measured by one of the four major unit tests for the course?
2. What were the students' perceptions of the CAI software P.L.A.T.O. as measured by the Plato Student Evaluation survey?

Participants

The population studied was from an accredited public high school located in a small school district in a southeastern state within the United States. There were approximately 1,700 students enrolled in Grades 9 through 12 at the high school. The racial/ethnic makeup of the school was approximately 78.6% White, 11% Black, 6% Hispanic, 2.4% Asian, and 2% other. There was a 17:1 student to teacher ratio, and 23% of the students received free or reduced lunches. Additionally, the students had use of the classroom computer lab, eight other computer labs, one or more computers in each classroom, the media center computer lab, the mobile chrome book lab, and the mobile iPad lab for checkout by faculty.

The participants in this study included ninth- through twelfth-grade students at a southeastern U.S. high school within the selected school district of study. The subjects were 53 students from two separate classes, one class of 28 students and one class of 25 students in the experimental class. There were males and females involved in this study. The ethnic backgrounds within the classes mirrored the demographics of the school. Within the experimental class, there were 14 White students, five Black students, and six other racially denominated students. Twelve were male and 13 were female. Students were from various socioeconomic statuses and had exposure to educational experiences outside of school based on each individual's socioeconomic situation. Classrooms were assigned to either the control or experimental group randomly once the master schedule for the school was complete in the summer. Twenty-eight students were assigned to the control group and 25 students were assigned to the experimental group.

The participants in the classrooms were selected prior to the beginning of the school year in August based on the master schedule provided by the leadership team at the school comprised of the Administrative and Guidance departments. All students were placed based on their need for the IBA class and the class's fit for their schedule. All students participated in the pre and postunit test statistical analysis. The classroom of students who were assigned to the experimental group also, with parent consent, participated in a survey process at the end of the mixed-methods action research study to gauge the students' perceptions of the supplemented CAI's impact on achievement.

In both classrooms, the students received lessons on the subject within the PowerPoint unit via lecture, were provided guided instruction examples, completed reinforcement practice activities similar to the instruction examples, and finally completed assessment projects. The difference in the control class and the experimental class was that the experimental class had the additional use of the CAI software P.L.A.T.O. within the class via the internet to supplement the lessons while the controlled class was provided supplemental traditional instruction.

P.L.A.T.O.

P.L.A.T.O. consisted of educational software or courseware designed especially for classroom use as tutorials for students who covered a subject's full curriculum based on state and national standards. The courseware used online learning technology. The P.L.A.T.O. courseware used a mastery-based model to set up the content for the courses and curriculum for the IBA unit of study used. The curriculum was divided into individual modules made up of an introduction to new material, a practice or application of new knowledge, and a demonstration of mastery of the objective. After completing a module, progression to the next module was achieved. Modules were structured with tutorials that provided a variety of interactive practice activities, judged activities, embedded videos, and links to valuable educational resources; lesson activities that were focused on lesson objectives; application activities that were focused on application to new situations and real-world problems; and mastery tests that concluded each module.

Procedures

The participants in the present study were selected prior to the beginning of the school year in August based on the master schedule. All students were placed based on their need for the IBA class and their total required credits necessary from each class type for the year. The students were placed in one of either of the two classes. One class comprised the control group, which received the traditional IBA instruction of one of the four units of study, PowerPoint, and for a 20-minute time period during instruction were provided supplemental traditional instruction on the unit of study. The other class, the experimental group, received the traditional IBA instruction along with the addition of P.L.A.T.O. for 1 hour to an hour and 40 minutes per week in replacement of the 20-minute supplemental traditional instruction provided each day, 5 days a week. Both groups were administered a preunit test prior to beginning the PowerPoint unit of study.

The study was conducted in a particular order. The classes both were administered the preunit test for later research testing and analysis. The students in both classes were taught traditional instruction with the control group receiving supplemental traditional instruction and the experimental group receiving supplemental CAI. The classes both were administered the postunit test for later research testing and analysis. In addition, the experimental group completed a P.L.A.T.O. student survey used for later testing and analysis. After all data were collected, the test data were used to provide results that tested for significant differences using *t* tests, and the survey data were used to provide results that tested for significant differences using chi-squared tests and results that found out how the students felt about the CAI and why. The results were analyzed to summarize and conclude the study.

This mixed-methods experimental action research study employed quantitative and qualitative methodologies. Johnson and Christensen (2008) stated that the mixed approach helped improve the quality of research because of the different strengths and different weaknesses that were identified by the different approaches (Johnson & Christensen, 2008). By having a mixed-method study, it was less likely to miss something or make a mistake (Johnson & Christensen, 2008). Quantitative experimental research was used to determine cause-and-effect relationships while qualitative research was used to document things like shared attitudes and perspectives (Johnson & Christensen, 2008). Other experts on research believed that the combination of quantitative and qualitative methodologies provided a better overall look at student achievement (Bell, Schrum, & Thompson, 2008).

After 4 weeks to properly teach the state-required PowerPoint unit of study, all participants took the postunit test which was a retest of the preunit test given prior to beginning the PowerPoint unit of study. The first research question, "What was the impact of using P.L.A.T.O. CAI software in a high school introductory computer science course required for graduation, IBA, on student achievement on one of the four major unit tests for the course," was answered quantitatively with the comparison of the preunit test grades provided for both groups, the control and the experimental groups, measured to the postunit test grades for both groups. The pre and postunit tests were analyzed using independent *t* tests with the assumption of equal variances. The assessment of normality was determined graphically by an analysis of normal probability plots for both groups for both pre and postunit tests. The *t* test used on the preunit test data for both classes determined any difference in prior knowledge existing between the experimental and control groups with the use of an alpha level setting of 0.05. Two variables, the dependent (grades) and the independent (groups) variables were used in the comparison. Also an independent *t* test analysis of the postunit test was used to analyze the differences in statistical significance levels between both groups with the use of an alpha level setting of 0.05. Analysis of the data required a calculation of the standardized mean difference scores to determine the impact on student achievement, positive or negative.

All participants within the experimental group took the student survey that was used to gauge student perceptions about P.L.A.T.O. The second research question, "What were the students' perceptions of the CAI software P.L.A.T.O.," was answered quantitatively and qualitatively by the survey completed by those participants from the experimental group. The Likert question data were tallied and presented in graphical or numeric figures or tables and the data were tested. The data were tested for each question utilizing a chi-square test to analyze the significant differences in the number of people agreeing or disagreeing about feelings based on the different race demographics for the group—White, Black, and other—to determine whether a significant difference in feelings existed between the different race demographics. The open-ended data were represented also in narrative form to determine how students perceived P.L.A.T.O. and why.

Instruments

Two types of instruments were used to gather and analyze data in the present study. The first instrument used was the pre and postunit tests. The researcher used existing course pre and postunit tests that were created and validated by GMetrix, which provided educational tools designed to prepare individuals with the current and relevant skills and credentials for the effective use of technology in the business environment based on the global standards for MOS certification. The pre and postunit tests procedure consisted of a test/retest format as these tests were the same. These tests were in application or performance-based simulations to assess problem solving similar to real-world experiences. The tests mapped to the MOS certification objectives similar to those listed below in Figure 2.

1. Managing the PowerPoint environment 1.1. Adjust views 1.2. Manipulate the PowerPoint window 1.3. Configure the Quick Access Toolbar (QAT) 1.4. Configure PowerPoint file options	**5. Applying transitions and animations** 5.1. Apply built-in and custom animations 5.2. Apply effect and path options 5.3. Manipulate an animation 5.4. Apply and modify transitions between slides
2. Creating a Slide Presentation 2.1. Construct and edit a photo album 2.2. Apply slide size and orientation settings 2.3. Add and remove slides 2.4. Format slides 2.5. Enter and format text 2.6. Format a text box	**6. Collaborating on a presentation** 6.1. Manage comments in a presentation 6.2. Apply proofing tools
3. Working with graphical and multimedia elements 3.1. Manipulate graphical elements. 3.2. Manipulate images. 3.3. Modify WordArt and shapes. 3.4. Manipulate SmartArt. 3.5. Edit video and audio content.	**7. Preparing a presentation for delivery** 7.1. Save a presentation 7.2. Share a presentation 7.3. Print a presentation 7.4. Protect a presentation
4. Creating charts and tables 4.1. Construct and modify a table 4.2. Insert and modify a chart 4.3. Apply chart elements 4.4. Manipulate chart layouts 4.5. Manipulate chart elements	**8. Delivering a presentation** 8.1. Apply presentation tools 8.2. Set up a slide show 8.3. Set presentation timing 8.4. Record a presentation

Figure 2. PowerPoint 2010 Objectives (Certiport Portal, n.d.).

The second instrument used was a student survey. This survey consisted of Likert and open-ended questions that gauged the participants' perceptions of the CAI software P.L.A.T.O. The researcher used an existing student survey created by Errol Magidson, researcher, professor, filmmaker, and guest editor of the April 1978 issue of Educational Technology devoted to trends in CAI. Mr. Magidson gave full approval for use of this research tool along with the updated revisions. The survey came from Mr. Magidson's research of mastery learning principles and CAI which sought to demonstrate that CAI facilitated student learning and fostered positive student attitudes toward learning. The research used 14 GED students studying "Divisibility Rules" as participants. The students were provided a pretest to determine if the students needed to complete the instruction, learning activities provided through P.L.A.T.O., a posttest to determine to what extent the students achieved the learning objectives, and a survey of the students' attitudes toward the CAI. The posttest analysis of the research stated that the hypothesis that a CAI lesson will enhance student achievement was not supported. Only five of 14 students tested within his study showed mastery. The results of the survey demonstrated that positive attitudes towards learning with CAI were fostered. The survey was used in the current study because it had already been proven to be objective, valid, and reliable to gather the intended analysis information from the audience.

Limitations of the Study

This study employed a mixed-methods action research design. Even with the use of such a data-driven study, there were limitations which were inherent. The size of the classes was limited due to the maximum number of 28 students allowed per class and the maximum number of classes of IBA, three, assigned per semester. Only one of the two schools within the district was studied; and thus the results were not generalizable of the results to teachers of various other subjects, grade levels, class configurations, and within other states providing more of probability of extreme scores. The researcher's subjectivity within the study while trying to teach the students within the control group similar supplemental instruction based on his experience with the CAI was a limitation. The idea that the researcher wanted to make sure to take care of students by providing both classes with similar instruction exhibited his subjectivity which was inevitable (Peshkin, 1988). Another limitation of the study was the timeframe for the study. A longer time for continued research of the CAI's impact on student achievement might have shown different results that could better answer the research questions, as "increasing student CAI use would facilitate and increase the growth of student achievement" (Patterson, 2005, p. 21). Also, the researcher may have required more time to gain an in-depth understanding of P.L.A.T.O. and its instructional benefits in the classroom. Patterson (2005) believed that additional in-service time would allow teachers to become accustomed to the structure of CAI and to be able to utilize it to its fullest potential for student achievement. A final limitation of the study was that the supplemental instruction provided was not graded in line with all other graded material. The CAI and the supplemental traditional instruction were graded as extra credit and thus not looked at with the same priority as other instruction or assignments within the classes.

Delimitations of the Study

One delimitation of the study was that the researcher used only the IBA classes that he taught during the one semester studied due to time constraints for completion of the study. The three other teachers who also taught the IBA course to at least two classes during the same semester at the same time could have been used within the study; therefore, results were only generalizable for students taught by the researcher. Some researchers determined that if a particular study was transparent to others for them to decide if it applied to them, then it could be generalizable. This study did have enough information for others to decide. Another delimitation of the study was that the researcher used the PowerPoint unit of study which was the shortest and final objective within the semester of the four possible units of study.

Chapter 4: Results

Overview

Students are not achieving to their highest potential ("The Underachieving Student," 2002). The purpose of this mixed-methods action research study was to determine the impact of CAI on student achievement by comparing two sets of instructional delivery in two IBA classes. One of the instructional delivery methods was the traditional instruction supplemented with additional traditional instruction. The other delivery method was the traditional instruction supplemented with CAI P.L.A.T.O. Both delivery methods covered the PowerPoint unit of study. The effect of CAI on student achievement was to be determined by measuring statistical significance of scores on pre and postunit tests within the PowerPoint unit. In addition, student perceptions about the supplemental lessons were gathered and used to determine how successful the students felt the additional lessons from P.L.A.T.O. were.

The research questions to be answered in this study were

1. What was the impact of using P.L.A.T.O. CAI software in a high school introductory computer science course, IBA, required for graduation on student achievement on one of the four major unit tests for the course?
2. What were the students' perceptions of the CAI software P.L.A.T.O.?

The two classes were taught using traditional instruction where the students received lessons on the subject within the PowerPoint unit via lecture, were provided guided instruction examples, completed reinforcement practice activities similar to the instruction examples, and finally completed assessment projects. The experimental class differed in that the students had the additional use of the CAI software P.L.A.T.O., within the class via the internet to supplement the lessons while the controlled class was provided supplemental traditional instruction.

This chapter presents the data collection procedures, demographic information about the experimental group participants, and the findings relative to the research questions.

Data Collection Procedures

The data collected for the study included the pre and postunit test scores for the unit of study, PowerPoint 2010. The PowerPoint unit of study covered various objectives that were to be mastered based on the Microsoft Office Specialist (MOS) certification standards. The objectives were (a) managing the PowerPoint environment, (b) creating a slide presentation, (c) working with graphical and multimedia elements, (d) creating charts and tables, (e) applying transitions and animations, (f) collaborating on a presentation, (g) preparing a presentation for delivery, and (h) delivering a presentation. Mastery for this unit of study was based on the set score of 90 and above obtained on the postunit test. The set score was predetermined by the business department of the school of study to be used to determine those students who would test for certification on the PowerPoint 2010 MOS test based on previous analysis of student test scores compared with student certification. To begin the unit of study, the students were given a preunit test to assess their prior knowledge. Once the unit of study was complete, the students were given the postunit test which was the same test given for the preunit test.

The students within the experimental group, in addition to taking the preunit test and the postunit test similar to that given to the control group, also completed a student survey used to gauge student perceptions about P.L.A.T.O.

Findings for Research Question 1

Summary statistics or the means of the test scores were used to analyze Research

Question 1. The data were analyzed using the Microsoft Excel 2010 data analysis package. The means of the test scores produced the lowest amount of error from the data. The results from the preunit test are shown below in Table 2 and Table 3.

Table 2

Preunit Test Scores of Experimental Group

Student	Score	Student	Score	Student	Score	Student	Score
1	23	8	70	15	80	22	60
2	13	9	40	16	87	23	70
3	23	10	20	17	73	24	20
4	30	11	43	18	67	25	73
5	7	12	67	19	33		
6	87	13	47	20	60		
7	20	14	77	21	73		

Table 3

Preunit Test Scores of Control Group

Student	Score	Student	Score	Student	Score	Student	Score
1	27	8	20	15	60	22	7
2	57	9	27	16	30	23	43
3	43	10	67	17	40	24	57
4	7	11	67	18	87	25	63
5	43	12	57	19	33	26	52
6	50	13	50	20	87	27	17
7	40	14	27	21	53	28	63

The two classes' preunit test scores provided the necessary data to determine normality. The following normal probability plots in Figures 3 and 4 below provided the assumption that the data were normal. The data in the plots appeared straight and contained no outliers, which provided the result of the assumption that the data were normal.

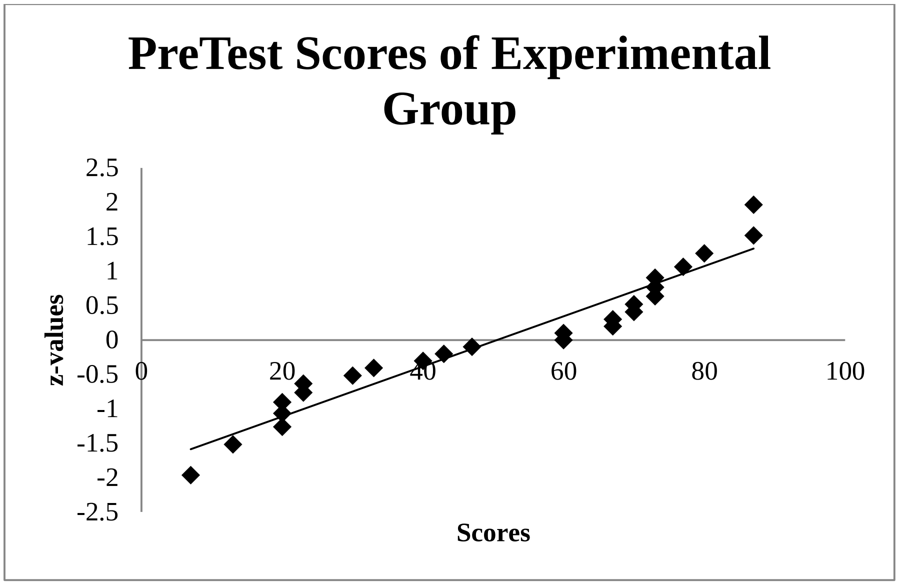

Figure 3. Preunit Test Scores of Experimental Group.

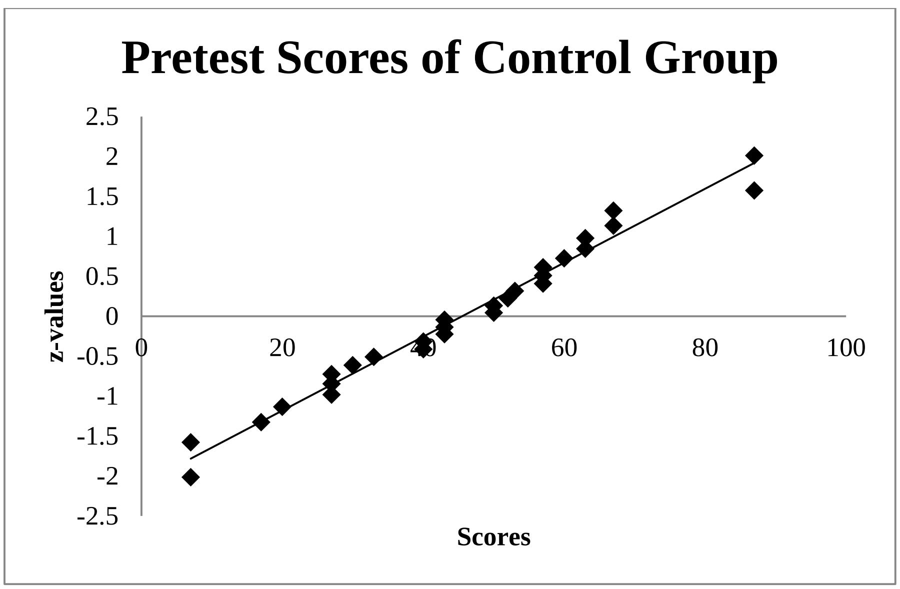

Figure 4. Preunit Test Scores of Control Group.

The scores for both groups of classes showed that there was no significant difference between the control and experimental groups based on prior knowledge.

Descriptive statistics were considered for all students' pre and postunit test scores. These statistics included the number of participants (N), the minimum score achieved, the maximum score achieved, mean (M), and the standard deviations (SD). In addition, independent *t*-test statistics were conducted on the pre and postunit test data. The null hypothesis (H_0) for the independent *t* test for the preunit test was that the means of the two groups' scores were equal (i.e. ($\mu_{experimental}=\mu_{control}$) and the alternative hypothesis (H_A) was that the means of the two groups' scores were not equal (i.e. ($\mu_{experimental} \neq \mu_{control}$). A *t* statistic of 0.79 and p value of 0.43 was provided from the preunit test data. The mean of the experimental group was 50.52 and the mean for the control group was 45.50. At the significance level of $\alpha=0.05$, the *t* test indicated a rejection in the alternative hypothesis and a failure to reject the null hypothesis with $p>.05$, and thus the means for the two classes were similar at the beginning of the study. The statistics are reported in the tables below.

Table 4

Descriptive Statistics for Preunit Test and Postunit Test (Experimental Group)

Test	N	Minimum	Maximum	Mean	SD
Preunit Test	25	7	87	50.52	25.62
Postunit Test	25	23	97	77.20	17.45

Table 5

Descriptive Statistics for Preunit Test and Postunit Test (Control Group)

Test	N	Minimum	Maximum	Mean	SD
Preunit Test	28	7	87	45.50	20.78
Postunit Test	28	10	100	80.39	18.45

Table 6

t Test: Two-Sample Preunit Test

	Experimental Group	Control Group
Mean	50.52	45.50
df	46.00	
t Stat	0.79	
P(T<=t) two-tail	0.43	

After receiving the 4 weeks of instruction on the PowerPoint unit of study, both of the classes were provided the postunit test. The postunit test was the same test administered as the preunit test to assess the students' knowledge of the PowerPoint unit objective standards after instruction. The results from the postunit test are shown below in Table 7 and Table 8.

Table 7

Postunit Test Scores of Experimental Group

Student	Score	Student	Score	Student	Score	Student	Score
1	47	8	97	15	87	22	93
2	40	9	83	16	90	23	83
3	70	10	67	17	83	24	70
4	67	11	77	18	83	25	83
5	83	12	87	19	80		
6	90	13	87	20	87		
7	23	14	83	21	90		

Table 8

Postunit Test Scores of Control Group

Student	Score	Student	Score	Student	Score	Student	Score
1	70	8	53	15	87	22	63
2	97	9	93	16	83	23	73
3	90	10	90	17	90	24	87
4	10	11	87	18	90	25	80
5	70	12	70	19	97	26	100
6	87	13	87	20	100	27	80
7	57	14	90	21	80	28	90

The two classes’ postunit test scores provided necessary data to determine normality. Normal probability plots in Figures 5 and 6 provided the assumption that the data were normal. The data in the plots appeared straight and contained no outliers, which provided the result of the assumption that the data were normal.

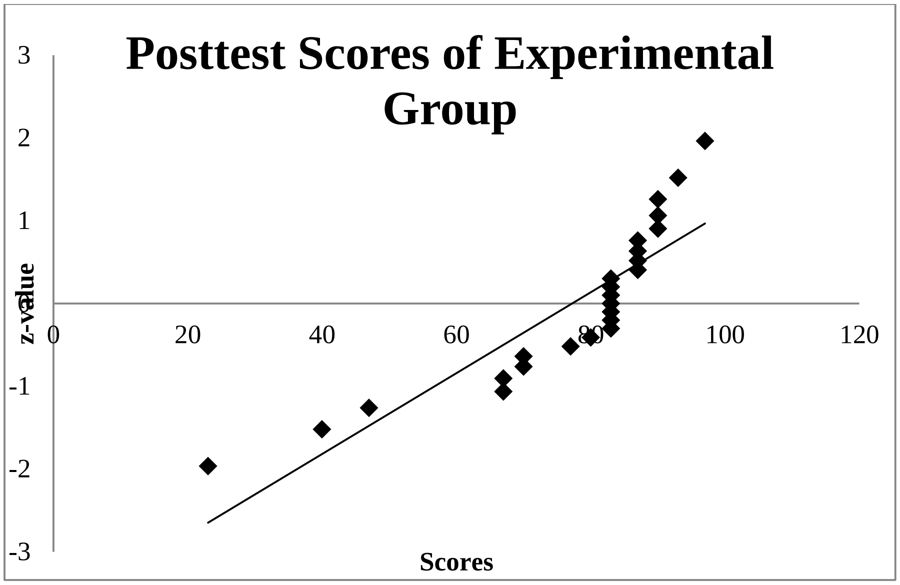

Figure 5. Postunit Test Scores of Experimental Group.

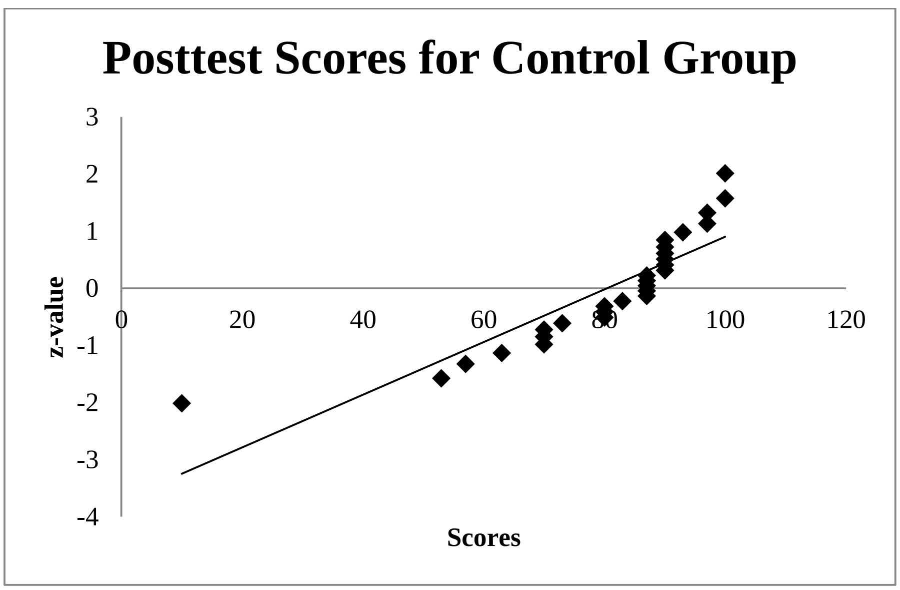

Figure 6. Postunit Test Scores of Control Group.

The comparison of the scores for the postunit tests exhibited no significant difference between the two groups. The null hypothesis (H_0) for the independent *t* test for the postunit test was that the means of the two groups' scores were equal (i.e.,

($\mu_{experimental}$=$\mu_{control}$)) and the alternative hypothesis (H_A) was that the means of the two groups' scores were not equal (i.e. ($\mu_{experimental} \neq \mu_{control}$)). A *t* statistic of 0.65 and p value of 0.52 was provided from the postunit test data. The mean of the experimental group was 77.20 and the mean for the control group was 80.39. At the significance level of α=0.05, the *t* test showed a rejection of the alternative hypothesis and a failure to reject the null hypothesis with $p>.05$, and thus the means for the two classes were similar at the end of the study. The *t*-test statistics are reported in Table 9 below.

Table 9

t Test: Two-Sample Postunit Test

	Experimental Group	Control Group
Mean	77.20	80.39
df	51.00	
t Stat	-0.65	
P(T<=t) two-tail	0.52	

The comparison of the scores for the average gains for the preunit test to the postunit test exhibited no significant difference between the two groups. The null hypothesis (H_0) for the independent *t* test for the gains was that the means of the two groups' gain scores were equal (i.e. ($\mu_{experimental}$=$\mu_{control}$)) and the alternative hypothesis (H_A) was that the means of the two groups' gain scores were not equal (i.e. ($\mu_{experimental} \neq \mu_{control}$)). A *t* statistic of 1.61 and p value of 0.11 was provided from the average gains for the preunit test to the postunit test data. The mean of the experimental group's gains was 26.68 and the mean for the control group's gains was 34.89. At the significance level of α=0.05, the *t* test showed a rejection of the alternative hypothesis and a failure to reject the null hypothesis with p>.05, and thus the mean gains for the two classes were similar at the end of the study. The *t*-test statistics are reported in Table 10 below.

Table 10

t Test: Two-Sample Average Gain Scores for Pre & Postunit Tests

	Experimental Group	Control Group
Mean	26.68	34.89
df	51.00	
t Stat	-1.61	
P(T<=t) two-tail	0.11	

In summary, the two classes' scores when compared showed no significant difference between the two classes. The preunit test scores were independent with no influence on each other. The means produced for the preunit tests did not show significant difference at the beginning of the study. The postunit test scores for both classes were independent with no influence on each other similar to the preunit test scores. The means for the postunit tests did not show significant difference in the scores for the two classes at the end of the study. The data produced from the average gain scores for the experimental and control groups suggested that the data were equivalent in average gain scores based on the *t* tests administered. The *t* statistics and p values produced by the data from the preunit tests and the postunit tests advocated that the numbers were equivalent. These results suggested that there was no difference in the impact of supplemental instruction provided, CAI or traditional instruction.

Findings for Research Question 2

Both quantitative and qualitative data analyses were used to analyze Research

Question 2 which asked, “What are the students’ perceptions of the CAI software P.L.A.T.O.?” The survey instrument (see Appendix E) was composed of several questions. These questions consisted of two questions about demographics, gender, and race; eight Likert questions used to gauge the differences in the number of students agreeing or disagreeing about various feelings about using the CAI, excitement, frustration, feeling challenged, annoyance, confusion, feeling proud, boredom, and feeling relaxed; and eight short-answer questions were geared at analyzing how and why students felt positive or negative about their experience with the CAI of study. When analyzing the data, the researcher grouped the data based on the types of questions and prepared the quantitative data in tables and figures while providing a narrative summary of the qualitative data provided from the short answer questions.

The demographics of the experimental group matched that of the school. Figure 7 depicts the gender data and Figure 8 depicts the race/ethnic data.

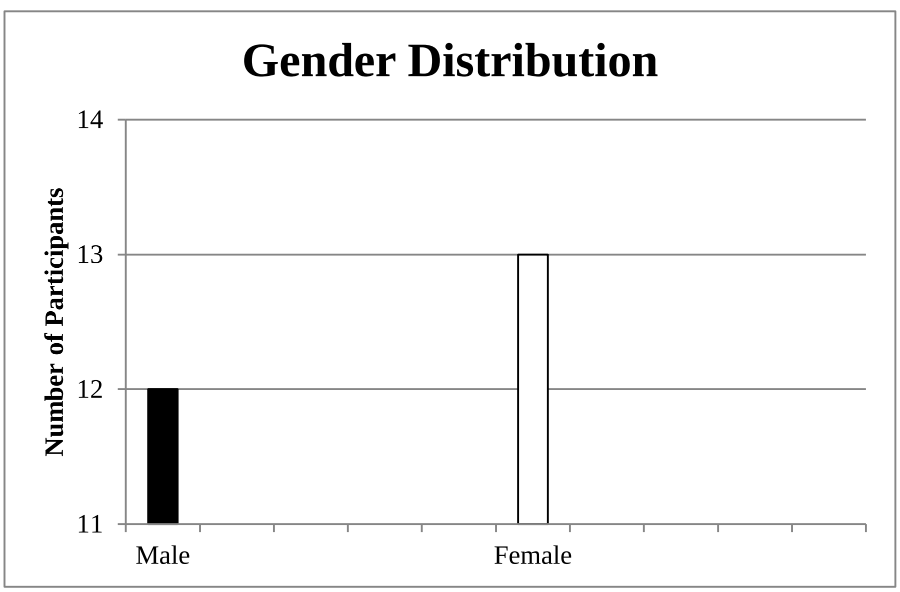

Figure 7. Gender Distribution of Experimental Group.

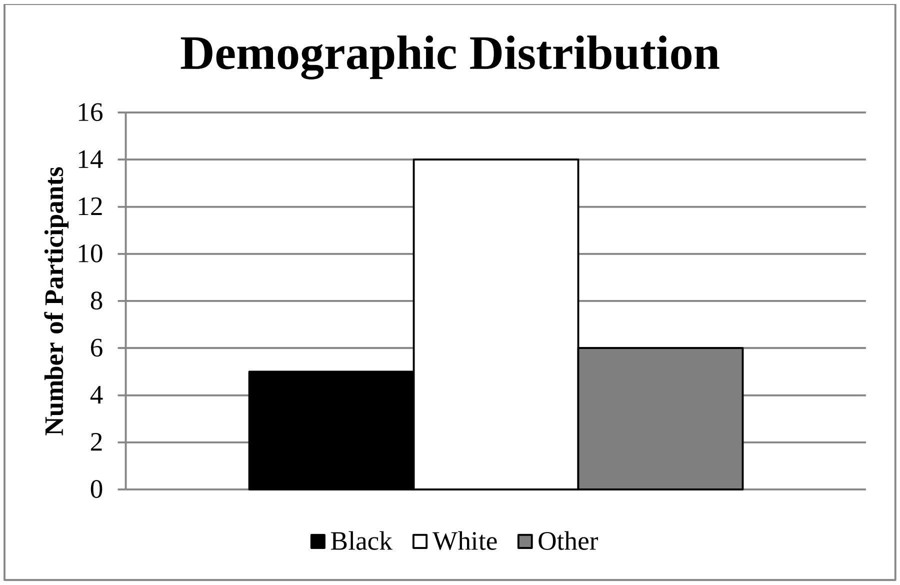

Figure 8. Demographic Distribution of Experimental Group.

The eight questions about the feelings the students had while using P.L.A.T.O. provided percentage information for the different racial groups agreeing or disagreeing about various positive versus negative feelings. The figures below depicted the information gaging each positive against its opposite negative.

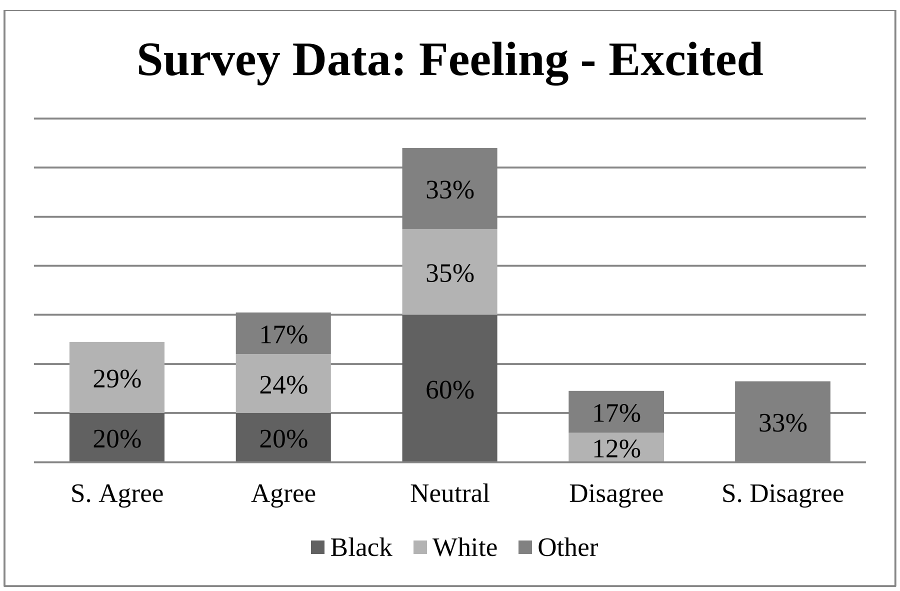

Figure 9. Survey Data: Percentage of Races Feeling – Excited.

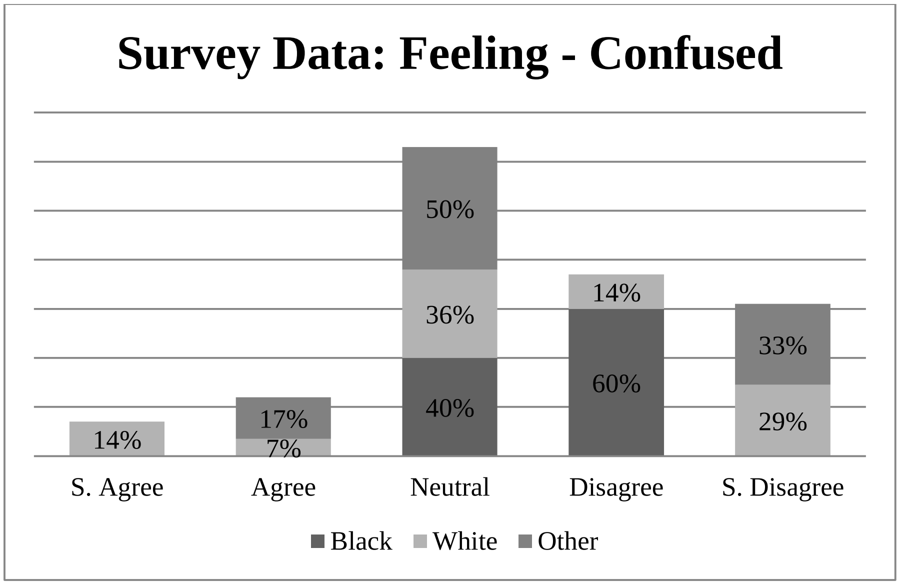

Figure 10. Survey Data: Percentage of Races Feeling – Confused.

In comparison, 40% of the Black students confirmed being excited while using the CAI and 60% confirmed that they were not confused while using the CAI. Fifty-three percent of the White students confirmed being excited and 43% were not confused. Of the other races within the experimental group, 40% confirmed not being excited and 33% were not confused.

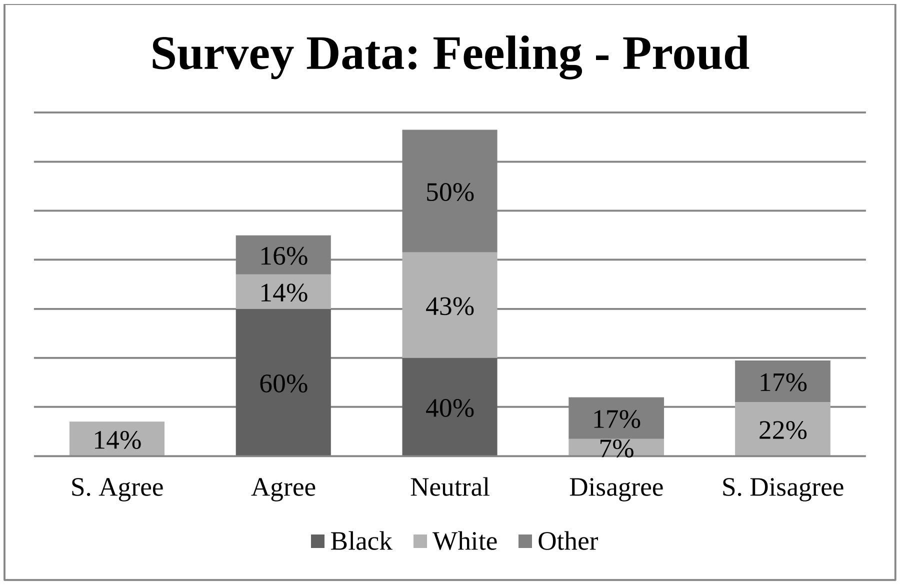

Figure 11. Survey Data: Percentage of Races Feeling – Proud.

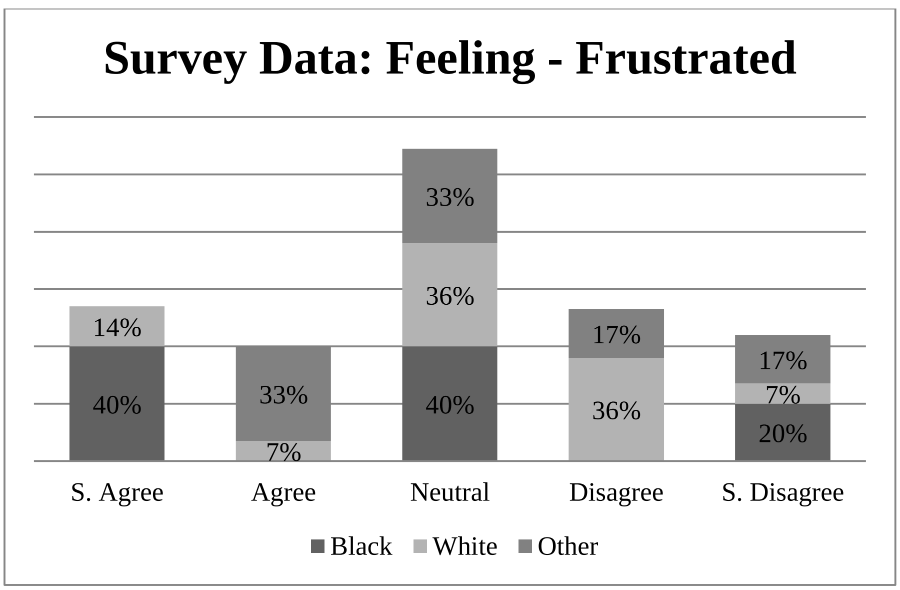

Figure 12. Survey Data: Percentage of Races Feeling – Frustrated.

In comparison, 60% of the Black students identified that they were proud of themselves and 40% clearly were frustrated while working with P.L.A.T.O. The White students confirmed that 28% were proud while 29% were not proud and 43% were not frustrated with the CAI. Of the other races in the experimental group, 34% confirmed they were not proud of themselves while 34% were not frustrated while using P.L.A.T.O.

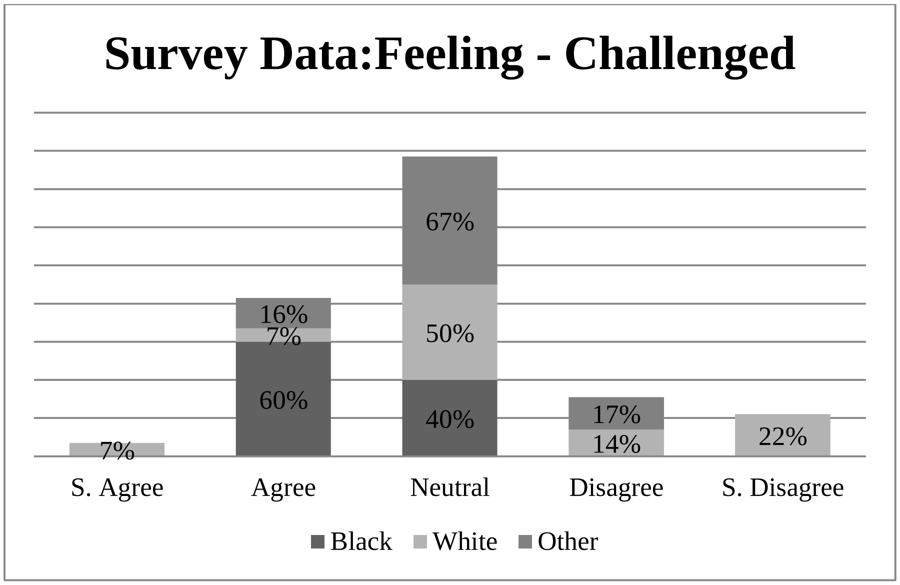

Figure 13. Survey Data: Percentage of Races Feeling – Challenged.

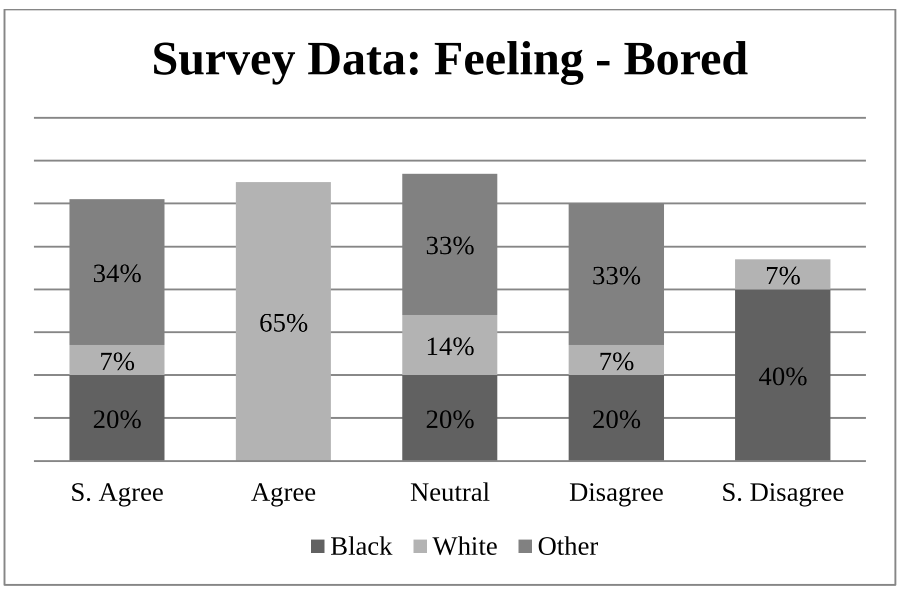

Figure 14. Survey Data: Percentage of Races Feeling – Bored.

In comparison, 60% of the Black students confirmed they found P.L.A.T.O. to be challenging while 60% of them were not bored when using it. The White students had only 36% to disagree to having a challenge and 72% confirmed being bored while using P.L.A.T.O. Of the other students, 17% felt no challenge and 16% did feel challenged. Of these students, 34% agreed strongly to feeling bored while 33% disagreed to feeling bored.

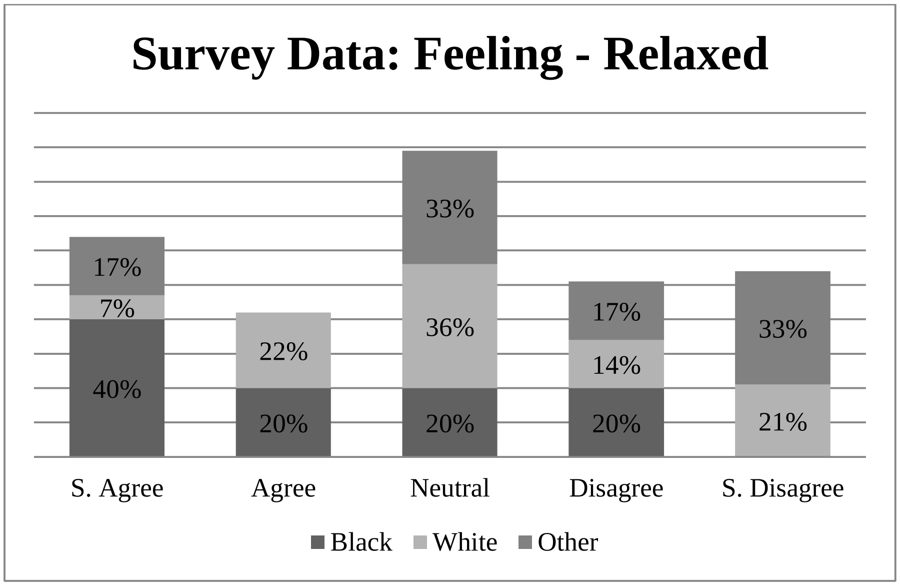

Figure 15. Survey Data: Percentage of Races Feeling – Relaxed.

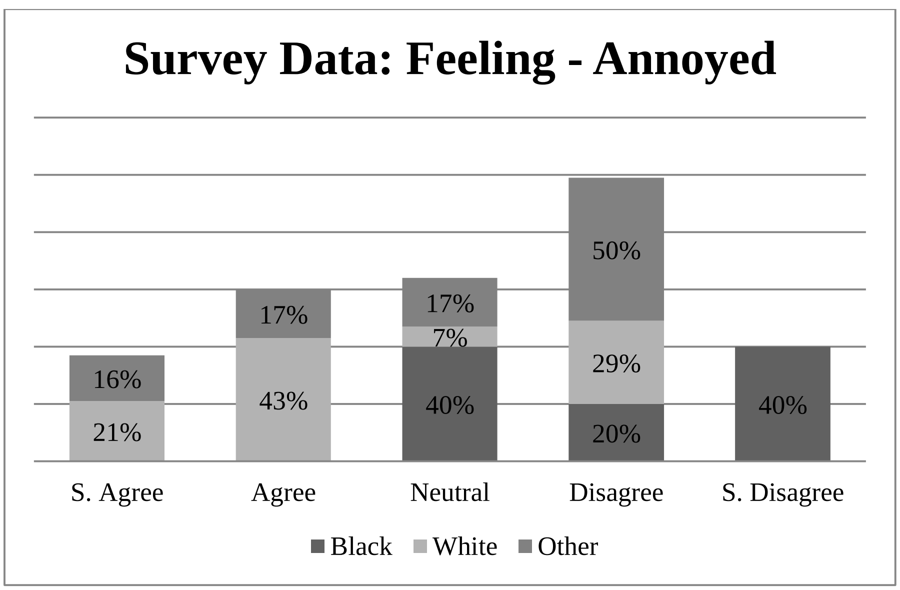

Figure 16. Survey Data: Percentage of Races Feeling – Annoyed.

In comparison, 60% of the Black students confirmed that they felt relaxed and 60% did not feel annoyed while using P.L.A.T.O. Of the White students, 35% disagreed to feeling relaxed while 64% agreed to feeling annoyed. Finally, 50% of the other racial ethnic groups did not feel relaxed and 50% did not feel annoyed while using P.L.A.T.O.

In addition, chi-squared tests were conducted on the feelings questions' data by race/ethnicity to determine if there was a significant difference in feelings expressed between the different racial groups about their use of P.L.A.T.O. Table 11 exhibits the test results for total positive feelings observed and expected for the chi-squared test results. The individual feelings chi-squared test results also were conducted on feelings questions' data by race/ethnicity (see Appendix F).

Table 11

Chi-Squared Test Result for Feeling Positive

Observed	Black	White	Other	Totals	Percentages
S. Agree	3	4	1	8	0.08
Agree	8	6	3	17	0.17
Neutral	8	24	11	43	0.43
Disagree	1	7	4	12	0.12
S. Disagree	0	15	5	20	0.2
Totals	20	56	24	100	
Expected	**Black**	**White**	**Other**	**Totals**	**Percentages**
S. Agree	1.6	4.48	1.92	8	0.08
Agree	3.4	9.52	4.08	17	0.17
Neutral	8.6	24.08	10.32	43	0.43
Disagree	2.4	6.72	2.88	12	0.12
S. Disagree	4	11.2	4.8	20	0.2
Totals	20	56	24	100	
p < .05	0.040	Chi-Squared Test Result			
We have enough evidence b/w/o are different					

Table 12 below exhibits the test results for total negative feelings observed and expected for the chi-squared test results.

Table 12

Chi-Squared Test Result for Feeling Negative

Observed	Black	White	Other	Totals	Percentages
S. Agree	3	16	3	22	0.22
Agree	0	10	4	14	0.14
Neutral	7	12	8	27	0.27
Disagree	5	12	6	23	0.23
S. Disagree	5	6	3	14	0.14
Totals	20	56	24	100	

Expected	Black	White	Other	Totals	Percentages
S. Agree	4.4	12.32	5.28	22	0.22
Agree	2.8	7.84	3.36	14	0.14
Neutral	5.4	15.12	6.48	27	0.27
Disagree	4.6	12.88	5.52	23	0.23
S. Disagree	2.8	7.84	3.36	14	0.14
Totals	20	56	24	100	
$p > .05$	0.275	Chi-Squared Test Result			
We don't have enough evidence b/w/o are different					

In summary, when White, Black, and other students were compared, there was statistically no significant difference in their positive or negative feelings towards P.L.A.T.O. based on the individual feelings test results. In the comparison of the students' feelings, the majority of the Black students confirmed having positive or neutral feelings. The majority of the White students confirmed having negative or neutral feelings. The other races of students within the experimental group confirmed being neutral and equal with regard to positivity and negativity. Many of the questions produced results of both positive and negative feelings maintained by all ethnic groups. In addition, the test results for the total positive feelings for the control group verified the statistically significant difference in their positive feelings. At the significance level of $\alpha=0.05$, the chi-square test indicated that there was enough evidence that the total comparison of the positive feelings of the Black, White, and other students were different. The p-value result of 0.040 provided the evidence from the test. The test results for the total negative feelings for the experimental group verified no statistically significant difference in their negative feelings. At the significance level of $\alpha=0.05$, the chi-square test indicated that there was not enough evidence that the total comparison of the negative feelings of the Black, White, and other students were different. The p-value result of 0.275 provided the lack of evidence from the test. In summary, the majority of the students were neutral or negative in their feelings about P.L.A.T.O.

Eight Short Answer Questions

The experimental group answered several short answer questions. The questions provided the how and why about the students' feelings towards P.L.A.T.O.

Question 4: "When using P.L.A.T.O., how did you work (i.e., independently, with instructor, with another, in groups, etc.) and why?" The majority of the students, 19 students, responded that they completed the work independently. The students stated that working independently allowed the work to be completed faster and easier. The other students, five, responded that they completed the work in groups or with another because completing the work in this manner made it easier and more fun. One of the students responded that she did not do the P.L.A.T.O. at all, while another student who worked in a group stated that he learns better in groups.

Question 5: "Do you think the material you saw could have been taught as rapidly or completely if it had been presented by a more usual educational medium (such as lecture or textbook?) Explain." Many of the students, 16, responded with no. Some wrote that they learn virtually, the lessons would not be as hard, the lessons would not have as good of a visual, P.L.A.T.O. was faster and easier, it was convenient, they do not like reading books, and being on the computer was good. The students who responded yes stated that a lecture or textbook would have explained the content better and allowed easier learning through listening rather than reading. One student responded yes because she believed that any other way would have been better for her because she hated P.L.A.T.O. One other student believed that all of the mediums of teaching the content would have provided the same result because the CAI was "average."

Question 6: "How do you feel the P.L.A.T.O. lessons linked to the unit being taught?" Most of the students, 18 of the 25, responded that the lessons linked to the unit taught. Some wrote that the lessons linked very well or strongly, the lessons were about the same stuff, the lessons sometimes linked, the lessons gave another look at how to complete the tasks for the unit, the lessons were in accord with the unit, and the P.L.A.T.O. lesson helped the students learn as another format to learning the skills. A student did not respond to this question. Other students wrote that the lessons did not link because the lessons were disliked and stupid.

Question 7: "Did you enjoy P.L.A.T.O. and why?" Many of the students, 15 of the 25 students, responded that they enjoyed P.L.A.T.O. Most stated that the lessons were fun and easy, a quick way to learn, helpful for doing well on quizzes later, more information about Microsoft Office, challenging, descriptive in explaining, and just okay. Those students who did not enjoy the lessons wrote that the lessons were not interesting but boring and time consuming. Some, three of the 25, simply wrote that they just did not enjoy P.L.A.T.O.

Questions 8 and 9: “Would you encourage your friends to take a course that uses P.L.A.T.O.? Why?” Many of the students, 12 of the 25, checked off that they were uncertain if they would encourage a friend to take a P.L.A.T.O. course. Some wrote that people learn in different ways, it would depend on the person, they do not know if their friends would enjoy, their friends do not like to learn or would not care much for it, the lessons are not fun, it was good but boring, and there were good and bad parts. The six students who checked off that they would encourage a friend wrote that it was a new learning method, easy and provided extra, helping learn, easy, and helpful with computer skills. The students who checked off that they would not encourage their friends wrote that it was not interesting, really boring not teaching anything, and will not help in the future.

Question 10: “What have you liked most about P.L.A.T.O.?” Many of the students wrote that the P.L.A.T.O. lessons were easy. The majority of the students also wrote that the number of questions provided in the mastery tests for the lessons were quick and easy. Some enjoyed the idea that the questions were short and the tool allowed them to be able to miss one of five questions and still be able to pass to move onto the next lesson. A few of the students stated that the idea of receiving extra credit for completing the lessons to improve their grade in the course was what they liked most. Some students wrote that they liked that the lessons offered extra help, provided more practice, and were relaxing. A few students, four of the 25, expressed that they did not like the lessons at all.

Question 11: “What have you liked least about P.L.A.T.O.?” Three students wrote that P.L.A.T.O. was boring and not very helpful. Two of the students stated that the lessons were confusing while another two students stated that they disliked everything about P.L.A.T.O. Eight students wrote that they disliked the trainings, which required what they denoted as a lot of reading. A couple students least liked the due dates. One student felt the trainings and assessments were too time-consuming. Another student did not like having to start the trainings over in order to retake the mastery tests. One other student disliked having to obtain a grade of 80 and above to move on to the next lessons. A student did not like the supplemental reiteration of the lessons. Finally, two of the 25 students wrote there was nothing about P.L.A.T.O. that they liked least.

Summary

The data collected for this mixed-methods action research study was used to compare the impact of two types of instructional delivery on student achievement in two IBA classes for one of the four major units for the course and the students' perceptions of the CAI software used as one of the types of delivery. The research findings provided an opportunity for detailed analysis of the two types of instructional delivery and the students' perceptions of the CAI.

Analysis of the quantitative data gathered from the pre and postunit tests indicated there was no statistically significant difference in achievement between the control group and the experimental group prior to beginning the unit of study. In addition, there was no difference in achievement between the control group and the experimental group after completing the unit of study. There was no difference in average gain scores between the groups.

Analysis of the quantitative and qualitative data gathered from the student perception survey indicated there was no statistically significant difference in the feelings about the CAI that the different races of the classroom had. In addition, the answers the students provided for the short answer questions were similar but did vary for some questions. Overall, the students felt that the software was easy, useful, and enjoyable; however, a little less than half felt that the software was a waste of time, not recommendable, and boring.

Chapter 5: Discussion

The purpose of this mixed-methods action research study was to gain information about the use of CAI as a supplement to traditional instruction within a high school business education classroom, IBA, to improve student achievement. This chapter includes a summary of the study results, the findings, and recommendations for practice, policy, and future research.

Summary

A comparison of the impact on achievement of CAI as a supplement versus additional traditional instruction as a supplement as measured by statistical significance of scores on pre and postunit tests was executed. Student perceptions about the CAI P.L.A.T.O. were analyzed to gauge how successful the students felt the additional lessons provided were.

The research questions to be answered in this study were:

1. What was the impact of using P.L.A.T.O. CAI software in a high school introductory computer science course required for graduation, IBA, on student achievement on one of the four major unit tests for the course?
2. What were the students' perceptions of the CAI software P.L.A.T.O.?

In answering the research questions, a couple of instruments were used to analyze the data. Research Question 1 used a quantitative analysis of the pre and postunit test data. Research Question 2 used a quantitative analysis of student survey data from questions about feelings had during the use of CAI based on race/ethnicity status. In addition, Research Question 2 used a qualitative analysis of student survey data from questions about how the students felt about the CAI and why the students felt a certain way about it.

The results of the study failed to reject the null hypothesis that the students from both groups, the control and the experimental, would not differ on their prior knowledge based on the preunit test data. The results also failed to reject the null hypothesis that the students from the groups would not differ on their obtained knowledge after being taught the unit of study and provided the differing supplemental instruction, CAI or traditional, based on the postunit test data. In addition, the results showed that the experimental group's overall perceptions were that P.L.A.T.O. provided additional instruction but was not received in an overwhelmingly positive light.

The Findings

The mixed-methods action research study was created to determine the impact of CAI on student achievement. The control group that received supplemental instruction using traditional instruction consisted of 28 students. The experimental group that received supplemental instruction using CAI consisted of 25 students. Originally, there were 56 participants consisting of 28 students within both IBA classrooms, but three of the students were dropped from the experimental class due to uncontrollable circumstances. Both classrooms received lessons on the subject within the PowerPoint unit via lecture, guided instruction examples, reinforcement practice activities similar to the instruction examples, and assessment projects. The difference in the controlled class and the experimental was that the experimental class had the additional use of the CAI software P.L.A.T.O. within the class via the internet to supplement the lessons while the controlled class was provided supplemental traditional instruction.

Both classes took the allotted 4 weeks to complete the unit. A preunit test was given at the beginning of the unit of study to assess the students' prior knowledge of PowerPoint 2010. Both groups received the same traditional instruction on the

PowerPoint unit as well as their class determined 20 minutes of supplemental instruction for the entire 4 weeks of unit study. Once the unit of study was taught, a postunit test was given and the experimental class was surveyed on their perceptions of the CAI P.L.A.T.O. (see Appendix E). The two research questions presented in the study were addressed using quantitative and qualitative analysis.

Research Question 1

Research Question 1 asked, “What is the impact of using P.L.A.T.O. CAI software in a high school introductory computer science course required for graduation, IBA, on student achievement on one of the four major unit tests for the course?” A comparison of the two methods of instruction was analyzed by interpreting the students’ significant score differences for the preunit test, postunit test, and the mean gains for the pre and postunit tests for the two classes. The preunit test data produced a p-value of 0.43 for the *t* test conducted. At the significance level of $\alpha=0.05$, the p value was $p>.05$, and the *t* test indicated a failure to reject the null hypothesis that the means of the two groups’ scores were equal. Therefore, the means for the two classes were similar at the beginning of the study; and thus, the students’ prior knowledge was similar for both classes. In addition, the postunit data produced a p value of 0.52 for the *t* test performed. The p value was $p>.05$ at the significance level of $\alpha=0.05$ and the *t* test indicated a failure to reject the null hypothesis that the means of the two groups’ scores were equal. Furthermore, the means for the two classes were equal at the end of the study; and thus, the student’s proficiency achievement was similar for both classes. Finally, the mean gain scores data when *t* tested produced a p value of 0.11. At the significance level of $\alpha=0.05$, the p value was $p>.05$, and the *t* test indicated a failure to reject the null hypothesis that the average gains of the two groups' scores were equal. There was no difference in the achievement between the experimental group and the control group after completing the research.

Research Question 2

Both quantitative and qualitative data analyses were used to analyze Research Question 2 which asked, "What are the students' perceptions of the CAI software P.L.A.T.O.?" There were eight Likert questions used to gauge the feelings the students had while using P.L.A.T.O. These feelings consisted of excitement, confusion, pride, frustration, challenged, annoyed, boredom, and relaxed. In looking at the comparison of the percentages of the three different racial/ethnic groups of students who felt excitement versus confusion, a large majority of the students felt neutral about feeling excited and confused, but many of the students confirmed their excitement and lack of confusion while using P.L.A.T.O. In comparing the percentages of students who felt proud versus frustrated, a large majority of the students felt neutral about feeling proud and frustrated, but many of the Black students were proud while many of the White and other students were not proud and their frustration while using the CAI was split. The comparison of the feelings of being challenged versus bored confirmed that a large majority of the students felt neutral about feeling challenged and bored. However, a huge percentage of the Black students did feel challenged, a large percentage of the White students confirmed feeling bored; and the other races of students confirmed having split results in regards to boredom. Finally, in comparing the percentage of students who felt relaxed versus annoyed, a large majority of the students felt neutral about feeling relaxed and a large majority did not feel annoyed. Most of the Black students felt relaxed and not annoyed, while most of the White students confirmed feeling not relaxed and annoyed.

The other races confirmed feeling not relaxed and not annoyed.

A chi-squared test was performed to determine if a significant difference in feelings confirmed between the different racial groups in regards to their use of P.L.A.T.O. The test results for the total positive feelings provided a p value of 0.040 which was $p<.05$. The results indicated that there was enough evidence that the total comparison of positive feelings for Black, White, and other races were different. The test results for the total negative feelings provided a p value of 0.275 which was $p>.05$. The chi-square results indicated that there was not enough evidence that the total comparison of negative feelings for Black, White, and other races were different.

There were eight short answer questions developed from the survey that provided the how and why about the students' feelings of P.L.A.T.O. The majority of the students preferred to work independently to complete the lessons in P.L.A.T.O. quicker and with little difficulty. A little more than half of the students believed that the supplemental lessons provided by the CAI could not have been taught or completed as rapidly if presented using traditional instruction. Many students stated that the lessons were faster, easier, and convenient. Almost all of the students confirmed that the lessons taught in P.L.A.T.O. linked directly to the lessons being taught through traditional instruction. There were students who stated that the lessons in the CAI were fun, easy, helpful, added information about PowerPoint, challenging, and descriptive. A little less than half of the students felt that the lessons were not interesting but boring and time consuming. Not many of the students would encourage their friends to take a course that uses P.L.A.T.O. due to their belief in their friends' lack of educational motivation and difference in learning styles. Some also felt that the lessons were not fun but boring; therefore, they would not encourage the taking of a course that utilized the CAI. When asked what the students liked most about P.L.A.T.O., many confirmed that the lessons were easy; and most wrote that the small amount of questions needed for the mastery tests was well liked. Some students liked the extra supplemental help and practice provided by the lessons. When asked what the students liked least about P.L.A.T.O., many of the students confirmed not liking the actual lessons because they considered them to be boring, too time-consuming, and required too much reading. Based on those responses, the students confirmed that the CAI was received more negatively than positively.

Relationship to Literature

The findings of this study added to the literature about the impact of CAI on student achievement and further added to the small amount of research about the impact of CAI on student achievement within a noncore course which was noted in the research of Cherian (2009) as being of importance to the total body of knowledge about the impact of CAI on student achievement.

The study was consistent with the findings of Clinkscales (2002) that there was no significant difference between the two forms of instruction. “Both methods have positive features that bring the best out of instruction” (Clinkscales, 2002, p.1). In a study of achievement in a college technology class, by O’Bannon, Lubke, Beard, and Britt (2011), there was also no statistically significant difference in achievement between a class using lecture instruction and a class using podcast instruction. Magidson (1974) confirmed in his study that the hypothesis that CAI would enhance student achievement was not supported by his pretest and posttest results. Clark’s (2001) study on the effectiveness of P.L.A.T.O. in improving reading skills noted that data from the National Assessment of Education Progress (NAEP) assessment found that students who used computers in the classroom once a week did not perform any better on the NAEP reading test than those who did not use computers in the classroom. The two types of supplemental instruction in the current study had similar findings for both groups based on the *t*-test results.

Patterson (2005) concluded in his study that increased comprehension and retention could be attained with reinforced or supplemental instruction similar to the instruction provided for both the control and the experimental groups of this study. Both groups benefited similarly from the additional supplemental instruction either provided directly from the instructor or from the CAI. “When students are reinforced with additional CAI instruction time, the probability of concept and objective comprehension and retention will be increased for the students” (Patterson, 2005, p. 20).

The results of the study indicated that using the CAI P.L.A.T.O. as a supplement was no different than using additional traditional instruction as a supplement. These findings were not consistent with the results of some of the literature such as with Traynor’s (2003) study. Traynor’s results indicated an increase in overall student learning measured by pretest and posttest gains. In contrast to the current study, the researcher documented that the sample size which possibly provided for an accurate representation of the population was considerably larger in Traynor’s study. The study by Boling et al. (2002) produced results that confirmed that students who used CAI demonstrated significant gains in their ability to recall vocabulary words in comparison to students who did not use CAI. The study was conducted on only 21 first-grade students, which possibly could not be an accurate representation of the population of first-grade students, produced the rejection in the null hypothesis that the current study could not. Clark’s (2001) research also confirmed that a significant difference in student achievement scores was attained in a study on journalism students improving their grammar skills using CAI versus traditional instruction. Some journalism students were scheduled in a P.L.A.T.O. lab section while the others were scheduled in a noncomputer-based section. The lab students obtained a mean score of 62% as opposed to the mean score of 42% obtained by the other section. Inconsistent with the current study, SERİN's (2011) study revealed that there was a significant difference between achievements for 52 science and technology students. The sample size for his study was similar to the current study but produced different results. The idea of implementing CAI versus traditional instruction as the primary method of learning in comparison to using the CAI and traditional instruction as a supplement may have produced the hypothesized result.

In all but one of the studies above, the experimental group differed entirely from the control group because both groups were taught the necessary lesson or curriculum using one method of instruction, the CAI or traditional instruction. The current mixed-methods action research study took use of the CAI as a supplement only. The study by Bennett (2012) on the effects of CAI on rural Algebra I students confirmed that in a study to determine the effects of P.L.A.T.O. on end-of-year state assessments that gain scores for an experimental group only using CAI to learn were higher than the gain scores for the control group. "At risk students had an average of 234.2 while non-CAI students, 245.4. CAI student has a size effect of 1.27, which translated to a gain score of 20.4 on the state test as opposed to a gain score of only 11.2 for non-CAI users" (Bennett, 2012, p. 18). Bennett also concluded that in another study on the primary use of CAI versus traditional instruction, a significant increase from pretest to posttest existed for the experimental group and did not exist for the control group. "Only 14% of the control group passed AIMS while 57% of the experimental group passed" (Bennett, 2012, p. 20). Two sides existed for the findings on the impact of CAI on student achievement; and two or more sides—positive, negative, and neutral—existed for the findings on the perceptions of CAI.

The Kulik and Kulik (1991) study on the effectiveness of CAI confirmed that in 15 of 19 studies that examined student attitudes towards computers there were more favorable attitudes for students in CAI classes than for students in non-CAI classes. Kulik and Kulik concluded that in 22 studies, 16 found more positive attitudes in CAI classes. Two of the studies found no difference in the attitudes of traditionally taught classes and CAI classes. Four of the studies confirmed more negative attitudes in CAI classes. Also, when examining the effects of CAI on student attitudes towards the subject matter, 20 of the 32 studies resulted in more positive attitudes than that of traditionally taught classes. Consistent with the findings from Kulik and Kulik, the current study provided survey results about the perceptions of P.L.A.T.O. that were mixed but more neutral and negative than positive.

Bennett’s (2012) study provided evaluative results about student perceptions on their method of instruction and attitude towards algebra from the study by O’Dwyer, Carey, and Klieman (2007). The study consisted of 463 students separated into a control group receiving traditional instruction in Algebra I all year and a treatment group receiving CAI in Algebra I all year. After taking the pretest and posttest, there was no significant difference between the groups’ mean scores, but 67.8% of the control group felt confident about their algebra and computer skills versus the 49.8% of the treatment group. “For the responses *yes* and *satisfactory*, 93.7% of the control groups’ responses fell into these categories and 79.3% of the treatment groups’” (Bennett, 2012, p. 25). Similar to the current study, negative feelings or negative perceptions about the CAI did not diminish the student learning exhibited in the significant pre and postunit test mean scores.

Implications of Findings

As a result of the findings from the study, several different aspects of the study can be changed to improve student achievement or further study results. Other researchers can look to conduct the study on a larger population for generalization purposes. Based on the findings, a more generalized population could provide for better results for student achievement in comparison to the current study. Also, the students did benefit from the supplemental instruction provided in both classes; therefore, the use of the CAI as a supplement for the students should prove to be a benefit by allowing the classroom to be more student-centered. The researcher will continue to utilize CAI in the classroom to improve student achievement. The additional supplemental instruction can be used in the researcher's future classes to allow for the students to work at their own pace and skill levels. Based on the perceptions provided about P.L.A.T.O., the additional instructional tool that used the computer will be acceptable by many of the researcher's students but a possible updated version of the CAI would be warranted. The student responses to the survey will give an instructor or future researcher the needed insight into how the students felt while using P.L.A.T.O. and why.

The researcher in future classes will require the additional supplemental instruction as regular graded assignments. Based on the students' responses to the short answer questions, the researcher feels that requiring the CAI be graded with all regular graded assignments rather than as extra credit will hold the students accountable for excelling at the CAI and make it more of a priority in comparison to how it was perceived in the study. The CAI grades will affect the students' grades similar to all other assignments within the class; thus, the students should apply more effort to insure that all aspects of the CAI get completed.

Limitations of the Study

The main limitation of this study was the size of the classes was limited to a maximum number of 28 students per class. This maximum amount of students per class only allowed for a maximum sample size of 56 students for the study. However, only 53 students were assigned within the two courses based on the researcher's schedule of classes for the semester; therefore, the results were not generalizable to the district or national population and had more of a probability of extreme scores. The researcher's involvement in the study to teach the control group the necessary supplemental traditional instruction to match the P.L.A.T.O. software was a limitation in the study. The researcher's subjectivity in wanting the students within the control group to obtain similar instruction may have led to the lack of statistical differences in the *t* tests analyzed. Peshkin (1988) believed that it was useful for researchers to acknowledge that subjectivity was a component of their research and this idea was as important as achieving objectivity. Another limitation of the study was with the short timeframe for the study. The study was conducted over a 4-week period utilized to conduct the PowerPoint unit of study only. Patterson (2005) believed that a longer time for continued research would facilitate and increase the growth of student achievement. More time to gain an in-depth understanding of P.L.A.T.O. may have benefited the study as well. Patterson also stated that additional in-service time would allow teachers to become accustomed to the structure of CAI and use it to the fullest potential.

Recommendations

CAI has been found in this study to produce no different significant gains and to produce neutral or negative perceptions. Based on the current study's findings, the study should be used to test students' improved achievement using CAI with multiple units of study within the IBA course. Due to the findings of the study, the researcher now has the belief that the testing of one unit of study does not provide the full look into how CAI or P.L.A.T.O. impacts student achievement within the IBA course. The Word, Excel, and Access units also need to be used in the study to test for the significant differences of mean scores for all the different units within the IBA course. All of the units could be broken into individual studies and analyzed similarly to the current study that used the PowerPoint 2010 unit. Studying one of the units does not justify that which affects all of the units.

An entire semester or curriculum study for the IBA course could take precedence over the singular unit studies to provide for a more accurate look at proficiency attainment or student achievement within a course. Clinkscales (2002) believed that having more time with the CAI might produce better results for students. The final exam for the course could be used as the preunit test and postunit test for the entire course. The final exam would be a good barometer similar to the pre and postunit tests provided for each unit. However, the final exam would be testing for proficiency of the entire course which would confirm overall achievement for the students.

Based on the findings presented earlier, sample size may have provided for better test results in regards to the null and alternative hypothesis. The sample size for the study should be increased to include half if not all of a semester of students taught in IBA in the school of study to obtain a sample that would be generalized to the school or district population. Also, students could be more randomly selected for each of the groups to produce a better comparison of the general population. A bigger sample size used in the next study should provide for a more accurate representation of the population.

An identification of the types of students within the classes based on socioeconomic statuses, prior computer usage, and current outside computer/internet usage may have added to the research. Identifying these students may have provided a better understanding and analysis of the student perceptions of the CAI. Possibly being able to identify those most exposed to computers and considered mavens versus novices may have added to the study prior to testing or instruction.

Another recommendation for future studies deals with the CAI of use, P.L.A.T.O. The study could focus on the impact of various other software packages such as NovaNET or others to compare to traditional instruction. The study could be conducted in the same manner but using a different CAI. Clinkscales (2002) recommended that research of other CAIs be performed before a determination of CAI's impact can be finalized. There could possibly be an updated software package that provides better instruction on all of the IBA units of study. The students' perceptions of P.L.A.T.O. do not justify as being their overall perception of CAI. To better gauge the impact on achievement and student perceptions of CAI, another or several other software packages must be researched. P.L.A.T.O. was the CAI of convenience being used currently in the school and the school district of study.

Based on the study results, administrators and policymakers need to be concerned with the lack of a difference statistically in the two types of supplemental instruction's impact. Statistically there was no difference in the impact of CAI and traditional supplemental instruction. The students were not impacted any more using the CAI versus being taught through additional traditional instruction. Possibly certain changes in the software determined by any needed upgrades and the students' perceptions about the CAI could provide change that administrators and policymakers would feel warranted further funding.

Finally, a look at teaching the IBA course grading the CAI similar to the traditional graded assignments may help to produce a more significantly positive set of results. Clinkscales (2002) recommended combining CAI with traditional instruction to provide the necessary instructional details both provide. The CAI may be looked at as more a part of the content by the students in comparison to the students' perception and use of it in the current study. Based on the student answers provided from the survey, many of the students viewed and used the CAI only as a supplement to instruction that they perceived did not have much bearing on their grades other than as extra credit. The value of the CAI modules and tests was less in comparison to the traditional instruction assignments and projects. The researcher believes that with the students being assigned individual grades for module completion and quiz or test mastery being used as a part of the primary means of grading for the course, the students may take the CAI more seriously to benefit from. Thus, by comparing the two different instructionally taught IBA courses, a more significant set of results might be obtained.

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Appendix A

2013 – ESEA/Federal Accountability System

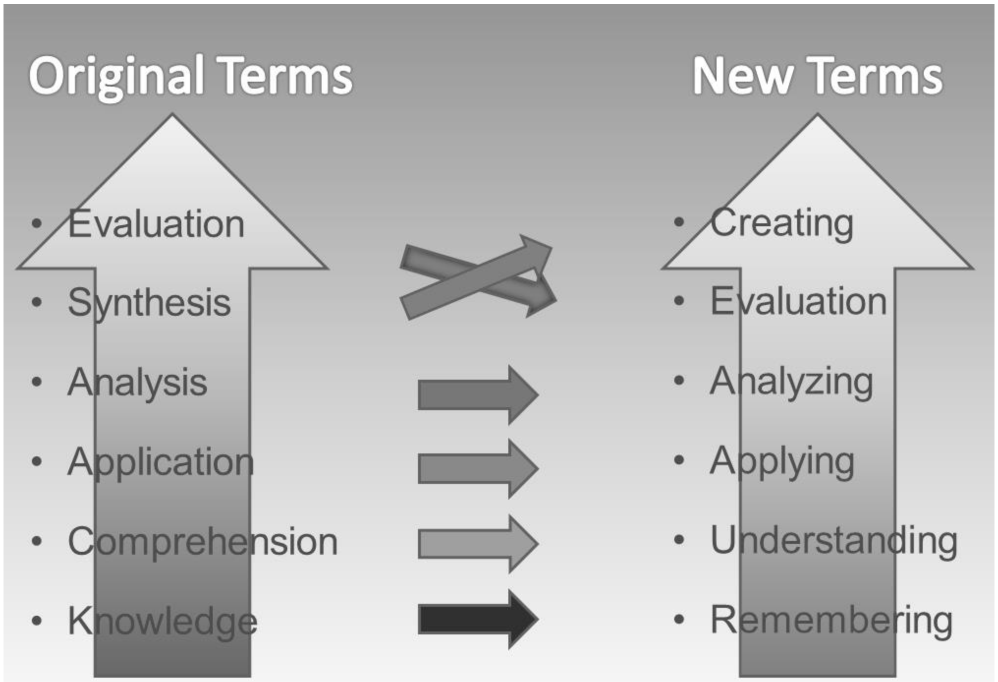
2013 – ESEA / Federal Accountability System

Overall Weighted Points Total	**91.3**	**Key**	**Index Score**	**Grade**	**Description**
Overall Grade Conversion	**A**		90-100	A	Performance substantially exceeds the state's expectations
Points Total - Elementary Grades	90.2		80-89.9	B	Performance exceeds state's expectations
Points Total - Middle Grades	92.6		70-79.9	C	Performance meets the state's expectations
Points Total – High School Grades	90.4		60-69.9	D	Performance does not meet the state's expectations
			Less than 60	F	Performance substantially below the state's expectations
			Blank	*	Insufficient data available to calculate an ESEA grade

2013 – ESEA / Federal Accountability System
Note: Adapted from 2013 Federal Accountability System Data, 2013.

Appendix B

Visual of Bloom's Original Taxonomy and the Revised Taxonomy



Visual of Bloom's Original Taxonomy and the Revised Taxonomy (Pohl, 2000, p. 8)

Appendix C

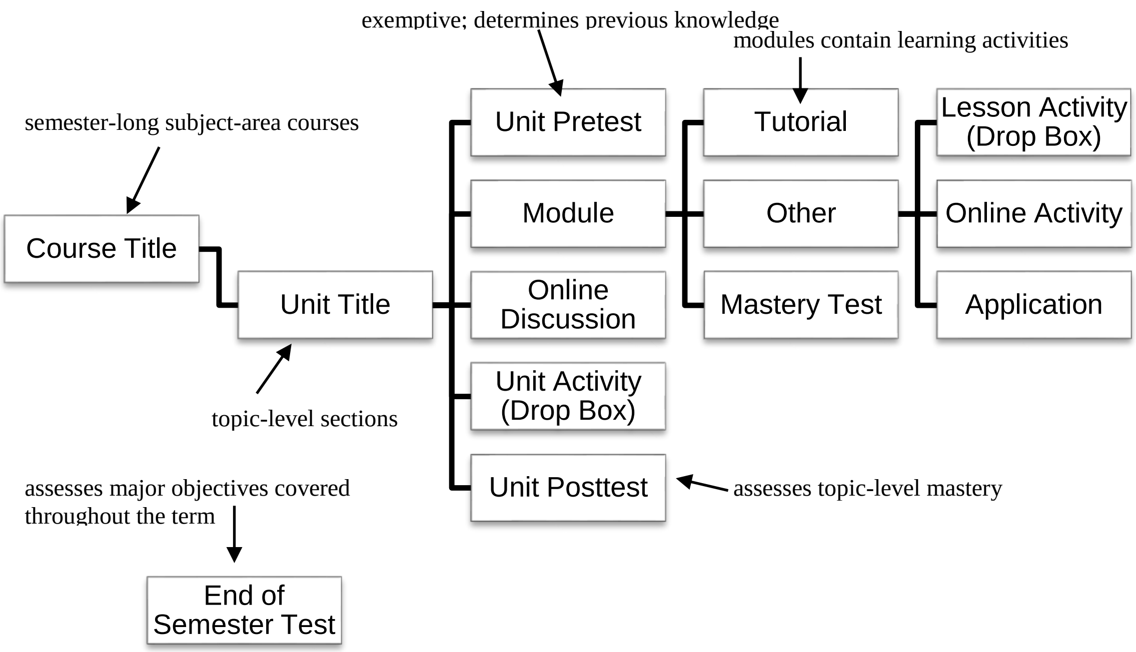
Technology Assumptions

Assumptions of Technology
Technology consists of the designs and environments that engage learners
Learning technologies can be any environment or activities where learners are engaged in active, constructive, intentional, authentic, cooperative learning
Technologies are not communicators of meaning
Technologies support meaningful learning when interactions with technologies are learner initiated and learner controlled
Technologies function as intellectual tool kits that enable learners to build more meaningful interpretations and representations of the world while supporting a course of study
Technologies and learners should be partners intellectually

Note: Adapted from Technology Assumptions (Crismond et al., 2010)

Appendix D

P.L.A.T.O. Courseware Model



Note: Adapted from P.L.A.T.O. Courseware Model (White Paper, 2010, p. 7)

Appendix E

P.L.A.T.O. Student Evaluation

P.L.A.T.O. STUDENT EVALUATION

Please answer the following questions about your background info and your experiences with and your opinions of the P.L.A.T.O. system and the lessons. Your responses will provide valuable information for evaluating the use of the P.L.A.T.O. system as a supplement to instruction.

1. What is your gender?

__Male **__Female**

2. Please specify your race/ethnic group.

__Black __Asian __White __Hispanic __Native American Other ________

Many of the following questions will require an answer rating of either of the following:

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
SA	A	N	D	SD

3. Please indicate the feelings you have had while using P.L.A.T.O.
   Circle the appropriate number in each row.

	SA	A	N	D	SD
Excited	5	4	3	2	1
Frustrated	5	4	3	2	1
Challenged	5	4	3	2	1
Annoyed	5	4	3	2	1
Confused	5	4	3	2	1
Proud of myself	5	4	3	2	1
Bored	5	4	3	2	1
Relaxed	5	4	3	2	1

4. When using P.L.A.T.O., how did you work (i.e. independently, with instructor, with another, in groups, etc.) and why?

5. Do you think the material you saw could have been taught as rapidly or completely if it had been presented by a more usual educational medium (such as lecture or textbook)? Explain.

6. How do you feel the P.L.A.T.O. lessons linked to the unit being taught?

7. Did you enjoy P.L.A.T.O. and why?

8. Would you encourage your friends to take a course that uses P.L.A.T.O.?

__Yes **__No** **__Uncertain**

9. Why?

10. What have you liked most about P.L.A.T.O.?

11. What have you liked least about P.L.A.T.O.?

Appendix F

Plato Individual Feelings' Chi-Squared Test Results

Feeling Excited: PLATO					
Observed	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	1	0	0	**1**	0.04
Agree	1	0	1	**2**	0.08
Neutral	3	6	2	**11**	0.44
Disagree	0	2	1	**3**	0.12
S. Disagree	0	6	2	**8**	0.32
Totals	**5**	**14**	**6**	**25**	

Feeling Excited: PLATO					
Expected	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	0.2	0.56	0.24	**1**	0.04
Agree	0.4	1.12	0.48	**2**	0.08
Neutral	2.2	6.16	2.64	**11**	0.44
Disagree	0.6	1.68	0.72	**3**	0.12
S. Disagree	1.6	4.48	1.92	**8**	0.32
Totals	**5**	**14**	**6**	**25**	
p > .05	0.271	*Chi-Squared Test Result*			
We don't have enough evidence b/w/o are different					

Feeling Confused: PLATO					
Observed	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	0	2	0	**2**	0.08
Agree	0	1	1	**2**	0.08
Neutral	2	5	3	**10**	0.4
Disagree	3	2	0	**5**	0.2
S. Disagree	0	4	2	**6**	0.24
Totals	**5**	**14**	**6**	**25**	

Feeling Confused: PLATO					
Expected	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	0.4	1.12	0.48	**2**	0.08
Agree	0.4	1.12	0.48	**2**	0.08
Neutral	2	5.6	2.4	**10**	0.4
Disagree	1	2.8	1.2	**5**	0.2
S. Disagree	1.2	3.36	1.44	**6**	0.24
Totals	**5**	**14**	**6**	**25**	
p > .05	0.284	*Chi-Squared Test Result*			
We don't have enough evidence b/w/o are different					

Feeling Proud: PLATO					
Observed	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	0	2	0	**2**	0.08
Agree	3	2	1	**6**	0.24
Neutral	2	6	3	**11**	0.44
Disagree	0	1	1	**2**	0.08
S. Disagree	0	3	1	**4**	0.16
Totals	**5**	**14**	**6**	**25**	

Feeling Proud: PLATO					
Expected	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	0.4	1.12	0.48	**2**	0.08
Agree	1.2	3.36	1.44	**6**	0.24
Neutral	2.2	6.16	2.64	**11**	0.44
Disagree	0.4	1.12	0.48	**2**	0.08
S. Disagree	0.8	2.24	0.96	**4**	0.16
Totals	**5**	**14**	**6**	**25**	
p > .05	0.530	*Chi-Squared Test Result*			
We don't have enough evidence b/w/o are different					

Feeling Frustrated: PLATO					
Observed	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	2	2	0	**4**	0.16
Agree	0	1	2	**3**	0.12
Neutral	2	5	2	**9**	0.36
Disagree	0	5	1	**6**	0.24
S. Disagree	1	1	1	**3**	0.12
Totals	**5**	**14**	**6**	**25**	

Feeling Frustrated: PLATO					
Expected	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	0.8	2.24	0.96	**4**	0.16
Agree	0.6	1.68	0.72	**3**	0.12
Neutral	1.8	5.04	2.16	**9**	0.36
Disagree	1.2	3.36	1.44	**6**	0.24
S. Disagree	0.6	1.68	0.72	**3**	0.12
Totals	**5**	**14**	**6**	**25**	
p > .05	0.363	*Chi-Squared Test Result*			
We don't have enough evidence b/w/o are different					

Feeling Challenged: PLATO					
Observed	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	0	1	0	**1**	0.04
Agree	3	1	1	**5**	0.2
Neutral	2	7	4	**13**	0.52
Disagree	0	2	1	**3**	0.12
S. Disagree	0	3	0	**3**	0.12
Totals	**5**	**14**	**6**	**25**	

Feeling Challenged: PLATO					
Expected	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	0.2	0.56	0.24	**1**	0.04
Agree	1	2.8	1.2	**5**	0.2
Neutral	2.6	7.28	3.12	**13**	0.52
Disagree	0.6	1.68	0.72	**3**	0.12
S. Disagree	0.6	1.68	0.72	**3**	0.12
Totals	**5**	**14**	**6**	**25**	
$p > .05$	0.302	*Chi-Squared Test Result*			
We don't have enough evidence b/w/o are different					

Feeling Bored: PLATO					
Observed	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	1	9	2	**12**	0.48
Agree	0	2	0	**2**	0.08
Neutral	1	1	2	**4**	0.16
Disagree	1	1	2	**4**	0.16
S. Disagree	2	1	0	**3**	0.12
Totals	**5**	**14**	**6**	**25**	

Feeling Bored: PLATO					
Expected	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	2.4	6.72	2.88	**12**	0.48
Agree	0.4	1.12	0.48	**2**	0.08
Neutral	0.8	2.24	0.96	**4**	0.16
Disagree	0.8	2.24	0.96	**4**	0.16
S. Disagree	0.6	1.68	0.72	**3**	0.12
Totals	**5**	**14**	**6**	**25**	
$p > .05$	0.179	*Chi-Squared Test Result*			
We don't have enough evidence b/w/o are different					

Feeling Relaxed: PLATO					
Observed	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	2	1	1	**4**	0.16
Agree	1	3	0	**4**	0.16
Neutral	1	5	2	**8**	0.32
Disagree	1	2	1	**4**	0.16
S. Disagree	0	3	2	**5**	0.2
Totals	**5**	**14**	**6**	**25**	

Feeling Relaxed: PLATO					
Expected	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	0.8	2.24	0.96	**4**	0.16
Agree	0.8	2.24	0.96	**4**	0.16
Neutral	1.6	4.48	1.92	**8**	0.32
Disagree	0.8	2.24	0.96	**4**	0.16
S. Disagree	1	2.8	1.2	**5**	0.2
Totals	**5**	**14**	**6**	**25**	
p > .05	0.684	*Chi-Squared Test Result*			
We don't have enough evidence b/w/o are different					

Feeling Annoyed: PLATO					
Observed	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	0	3	1	**4**	0.16
Agree	0	6	1	**7**	0.28
Neutral	2	1	1	**4**	0.16
Disagree	1	4	3	**8**	0.32
S. Disagree	2	0	0	**2**	0.08
Totals	**5**	**14**	**6**	**25**	

Feeling Annoyed: PLATO					
Expected	*Black*	*White*	*Other*	**Totals**	Percentages
S. Agree	0.8	2.24	0.96	**4**	0.16
Agree	1.4	3.92	1.68	**7**	0.28
Neutral	0.8	2.24	0.96	**4**	0.16
Disagree	1.6	4.48	1.92	**8**	0.32
S. Disagree	0.4	1.12	0.48	**2**	0.08
Totals	**5**	**14**	**6**	**25**	
p > .05	0.055	*Chi-Squared Test Result*			
We don't have enough evidence b/w/o are different					

Plato Individual Feelings' Chi-Squared Test Results