The Effect Of Technology Acceptance On Post Secondary African-American Students Achievement In Mathematics: A Path Analytic Inquiry

Sulakshana Sen
University of Central Florida

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THE EFFECT OF TECHNOLOGY ACCEPTANCE ON POST SECONDARY AFRICAN-AMERICAN STUDENTS’ ACHIEVEMENT IN MATHEMATICS:
A PATH ANALYTIC INQUIRY

By

SULAKSHANA SEN
M.S University of Central Florida, 1998

A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor in Education
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Major Professor: Dr. Stephen A. Sivo
The purpose of this research was to investigate the effect of technology acceptance on post secondary African American students’ achievement in Mathematics. The study was conducted in a historically Black four-year college in Daytona Beach, Florida on students using the computer to enhance their mathematics performance in an introductory algebra mathematics course. By using Technology Acceptance Model (TAM) developed by F. Davis (1989), this study focused on variables such as perceived usefulness, perceived ease of use, computer self-efficacy, subjective norms, attitude and actual use of the computer to account the effect towards the achievement in the final exam which is an outcome variable. The data were collected over four different time periods during the fall semester of 2004 to find how these results changed over time.

The study was conducted by using six instruments to measure perceived usefulness, perceived ease of use, computer self-efficacy, subjective norms, actual use of computer (frequency and duration), attitude and an additional demographic instrument. The data were analyzed by path analysis using multiple regressions (SPSS for windows) to find the contribution of each independent variable to the dependent variable that ultimately predicted the final outcome. Computer self-efficacy and subjective norms were determinants of perceived usefulness and perceived ease of use which in turn determined the attitude of students using computer for enhancing their math score in the final. The findings of path analysis indicated that the research did not support TAM.
The results suggested that perceived usefulness is the most significant predictor of perceived ease of use. The duration of actual use of the computer in a single session contributed significantly towards their final score for achievement in mathematics. The students preferred a face-to-face instruction in mathematics by the instructor than interaction with a computer. Additional research endeavors should be devoted to the measurement of system use in different set up with different ethnic background to further analyze students’ acceptance or rejection of technology towards their achievement in mathematics.
To my husband, Shukdeb, this intellectual journey would not have completed without your constant support and love. To my daughter, Susan, who grew up from four to seven years old with enormous patience counting in her little fingers when mommy would be done. To my loving sister Sanu, who is always proud of me with or without this accomplishment. Nothing can be more gratifying than sharing this moment with you.
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Lastly, I acknowledge my deepest gratitude to the memory of my beloved parents, who would have been proud of the biggest accomplishment of their daughter and I thank them for their unending blessings to make it all possible.
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CHAPTER I: INTRODUCTION

Rationale

The ethnic educational achievement gap is a well-documented phenomenon where African American students nationwide do not perform as well as whites on standardized academic achievement measures (Singham, 98). A longitudinal research study of African American and Caucasian students from 18 Four-year institution also suggested that the Caucasian students scored higher than their African American counterparts on seven standardized tests measuring critical thinking scale, knowledge of mathematics, science reasoning, reading and writing skills (Flowers & Pascarella, 2003). This study conducted by Flowers and Pascarella, also revealed that Caucasian students achieved greater gains on standardized measures such as mathematics and vocabulary than African American students.

Researchers have paid special attention to the phenomenon that the Black-White achievement gap narrowed and tried to account for the success (Grissmer, Flanagan, & Willamson, 1998). The list of factors affecting racial and ethnic achievement gaps may include socioeconomic and family conditions (educational attainment, income, poverty, single household); youth culture and student behaviors (motivation and effort for learning, alcohol and illicit drug usage, crime); and schooling conditions and practices like instructional resources, teachers, course taking, dropout, segregation (Lee, 2002).

Meta-analytic reviews of media research have produced evidence that exhibit positive learning benefits with various media, particularly computers (Clark, 1983, 1985a, 1985b). These analyses reported an approximate 20 percent increase in final
exam scores following computer-based instruction (CBI) when it is compared to
traditional forms of instruction. It is not just the computer but the teaching method built
into the computer that accounts for the learning gains (Kulik, 1985). The use of
technology in the classroom has afforded educators the opportunity to explore more
complex problems with their students than would otherwise be possible with a paper and
pencil format (Robison, 2000). The importance of using technology in classroom for
teaching mathematics has “increased dramatically” over the course of the last several
years (Lappan, 2000, p.319). Amarasinghe and Lambdin (2000) described three different
varieties of technology usage: I-using technology as a data analysis tool, II-using
technology as a problem solving/mathematical modeling tool, and III- using technology
to integrate mathematics with context.

Meanwhile, the researchers (Balacheff & Kaput, 1996; Kilpatrick & Davis, 1993)
have discussed the impact of technological forces on learning and teaching mathematics.
The power of computers leads to fundamental changes in mathematical instruction. For
example, the ability to build and run complex mathematical models, and exploration of
“what if” questions through parametric variation has opened up new avenues for
mathematics (Dreyfus, 1991). It is also reported that weaker students often are better
able to succeed with the help of technology, and thereby come to recognize that
mathematics is not just for their more able classmates (Wimbish, 1992). Although there
is plenty of literature available about the potential of technology that can guide how
mathematics is taught, but very little information is available about how the use of
technology can change students’ perception about mathematical problem solving. The
researchers want to know whether the perception of acceptance of technology could
change students’ grades in mathematics or enhance their mathematical problem solving skills.

Jonassen and Reeves (1996) wrote about computer based cognitive tools and learning environments that have been developed to function as intellectual partners to enable and facilitate critical thinking and higher order learning like mathematics.

Learners themselves function as designers using technologies as tools for analyzing the world, accessing information, interpreting and organizing their personal knowledge and representing what they know to others. Ever since Taylor (1980) presented his classic model of the roles of computers in education as “tutor, tool, and tutee,” many educators have predicted that computers have revolutionized education through one of these roles. But, the real power of computers to improve education will only be realized when students actively use them as cognitive tools rather than passively perceive them as tutors or repository of information (Jonassen & Reeves, 1996). Norman (1983) contends that computers support reflective thinking when they enable users to compose new knowledge by adding new representations, modifying old ones, and comparing the two. Salomon, Perkins, and Globerson (1991), make an important distinction between the effects of learning with and of technology:

First, we distinguish between two kinds of cognitive effects: Effects with technology obtained during intellectual partnership with it, and the effects of it in terms of the transferable cognitive residue that this partnership leaves behind in the form of better mastery of skills and strategies (p.2).

According to Salomon et al. (1991), the cognitive effects with computer tools greatly depend on the mindful engagement of learners in the task afforded by these tools.
Computer as a technology tool for Blacks or lower achievers may serve as powerful catalyst for facilitating mathematics skills assuming that they are used in ways that promote reflection, problem solving in enhancing skills in mathematics.

The African American students’ attitude towards using computer may help towards their success in mathematics. Computer Assisted Instruction (CAI) in Mathematics is definitely a supplement to regular classroom in basic mathematics and algebra to benefit the students in mathematics. If CAI is used appropriately, the gap between white/Asians and African Americans students should begin to close (Brown, 2000).

Although recent studies have indicated that the gap in achievement test scores among ethnic groups has narrowed appreciably over the years (Cross, 1995; Gross, 1993; & Jones 1985), many of these studies revealed that Asian/white students continue to substantially outperform students from underrepresented ethnic minority groups, particularly African Americans, on tests of mathematics achievements. Moreover, while some ethnic minority groups have made substantial gains on mathematics achievement tests in recent years, African Americans have exhibited the least amount of improvement among the major ethnic and language minority groups in the United States (Cross, 1995).

The researcher is interested to investigate the African American’s attitude and acceptance level as these students actually use computers in this project. Attitude has been defined as inclination to act or to be in state of ‘readiness to act’ (Gagne, 1985). A positive attitude arises due to previous successful experiences or from a perception that success is possible.
The Technology Acceptance Model (Davis, Bagozzi, & Warshaw, 1989), suggests that perception or attitude towards its use directly influence intentions to use the computer and ultimately actual computer use and the computer usage behavior. An individual’s initial attitude regarding a computer’s ease of use and computer’s usefulness influence attitudes towards use and that training significantly improved the computer self-efficacy for both males and females (Torkzadeh, Pflughoeft & Hall, 1999).

A significant and growing body of subsequent research has confirmed the usefulness of the Technology Acceptance Model (TAM) – and various extensions and revisions – as a tool for investigating user information technology acceptance (Chau, 1996; Geffen and Straub, 1997; Szajna, 1996; Taylor and Todd, 1995). The TAM by Davis was developed to explain computer-usage behavior.

Adapted from the theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM) by Davis (1989) identified two distinct constructs, perceived usefulness and perceived ease of use which directly affect the attitude towards target system use and indirectly affect actual system use. TAM has proved that the perceived ease of use and perceived usefulness can predict attitude towards technology that then can predict the usage of that technology. Davis has shown the usage of information technology. He applied the theory of Ajzen and Fishbein (1980) about reasoned action to show that beliefs influence attitudes that lead to intentions, and therefore generate behaviors. Davis conceived that TAM’s belief-attitude-intention-behavior relationship predicts user acceptance of technology. TAM has been well tested and proven to be quite reliable and robust in predicting user acceptance in business related studies. TAM posits that an individual’s intention to use a system is determined by two belief factors: Perceived
usefulness and Perceived ease of use. Davis asserted that perceived usefulness is the
degree to which a person believes that a particular technology would enhance his or her
job performance. Perceived ease of use is the degree to which a person believes that
using a particular technology would be free of effort (Davis, 1989). To gain a better
understanding of information technology, adoption and its use in organization the TAM
has been widely used (Chismar & Wiley-Patton, 2003). The Technology Acceptance
Model may allow us to identify the degree to which a Black student’s attitude regarding
technology moderates the effect of supplemental computerized instruction on the
development of mathematical skills.

Research Questions

Questions that must be answered in this correlational inquiry are as follows:

• How well does the initial Technology Acceptance Model (Time1) explain the
  Algebra course grades of African American students in a historically Black
  college?

• How well does the Technology Acceptance Model (Time2) explain the Algebra
  course grades of African American students in a historically Black college?

• How well does the Technology Acceptance Model (Time3) explain the Algebra
  course grades of African American students in a historically Black college?

• How well does the Technology Acceptance Model (Time4) explain the Algebra
  course grades of African American students in a historically Black college?

• How do the results obtained from the Technology Acceptance Model (TAM)
  change over time?
Purpose and Objectives of the Study

The Technology Principle (NCTM, 2000, p. 24) stated that “technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students’ learning”. The purpose of this study using Technology Acceptance Model (TAM) was to investigate the causal relationship between African American students’ attitude toward the use of computer and their actual use of the computer for improving their mathematical skills. The researcher also intended to find if the study would support the TAM.

It was anticipated that the researcher would find evidence suggesting that students’ positive and negative attitude towards computer influences their actual use of computer for improving their mathematics performance. The scores concerning the perceived usefulness of computer and perceived ease of using the computer are both reliable and valid. The researcher also extended this model to explain the perception-attitude-behavior relationship of students using the computers for their mathematics success. Previous research studies indicated that computer self-efficacy (Lee, 2002; McCauley & Courneys, 1993) and the subjective norms (Fisher, 1990; Wolski & Jackson, 1999) are two latent factors that will be measured to determine their role in the study of attitudes toward using computer to help improve African American students’ mathematics performances.
Relevance of the study

The intent of this study is to assist Bethune Cookman College (BCC) to tailor customized instruction in mathematics classes using the technology for the purpose of better suiting the students of Bethune Cookman College who most often feel mathematics is not their strong area. Due to limited financial resources, it is incumbent upon the college to make learned decisions for implementing information. But, the significance of the study may provide an insight to the students’ perception about the system employed, use and usage. This study is going to be helpful in analyzing the influence of using computer technology to improve students’ mathematics learning.

Limitations of the study

The limitations of the study are:

1. A self-reported study may not portray the full picture of the students’ acceptance of computer using towards enhancing their math skills due to imperfection of qualitative research (Cheung, Chang, & Lai, 2000).

2. All participation was limited to the population enrolled in 16 sections of MA 112 (Introductory Algebra) course, which is the lowest level mathematics class in the college.

3. Validity of the study relies on participants’ honest responses to the questionnaire.

4. Since the sample is taken from the BCC population, the result can, at least, apply to that particular population and to other academic units that are similar to BCC.

5. Internal and external validity were limited to the reliability of the instruments utilized.
6. Results may not be represented in multiple facets, as qualitative inquiry is not included in the present study, so the results may not be represented in multiple facets.

Assumptions of the study

The assumptions of the study are as follows:

1. The sample participants used the targeted computer system and had their response in the questionnaire in an honest fashion.

2. The answers the participants provided were based on their belief and for better usefulness of the computer used towards enhancement of their mathematics skills.

3. Cost was not a factor to BCC students in adopting computer for the math class. The cost was not considered a factor for students in an institutional and organizational context for answering the questionnaire.

4. Validity and reliability of the questionnaire items were secured to allow for accurate results.

5. The participants in the research study had access to questionnaire presented by the researcher in the class.

6. The participants answered the questionnaire without the help of other individuals, classmates or teachers.

7. The homogeneity of the groups of participants and non-participants’ is confirmed.
Definition of Terms

The definition of terms used in this research study for path analytic procedure is as follows:

Perceived usefulness (PU): According to Davis (1989), the degree to which a person believes that using a particular system would enhance his or her job performance.

Perceived ease of use (PEU): According to Davis (1989), the degree to which a person believes that using a particular system would be free from effort.

Attitude (AT): According to Davis (1993) the Attitude toward use of target system, the degree to which an individual evaluates and associates the target system with his or her job (Davis, 1993, p. 476).

Computer self-efficacy (CSE): Computer self-efficacy is an individual’s belief in their ability to perform a particular task using the computer (Bandura, 1977).

Actual Use (AU): Actual Use of the system is a behavioral response measured by the individual’s action in real life (David, 1993). This refers to the time students really put forward to use the computer for their course.

Subjective Norms (SN): Subjective Norms are the user’s perception of the external forces and their motivation to comply with the forces (Robinson, 2001).

Computer Algebra System (CAS): A program for symbolic manipulations of mathematical expressions and development of mathematical algorithms.

Computer Assisted Instruction (CAI): Computer Assisted Instruction is a supplement to regular classroom instruction.

Computer Based Instruction (CBI): Instructional setting using a computer.
Scholastic Aptitude Test (SAT): A test used to determine students’ scholastic aptitude for high school students.

Technology Acceptance Model (TAM): The technology acceptance model is an information systems theory that models how users come to accept and use a technology.

Theory of Reasoned Action (TRA): Theory of reasoned action suggests that behavioral intentions are a measure of one’s intention to perform a specified behavior. (Fishbein & Ajzen, 1975)

R-square: “coefficient of determination”. Measure of the proportion of the variance of the dependent variable about its mean that is explained by the independent variable(s), (Geffen, Straub, & Boudreau, 2000, p.72)

Path Analysis: A model that “…concerns only observed variables and structural models: multiple exogenous and endogenous variables; endogenous variables can affect one another” (Kline, 1998, p.64). A path diagram is always used to depict the causation in path analysis.
CHAPTER II: REVIEW OF LITERATURE

Background

Crystal (1993) reflected on the increased importance of mathematics in civilization beginning with the representation of etched marks on the pole indicating the number of animals in the grazing herds to the advanced complexities of numerical analysis and the theory of fractals. The importance of mathematics in our day-to-day world is undeniable and a better foundation of mathematical concepts is an essential requirement for all citizens. Drosjack (2003) reported that one in three high school students could not achieve a proficiency level in mathematics that is necessary to solve problems encountered in everyday life. Bayer Corporation (2003) found that 90 percent of people believe that today’s students may not have the math and science skills necessary to produce scientific excellence required for homeland security and economic leadership in the 21st century.

The National Assessment of Educational Progress (NAEP) under the auspices of National Center for Educational statistics, U. S department of Education has developed instruments that can determine the achievement levels of pre-college students in mathematics to measure changes in achievement over time. Mathematics achievement tests were administered periodically to students in the 4th, 8th, and 12th grades. The results of 1990 mathematics assessment showed that among 12th graders the average difference between white students’ scores and African American students’ was 33 points (NAEP, 1999). The most recent NAEP report (2003) indicates that fourth and eight graders average mathematics scores increased from scores reported earlier. However, the
average math score gap between White and African American students remained the same. At grade 4, the score gap showed 27 points, whereas for 8th graders 35 points.

Jencks and Phillips (1998) reported that African American students’ score lower than whites on reading and math tests as well as on tests such as the SAT. A study in 1998 involving applicants to five highly selective universities found that the white candidates’ average combined SAT score was 186 points higher than the corresponding SAT average for African American applicants (Bowen & Bok, 1998). Close to 75 percent of white applicants scored over 1200 on the SAT while only 29 percent of the African American applicants achieve that score.

Although the gap in the achievement test scores among ethnic groups has narrowed appreciably over the years (Cross, 1995; Gross, 1993; & Jones, 1985), many of these studies revealed that Asian/ Pacific Islander, and white students continue to perform better than underrepresented minority groups, particularly African Americans on mathematics achievement. These substantial disparities in mathematics and science achievement between Asian/ Pacific Islanders, and Whites and underrepresented minority groups have raised serious concerns among educators and policymakers (Thomas, 2000). According to Thomas, the deficiencies in the education of any ethic minority group in mathematics and science would subsequently impact the quality and quantity of human resources in the United States.

While many factors that are responsible for this disparity between white and African American achievement in mathematics, various studies indicate that the technology can help to raise student achievement and narrow the gap that exists between white/others and African American students. The International Society for Technology in
Education (ISTE) advocated the use of technology in the mathematics classroom. The ISTE had set the technology standards as the National Educational Technology Standards for Students: Connecting Curriculum and technology (NETS). This organization lists National Council of Teachers of Mathematics (NCTM) as one of its project partners. The ISTE NETS (2000) devotes 30 pages to mathematics learning activities and states in their introduction to this section:

Technology can play a role in enhancing mathematical thinking, student and teacher discourse, and higher-order thinking by providing the tools for exploring and discovering mathematics. Technology allows students to reflect on their activities and promotes reflective and cognitive processes in their problem solving that go below the surface and connect with the real world (p. 96).

Certainly the use of technology in this manner supports the notion of curriculum being “like and animated conversation on a topic that can never be fully defined, although one can set limits upon it” (Bruner, 1992, p.5).

The teaching and learning process has been dramatically altered by the convergence of a variety of technological, instructional and pedagogical developments in recent times (Bonk & King, 1998; Marina, 2001; Smith, 2002). Technology is challenging the boundaries of the educational structures that have traditionally facilitated, and supported learning (Garmer & Firestone, 1996). Recent advances, especially in the area of computer technology, have heralded the development and implementation of new and innovative teaching strategies.

Instructional technology is influencing education in many ways. According to Hoffman (2002), educational opportunities are now accessible to students who in the past
lacked opportunities due to such restraints as geography, time, family and money. Instructional technology is also influencing the way learners make choices on when to learn, how to learn, and where to learn (Arger, Ling, Smallwood, Toomey, Kirkpatrick, & Banard, 2001). The web has expanded the opportunities for the increasing information to enhance the traditional classroom instruction.

Currently, there is greater possibility of accessing up-to-date content, as updating information on the web can be done faster and more easily than with textbooks. In addition, educators can make choices as to what technologies to integrate into their classroom situations from the large pool of resources available, such as CD-ROMS, DVD-ROMS, application software, multimedia applications, laserdisc, and communications applications (Shelly, Cashman, Gunter, & Gunter, 2002). Those who advocate technology integration in the learning process believe it will improve learning and better prepare students to effectively participate in the 21st century workplace (Butzin, 2000; Hopson, Simms & Knezek, 2002; Marina, 2000; Reiser, 2001).

Technology has no doubt become an integral part of higher education enabling students to access information rapidly and visually (Smith, 2002). It is appropriate to note how the computer algebra systems (CAS) are becoming a part of the growing technology-based curriculum for mathematics. The influences of these types of software are being investigated around the world. A three-year research grant for a pilot study was underway in Victoria, Australia examining CAS mathematics courses and corresponding CAS examinations (Leigh-Lancaster, 2000). Here in the United States, several studies on the use of CAS within college mathematics curriculums, more specifically calculus courses, differential equations courses, and college algebra courses have been
investigated. The first calculus study found students’ attitudes and confidence were positively affected by CAS (Schrock, 1989), a second study also indicated student achievement was positively affected by CAS (Cooley, 1995), while the last study found no significant improvement in academic performance following the implementation of CAS in the Calculus curriculum (Keepers, 1995). But, when CAS was used as an instructional tool, students outperformed the control group both conceptually and computationally (Tiwari, 1999). Finally, in the college algebra class studied, students using CAS were again able to outperform non-users both conceptually and computationally.

The benefit of computer and related technology during secondary and post-secondary education are multifaceted. Students who use the computers in mathematics have a more positive attitude about their mathematics abilities and show significant gains in problem solving abilities and content knowledge (Funkhouser, 1993). Harris and Harris (1987) go on to say that a type of teaching, known as authoritarian teaching, occurs when teachers imply that their way is the only way to solve a particular problem. Mathematics anxiety may be produced in the students by this approach. A lack of variety occurs when the teacher becomes so familiar with the subject that the teaching becomes staid (Harris & Harris, 1987). For many students, emphasis on memorization becomes a cause of mathematics anxiety.

According to Harris and Harris (1987), using a computer in the ‘tutor’ mode can reduce mathematics anxieties in many students at all grades. The computers can help students gain self-confidence in a number of ways: (1) infinite patience, (2) never tire, (3) never frustrated or angry, (4) never forget to correct or praise, and (5) individualized
learning (Lawton & Gerschner, 1982); thus helping students maintain a positive attitude about using the computer to learn. Research has also shown that the computer has the potential to help students rid themselves of negative attitudes toward personal use of computers. The computer has an initial fascination for students; it can be fun. Papert (1980) discussed the attitudes of fifth graders being taught geometry through the use of the language LOGO and a “turtle”, a cybernetic toy. The students did not classify working with a computer as mathematics and yet they are learning some basic ideas of geometry. There is evidence that computers can affect students’ attitudes and behaviors in a positive way (Fischer, 1984).

The findings of a study conducted by Gressard and Loyd (1987) on the effects of mathematics anxiety and gender on computer attitudes suggest that less mathematics anxiety corresponds to more positive computer attitudes. While the computer is commonly viewed as a tool for simplifying and enriching lives, many individuals react to this technology with feelings of anxiety, paranoia, and alienation. These reactions may have potentially serious career and educational consequences (Baumgarte, 1984). Although Wimbish (1992) stated that weaker students are better able to succeed with the help of technology, the researcher wants to find out if the success of computer or technology can show African American students’ improvement in mathematics skills, and the success of computers may to some degree be moderated by the African American students’ attitude towards such programs.

The traditional classroom instruction has been enhanced by the expansion of opportunities for increasing information by the web. Technology integration in the
learning process will better prepare students to participate in the 21st century workplace (Butzin 2000; Hopson, Simms & Knezek, 2002; Marina, 2000; Reiser, 2001).

Rather than asking whether to use technology, today’s educators are concerned with how to use the technology to enhance and enrich their learning environments (Barker, 2000). The classroom environments are richer and better by the attempts to assist teachers to develop problem solving skills, flexible thinking and creativity (Grabinger, 1996; Hopson, Simms & Knezek, 2002). Resource sharing in the learning environment is like course sharing in the learning environment. Course sharing is using the technology to share resources like having an instructor outside the class. Technology has no doubt become an integral part of higher education, enabling students to access information rapidly and visually (Smith, 2002).

When the technology is used effectively in the classroom, the focus shifts away from teacher-centered instruction to a learning environment that is more student-centered and flexible. In addition, the possibility for engaging students with physical challenges and other special needs increases dramatically with the use of technology. The computer software offers immediate, personal feedback, as well as privacy, so that students can move at their own pace and either make repeated attempts at the same task, go back to simple problems, or move swiftly ahead into more difficult subject matter without becoming discouraged, bored or frustrated.

Classrooms with computers provide an ideal environment for student collaboration and group investigations, which have a positive effect on students’ attitudes and confidence (Cohen, 1985; Kulhavy, 1977). Educators have speculated that the students will recall basic math facts more rapidly using Computer-Based-Instruction
(CBI) rather than finishing a worksheet filled with drill and practice problems. CBI can be an effective tool in the math classroom by providing feedback and individualized instruction, as well as improving student attitudes towards math. In an instructional setting, the term feedback can be defined as “any communication or procedure given to inform a learner of the accuracy of the response, usually to an instructional question” (Cohen, 1985; Kulhavy, 1977). Feedback can be used as a motivator and an incentive for students to increase their accuracy in solving math problems.

Use of the technology in education is a basic requirement across this country, but many people involved in teaching and learning fields have yet to accept its importance and need of this instrument. Many people are reluctant to use the technology. Researchers (Davis, 1986; Kelman, 1958) have observed that it is difficult to distinguish if usage behavior is caused by the influence on one’s intent or by one’s own attitude.

The Technology Acceptance Model

The Technology Acceptance model (TAM) is a management information system-specific model that originated from the theory of reasoned action (TRA). The TAM is an important theoretical tool used to analyze how people perceive technology and its usage. Fishbein & Ajzen (1975) provided the theoretical basis in developing the Theory of Reasoned Action (TRA) that emphasized the importance of the determinant’s consciously intended behaviors. According to the TRA, a person’s performance of a specified behavior is determined by his or her behavioral intention to perform the behavior. The TAM was formulated to trace the impact of external factors on internal beliefs, attitude and intentions. The behavioral intentions suggested by TRA are a measure of one’s
intention to perform a specified behavior and attitude represents an individual’s feelings about performing the behavior (Ajzen & Fishbein, 1980). According to Stefl-Mabry (1999), the theory of reasoned actions (TRA) defines the relationships between beliefs, attitudes, norms, intentions and behavior:

An individual’s behavior (e.g., use or rejection of technology) is determined by the person’s intention to perform the behavior, and this intention is influenced jointly by the individual’s attitude and subjective norm, defined as “the person’s perception that most people who are important to him think he should or should not perform the behavior in question” (Dillon & Morris, 1996, p.8).

According to the theory of reasoned action, beliefs determine attitudes towards a behavior and consequences of that behavior. Beliefs are defined as the “…individual’s subjective probability that performance of a given behavior will result in a given consequence” (Dillon & Morris, 1996, p.9). Simply put, if I do A, then B will follow. According to the TAM, perceived usefulness and perceived ease of use will have a significant impact of a user’s attitude towards using the system (A) that is defined as feelings of favorableness or unfavorableness towards the system (Stefl-Mabry, 1999).

The TAM uses the ideas delineated in TRA and expands it by incorporating two key sets of constructs: a) Perceived usefulness (PU) and Perceived Ease of Use (PEU) (b) User’s Attitude (AT), Actual Use (AU) of the computer. The TAM model has been extensively used in Management and Information System analysis.

The Technology Acceptance Model was one of the most influential extensions of Ajzen and Fishbein’s theory (1980) of reasoned action (TRA) and was developed by Fred Davis and Richard Bagozzi (Bagozzi, Davis & Warshaw, 1992; Davis, Bagozzi &
Warshaw, 1989). Davis (1986) introduced the TAM to account for the psychological factors that affect computer acceptance. The user acceptance of any technology can be predicted by the TAM, and is determined by two unique factors that is perceived usefulness and perceived ease of use. Many of TRA’s attitude measures were replaced with the technology acceptance measure’s ease of use, and usefulness. TRA and TAM, both of which have strong behavioral elements, assumes that when someone forms an intention to act, that they will be free to act without limitation. In the real world there will be many constraints, such as limited ability, time constraints, environmental and organizational limits, or unconscious habits which will limit the freedom to act (Bagozzi, Davis & Warshaw, 1992).

Bagozzi, Davis and Warshaw say:

Because new technologies such as personal computers are complex and an element of uncertainty exists in the minds on decision makers with respect to the successful adoption of them, people form attitudes and intentions toward trying to learn to use the new technology prior to initiating efforts directed at using. Attitudes towards usage and intentions to use may be ill-formed or lacking in conviction or else may occur only after preliminary strivings to learn to use the technology evolve. Thus actual usage may not be a direct or immediate consequence of such attitudes and intentions (p.662).

Earlier research on the adoption of innovations also suggested a prominent role for perceived ease of use. Tornatzky and Klein (1982) analyzed the relationship between the characteristics of an innovation and its adoption, finding that compatibility, relative advantage and complexity had the most significant relationships with adoption.
Attitude towards usage and intentions to use may be ill-formed or lacking in conviction or else may occur only after preliminary strivings to learn to use the technology evolve. Thus actual usage may not be a direct or immediate consequence of such attitudes and intentions (Bagozzi, Davis & Warshaw, 1992). Each of the factors of TAM is defined as follows:

- **Perceived usefulness**: The degree to which the individual believes that use of target system could enhance the job performance (Davis, 1993, p.477).

- **Perceived ease of use**: The degree to which the individual believes that using the target system would be free of mental and physical efforts (Davis, 1993, p. 477).

- **Attitude toward use of target system**: The degree to which an individual evaluates and associates the target system with his or her job (Davis, 1993, p. 476).

- **Actual system use**: a behavioral response, measured by the individual’s action in reality (Davis, 1989).

The TAM is an information theory that models how users come to accept and use a technology. The model suggested that when users are presented with a new software package, a number of factors influence their decision about how and when they will use it, notably: perceived usefulness and perceived ease of use. A causal relationship between attitude towards mathematics (ATM) and achievement in mathematics (AIM) has long been assumed to exist. That is, a more positive ATM contributes to a higher level of AIM (Suydam & Weaver, 1975). According to this study there was a reciprocal relationship between attitudinal measures and achievement in mathematics which implied that making to learn mathematical content in different set up, either computer software or any other method will improve the performance in mathematics.
The usage of technology in mathematics instructions shows a positive relationship between technology and student achievement in mathematics. However, influence of perception regarding technology among post-secondary learning communities has not been evaluated. This study will try to fill the gap in this important area by asking questions such as, how does the Technology Acceptance Model (TAM) explain the student’s actual use of computer software for mathematics and students’ end-of-course grade reflected by their final exam score? What is the inter-relationship among perceived usefulness, perceived ease of use, and students’ attitudes toward using the computer software for mathematics? How does students’ attitude toward the computer predict actual use and students’ final exam scores in mathematics? To what extent does computer self-efficacy affect perceived usefulness, perceived ease of use, students’ attitude toward using computer, and their actual computer use and students’ final exam score? By using the TAM model, this study will try to answer these questions through this correlational inquiry and develop a conscientious analysis of how African American students feel about the technology usage, and how technology can improve their achievement in mathematics.

In TAM the end users’ attitude toward technology: perceived usefulness and perceived ease of use are two determinants of end users’ attitude which were identified from a system users’ view point (Davis, 1986). The end users’ feedback on a hypermedia application was categorized in seven groups (Crowder, Hall, Heath, & Wills, 2000) as follows:

1. Users’ first impression of the system for information provision
2. Perceived controllability of the system
3. Perceived effectiveness of the system to deliver information on the factory floor
4. Perceived use of navigating the resource base
5. Perceived ease of learning the system
6. Users’ view on how the system could aid them in the activities
7. The overall weighed summary of the results

The productive capabilities of perceived usefulness and perceived ease of use was measured by Hubona and Blanton (1996) to task accuracy, task latency (i.e., response time) and user confidence in decision quality. Hubona and Blanton (1996) found that these three variables were affected by perceived ease of use. Igbaria, Zinatelli, Cragg, and Cavaye (1997) supported that the administrative/management support coupled with external expert support (e.g., vendors) can influence perceived ease of use and perceived usefulness. Davis (1993) suggested that the perceived usefulness and perceived ease of use are both effective predictors of attitude towards system use. Al-Gahtani and King (1999) pointed out that the indirect relationship to end user’s attitude towards the technology and attitude variables superiority to user satisfaction on system use depends on the compatibility. Compatibility is defined as “the extent to which a system is being perceived as consistent with the users, needs values and experiences” (pp. 290-291).

The success of an information system can be measured by two indicators: frequency and intensity (Davis, 1993). According to Davis, frequency of use and amount of time spent using a system are typical of usage metrics. Davis suggested that the frequency is measured by using scales such as “Don’t use at all” to “Use several times a day”.
Kelman (1958) distinguished between three different processes of social influence that affect individual behavior: compliance, identification and internalization.

According to Kelman, compliance is when an individual adopts the induced behavior not because she believes in its content but with the expectation of gaining rewards or avoiding punishments (Kelman, 1958). But, when an individual accepts influence because she wants to establish or maintain a satisfying self-defining relationship to another person or group is the identification (Kelman, 1958). When an individual accepts influence because it is congruent with his or her value system, that is considered as internalization (Kelman, 1958).

By distinguishing between these processes, one could ascertain if usage behavior is caused by the influence of referents on one’s intent or by one’s own attitude.

Based on Kelman’s framework, Davis, Bagozzi, & Warshaw (1989) had noted that social influences may affect behavioral intentions indirectly via attitude, due to internalization and identification processes, or influence behavioral intentions directly by compliance.

Much of the research seeking to understand the dynamics of human decision making in the context of accepting or resisting the technology has come from the field of management information systems (MIS). Researchers in the MIS field seek to predict how users in an organization will react to new technologies (Dillon and Morris, 1996). User acceptance is defined by Dillon and Morris as the willingness within a user group to employ information technology to the tasks it is designed to support.

According to Chismar and Wiley-Patton (2003), in previous studies the TAM has been widely used by information technology researchers to gain a better understanding of information technology adoption and its use in organizations. It had been applied and
tested in academic and corporate settings involving students, business managers, clerical and administrative types as subjects.

Although the TAM has been validated and re-tested since 1985, the studies on the efficacy of TAM were rarely conducted on a non-voluntary basis. According to Venkatesh (2000), future research should be conducted to test the boundary conditions of the proposed Technology Acceptance Model.

The MIS practitioners employed the TAM to find out the success or failure of using an information system. The TAM is based on the assumption that when end users perceived the target system as one that is easy to use and nearly free of mental effort, then they may have a favorable attitude towards using the system as implied by a research study by Pan, Sivo, and Brophy (2003). But according to Sanders and McCormick (1993) an individual must use some or all of one’s mental resources in order to perform a task. If the end users perceive the target system to be helpful toward their job then they can have a positive attitude toward the target system. When the end users have a positive attitude towards the use, then the frequency and duration of system use would prove successful (Pan, Sivo, & Brophy, 2003).

One of the most important factors which regulate end users’ behavior (e.g., adoption or rejection of the system) is their attitude towards the system (Harris, 1999). The success of a computer training program has been studied widely from the angle of system user characteristics, because success of using this is determined by the attitudes and perception that the participants possess when either opportunities or demands to use technology arise (Sivo, Pan & Brophy, 2004).
Davis’s original study (Davis, 1989) was replicated to provide empirical evidence on the relationships that exists between usefulness, ease of use and system use (Adams, Nelson & Todd, 1992). Much attention has focused on testing the robustness and validity of the questionnaire instrument used by Davis. The original TAM model was extended by Venkatesh and Davis (2000), to explain usage intentions in terms of social influences and perceived usefulness. The extended model, was referred to as TAM2, was tested in both voluntary and mandatory settings. The results strongly supported TAM2 (Venkatesh and Davis, 2000). In TAM 2, a significant effect was impacted on usage intention, perceived usefulness and perceived ease of use.

Computer Self-efficacy

Davis (1989) cited Bandura’s cognitive theory that defined self-efficacy as “judgments of how well one can execute courses of action required to deal with prospective situations” (p.321). Self-efficacy beliefs are theorized to function as proximal determinants of behaviors. According to the theory of Bandura (1977), self-efficacy judgments are distinguished from outcome judgments. Bandura’s “outcome judgment” is similar to perceived usefulness (Davis, 1989). Originally from Bandura’s (1977) self- efficacy theory, computer self-efficacy became a pivotal issue in technology acceptance. McCauley and Courneya (1993) stated as self-efficacy is not concerned with the possessed skills of the individual, but rather, using his or her own judgment how and what the individual can do with the skills he or she possesses. The self-efficacy is
achieved but not ascribed. In real life situations, human beings tend to regulate choices and efforts by first evaluating information regarding their skills and abilities (Torkzadeh & Van Dyke, 2001). They also believed that self-efficacy is achieved at various levels of specificity and at different degrees.

According to Decker (1998), human interaction is a cognitive process and self-efficacy is achieved through the cognitive interaction. Self-efficacy significantly transfers positive skills to real life experiences.

According to Agarwal and Karahanna (2000), self-efficacy inhibits a stronger influence on perceived ease of use than perceived usefulness. Morris and Turner (2001) also said that people who believe they are capable of using information technology to accomplish their tasks are more likely to use the technology than those who do not share similar self-efficacy beliefs. More specifically, Mylona (1999) claimed, “students’ beliefs about their capabilities to use advanced technology, such as the World Wide Web, will effectively determine their initial decision to participate in a course where such media is employed (p. 107). The researcher used computer self-efficacy (CSE) in the present study to denote self-efficacy for enhancement of mathematics achievement through using computer technology for the course.

Subjective Norms

According to Anandarajan, Igbaria, and Anakwe (2000), the definition of Subjective Norm (SN) is two-fold: vertical pressure and horizontal pressure. Vertical pressure is referred to the social pressure from people who are subordinate to the individual (i.e., a vertical dyads relationship); horizontal pressure refers to the social
pressure from people closely related to the individual (e.g., close friends). There is more likelihood for those who report high subjective norms to accept and adopt the new system (Anandarajan, Igbaria & Anakwe 2000; Liker & Sindi, 1997). Subjective norms include users’ perception of the external forces and their motivation to comply with the forces (Robinson, 2001). From the perspective of university faculty in the context of faculty development, Wolski and Jackson (1999) also agreed to this proposition.

A user acceptance study was measured by Anandarajan, Igbaria and Anakwe (2000) for perceived usefulness, perceived ease of use, social pressure and microcomputer use. This study was conducted on a group of bank staff those used the microcomputer. It was found out that perceived ease of use and social pressure had a high support towards the computational skill of the bank staff. With regard to user’s acceptance, normative beliefs and subjective norms are worthy of pursuit (Al-Gahtani & King, 1999).

The vital role of Subjective Norms (SN) was acknowledged by Lim (1999) that subjective norms with perceived behavioral control are the strongest predictors of users’ intention to technology acceptance. Based upon his research the perceived behavioral control is a similar construct as to perceive ease of use, that focuses on one’s own perception of the behavior. The behavior performed could be easy or difficult.

According to Choi, Choi, Kim, and Yu (2003), subjective norms exerted moderate influence (Beta = .43) on user’s behavioral intention to interactive TV adoption. Cheung, Chang, and Lai (2000), employed measures on two major dimensions which are external forces from the top management team including immediate supervisor and those from colleagues or coworkers. Cheung, Chang, and Lai (2000), arrived at the same conclusion
in a TAM study in a Web learning situation what Wolski and Jackson (1999) found in respect to subjective norms. To measure social pressure, Anandarajan, Simmers, and Igbaria (2000) used one variable: “Most people who are important to me in my job think I should be using the internet regularly in my job” (p.72).

To prepare students for future job competition, technology is used to better manage online business. As online systems continue to evolve, measurement of their use becomes an issue of significance in education. The great media debate conveys a message that educational media alone cannot explain learning (Pan, 2003). The learning process involves more than just media like the learners’ characteristics, the nature of the learning tasks and the interrelationship of these variables. Venkatesh and Davis (2000) successfully applied the TAM with the Subjective Norms constructs to a non voluntary setting but results might change in a different setting of African American students’ mathematical learning at Bethune Cookman College.

Instructional technology is influencing education in many ways. Although education has brought significant contributions to society, it has remained elusive to many people. Instructional technology is bridging this accessibility gap by permeating the walls and opening the doors for as many people as wish to participate in learning (Hanna, 1999).

Although the TAM has been validated and retested since 1989, studies of the TAM on a non-voluntary basis are rarely conducted (Sivo, Pan & Brophy, 2004). Venkatesh (2000) advises that “Future research should examine mandatory usage contexts to test the boundary conditions of the proposed technology Acceptance.
According to Pan, Sivo and Brophy (2003), the relation between attitude and students’ achievement should be addressed.
CHAPTER III: METHODOLOGY

The purpose of the study is to evaluate the effects of technology acceptance on post secondary African American students’ achievement in mathematics.

Participants

Student participation in the study is voluntary. The participants in this study are students of Bethune Cookman College, Daytona Beach, Florida. Bethune Cookman College (BCC) is a historically Black four-year degree college. This college was chosen for the study because of the predominantly African American student population and the fact that the literature reveals that, although many studies have been conducted concerning mathematics achievement, anxiety and computer/technology assisted instruction in mathematics, very few have been focused upon the African American student population and their attitude on if the acceptance of the technology has any effect on their performance.

The college has an annual enrollment of 3000 and 66% of students are from Florida. The other 28% of the students are from outside the state in the USA and foreign countries (5%). The student body on a yearly average has a make up of approximately 60% female and 40% male. The participants in MA 112 course (Introductory Algebra) in the fall semester of 2004 are predominantly African American students and are all over 18 years old. In this introductory mathematics class, students are enrolled on the basis of a placement test and students only having high SAT scores are exempted from this placement test. Most students live on the college campus for their four years of schooling
in the dorms in the campus until they get their Bachelor degree in various majors. Some students are directly enrolled in higher mathematics classes e.g. Calculus or Differential equation in the basis of their placement test result. The division of General Studies administers the academic and advisement programs for all first and second year students entering the college. The division provides an academic program with academic support services to meet the diverse needs of freshmen and sophomore students.

This introductory algebra class is the first class they have to take for any major they are in. Introductory Algebra provides a smooth transition from arithmetic to the more abstract skills and reasoning abilities developed in a beginning algebra course. The emphasis is placed on learning to read the language of mathematics in addition to the use of technology. The style of the textbook *Introductory Algebra* is informal and non-technical, while maintaining mathematical accuracy. The chapters of the textbook include the topics from Integers and real numbers, solving equations and inequalities, graphing linear equations, exponents and polynomials, factoring polynomials and solving quadratic equations. The National Council of Teachers of Mathematics (NCTM) and the American Mathematical Association of Two-Year Colleges (AMATYC) curriculum standards have been taken into consideration in the development of topics

(http://www.hawkeslearning.com/PC_IDAtext.htm)

Materials

The total points in MA 112 course are 1000 points and 30% of it is the lab work and homework that carries 300 points. The style of the text book “Introductory Algebra” is informal and non-technical, while maintaining mathematical accuracy. The chapters of
the textbook include the topics from integers and real numbers, solving equations and inequalities, graphing linear equations, exponents and polynomials, factoring polynomials and solving quadratic equations. The National Council of Teachers of Mathematics (NCTM) and the American Mathematical Association of Two-Year Colleges (AMATYC) curriculum standards have been taken into consideration in the development of topics (http://www.hawkeslearning.com/PC_IDAtext.htm).

Students do their homework assignment strictly in the computer that uses the “Hawkes Learning System” software that claims to be the leading software in computer assisted mathematics learning (http://www.hawkeslearning.com/PC_IDAtext.htm). The software is custom made for the textbook written by the author, D. Franklin Wright. In the learning lab there are at least 50 computers to accommodate the students of one section at any time. The students sign in and sign out and use their password to log in. They can get the password by buying the CD that accompanies the text book. It is unique for each student. The software has the instructor mode in which the instructor only has access to grade the homework of students. Students can go to any section and any chapter that is related to their class work.

The following six instruments are going to be used in the data collection questionnaire. They are: (1) Usability instrument (2) Attitude instrument (3) Computer self-efficacy instrument (4) Subjective-norm instrument (5) Computer use instrument (6) Demographic instrument.
Usability Instrument

The Usability instrument measures two constructs: students’ perceived ease of use of computer and students’ perceived usefulness of computer. According to Davis (1989), the perceived ease of use exerts a causal influence on perceived usefulness and both affected users’ attitudes toward new technology use. Perceived usefulness measured four items and perceived ease of use measured nine items. Each of the two scales adapted from Davis’ (1989) research measured 13 items together. Students were asked to respond based on their perception about the use of computer towards their mathematics performance. The variables will be measured on a six-point Likert scale starting from “Strongly Disagree”, Disagree”, “Neither Disagree or Agree”, “Agree”, “Strongly Disagree” and “Not Applicable”.

Attitude Instrument

The Attitude instrument is adapted from Ajzen and Fishbein’s (1980) attitude scales. The instrument was introduced by the general statement “All things considered, using the computer in my course work is ...” On a 6-point scale with 3 pairs of adjectives as positive or negative are going to be measured. The examples of the pair of adjectives are “Bad – Good”, “Foolish – Wise”, and “Unfavorable – Favorable”. Students will be requested to respond to the five scales by selecting one option for each item that best matched their attitude toward computer use. The attitude scale is inserted in three occasions: Time2, Time3 and Time4. Attitude is not measured in Time1, assuming
students may not be able to develop an attitude towards using computer technology that soon.

Computer Self-Efficacy Instrument

The computer self-efficacy instrument validated by Lee (2002) will measure students’ beliefs about their computer skills. The questionnaire is composed of two sections: course content self-efficacy, general software feature use self-efficacy. This instrument is called the computer self-efficacy (CSE) instrument in the present study, because Lee’s instrument measured the end-user computer skills in WebCT. In this research study eight items measured the computer self-efficacy. This instrument was introduced with a general statement, “I feel confident…..doing well in my math course or understanding course material in math class.

Subjective Norms Instrument

According to Wolski and Jackson (1999), there are two types of external pressures from vertical (relationship between faculty and students) and horizontal (relationship between students and students) relationships influenced the technology acceptance in higher education settings. In this study, the subjective norms construct was measured by a four item subjective norms instrument. Participants were asked to answer the questions to the best of their perceived ability about the use of computer technology on four occasions during the semester. The four items in the subjective norms instrument started with: “My Parents think….My Instructor thinks….My Peers think….”
who are important to me think…. These variables will be measured on the six point Likert scale starting from “Strongly Disagree”, “Disagree”, “Neither Disagree or Agree”, “Agree”, “Strongly Disagree” and “Not Applicable”.

System Use Instrument

The system Use Instrument will be used to measure frequency and duration of students’ use of the computer component of the class as suggested by Davis (1993). Davis argued, “Frequency of use and amount of time spent using a target system are typical usage metrics employed in MIS research” (P. 480). The two self-report scales were measured on a five-point nominal scale. The system use instrument was used on four occasions during the semester. To measure frequency of students’ use of computer, students were asked to select one of the five options that best matched their use of the computer in the following questions: “Less than once a week”, “Once a week”, “Twice a week”, “Three times a week” and “More than three times a week”. To measure how intensely students used the computer in the course, students will be requested to choose one of the following options: “Less than 15 minutes”, “Between 15 and 30 minutes”, “Between 31 and 45 minutes”, “Between 46 and 60 minutes” and “More than 60 minutes”.

Student Demographic Instrument

To evaluate users’ computer environment, the Student-Demographic Instrument was adapted from Bayston (2002) and Lee (2002) instrument to enquire about the
descriptive information about computer users of the MA 112 Introductory algebra class. A total of 11 items were compiled and modified to inquire about the descriptive information of students using computer. These acquire information about students’ gender, academic status, age, racial/ethnic group, reason for being in this class, prior experience, length of experience, learning habit, access to computer, available computer resource and choice of the participants. Sample questions will be included statements such as “Have you ever taken any class using the computer prior to the current one?”, “In general, how long have you used the computer?”, “What is your racial/ethnic group or about the students’ gender”.

Procedures

In this correlational study the data collection instrument is the questionnaire that was used to find the students’ perception and attitude about their use of the computer technology to assist their performance in mathematics achievement. Prior to the participation of the students in the survey questionnaire, the researcher briefly introduced herself to the class and state the reason for the research study, the name of the topic and why their participation would significantly contribute for the purpose of the study.

The researcher made it clear to the participants that whether or not students participated in the study, there would be no detrimental effect on their relationship with the instructor, the researcher, or the college. The project was solely designed for research purposes and no one except the researcher would have access to their information. All responses would remain confidential to the extent provided by law. The improvement of mathematics education provided by the participation of students was significant.
The questionnaire with six varied sections was administered four times in the 13 week fall semester. Each questionnaire was comprised of six scales as well as 11 demographic questions to measure six constructs: students’ perception of computer (i.e. perceived usefulness and perceived ease of use), students’ attitude towards computer, students’ actual use of computer, subjective norms, and computer self-efficacy to acquire individual information.

The questionnaire was administered to the students four times during the semester to see if there would be any change in their attitude that contributes to their achievement. The author incrementally tested the plausibility of the research model. The hypothetic model was tested with focus on the original TAM (Davis, 1993), which contained perceived usefulness, perceived ease of use, students’ attitude towards computer use for enhancement of their mathematics skills or improve their grades, students’ actual use of the computer and their end of course grade as the outcome variables.

The survey questionnaire was distributed to students in 16 sections comprising around 317 students taught by eight instructors in different time of the day in the fall semester. The data were taken in the fall semester, as the enrollment is highest in these classes than other semesters of the year.
CHAPTER IV: RESULTS

Introduction

The purpose of this study was to investigate the effect of technology acceptance on post secondary African American students’ achievement in Mathematics by replicating the Technology Acceptance Model. The subjective norms and the computer-self-efficacy were added to the hypothetical model to better explain the student’s attitude towards using technology to achieve a better grade or better score in mathematics.

A total of 327 students participated in the survey designed for the study who were enrolled in the Introductory Algebra course in the fall semester. The survey was administered four times during the semester to see the increment in different variables towards the contribution to final score or grade of students. Of those, there were 270 students participated in the initial Technology Acceptance Model (TAM1), 278 students participated in TAM2, 241 students participated in TAM3 and 237 students participated in TAM4 survey questionnaire administered in the classroom in a voluntary basis. The confidentiality of sample participants was given first priority. Student demographics indicated that 60% of the participants were female and 40% were male students in the introductory algebra class. The results of the study are reported in the following sections that showed the data characteristics.

Though the instruments are adapted from the literature, the author attempted to reaffirm that the instrument carried the validity and reliability to a satisfactory degree. Thus exploratory factor analysis and internal consistency reliability analysis were done using SPSS for windows. The factor analysis is a procedure that reduces larger set of
variables to a smaller set of factors, fewer in number than the original variable set, but capable of accounting for a larger portion of total variability in the items.

Reliability

There were five scales used to measure perceived usefulness, perceived ease of use, computer self-efficacy, subjective norms, and attitude. The perceived usefulness scale has four items; perceived ease of use, nine items; computer-self-efficacy, eight items; subjective norms, four items; and attitude has one item with a total of 26 items. Using SPSS for windows the reliability of those five scales was studied and is presented by the following table with the population.

<table>
<thead>
<tr>
<th></th>
<th>Time1</th>
<th>Time2</th>
<th>Time3</th>
<th>Time4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>.7241</td>
<td>.7797</td>
<td>.8337</td>
<td>.8584</td>
</tr>
<tr>
<td>N</td>
<td>270</td>
<td>273</td>
<td>233</td>
<td>226</td>
</tr>
</tbody>
</table>

From the Cronbach Alpha Coefficients of reliability analysis of the data varied on four time occasions varied from .7241 to .8584. The Time2, Time3 and Time4 are all deemed satisfactory except Time1. The attitude scale was excluded from Time1, which might be the cause for low alpha.
Research Question 1

How well does the initial Technology Acceptance Model (Time1) explain the Algebra course grades of African American students in a historically Black college?

Path analysis is a way of analyzing the direct and indirect effect of variables hypothesized as causal. One useful application of the Path analysis is as a way to find the best regression model by elimination of variables that contribute little to the equation. SPSS was used to find the coefficients of the pathways through multiple regressions. In the initial Technology Acceptance Model (Time1), the subjective norm contributed highest (.312) to perceived usefulness while it contributed almost one third (.111) to perceived ease of use. Perceived usefulness apparently contributed the most (.462) to perceived ease of use. The computer self-efficacy is the next contributor (.258) and the subjective norm is the lowest (.111) contributor to perceived ease of use. There was a difference noticed in the reported frequency of use and actual frequency of using the computer towards their coursework.

The duration of actual use and reported use was differed and not supported by data that was indicated by perceived ease of use and perceived usefulness in which the path coefficients were found negative. The attitude variable was excluded in the initial TAM model, as students are yet to develop an attitude towards using the computer to improve their course grade. For the final score, the duration of actual use supported the most and the frequency of actual use is the least. In accordance with the results the relationships among variables in the initial TAM (Time1) are illustrated as follows, using path analysis.
Table 2: Path Equations for Time 1

<table>
<thead>
<tr>
<th></th>
<th>Equation</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PU = .181CSE + .312SN</td>
<td>+</td>
<td>.831</td>
</tr>
<tr>
<td>2</td>
<td>PEU = .111SN + .258CSE + .462PU</td>
<td>+</td>
<td>.581</td>
</tr>
<tr>
<td>3</td>
<td>FP = .129PEU + .141PU</td>
<td>+</td>
<td>.953</td>
</tr>
<tr>
<td>4</td>
<td>FA = .014PEU + .031PU</td>
<td>+</td>
<td>.998</td>
</tr>
<tr>
<td>5</td>
<td>DP = .198PEU - .014PU</td>
<td>+</td>
<td>.964</td>
</tr>
<tr>
<td>6</td>
<td>DA = -.005PEU + .030PU</td>
<td>+</td>
<td>.999</td>
</tr>
<tr>
<td>7</td>
<td>FINAL = .096FP - .253FA + .017DP + .382DA + .954</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PU: Perceived usefulness; PEU: Perceived ease of use; FP: Frequency of reported use; FA: Frequency of Actual use; DP: Duration of reported use; DA: Duration of actual use; Final: Final exam score at the end of the semester.

Figure 1: TAM 1

SN: Subjective norms; CSE: Computer self-efficacy; PEU: Perceived ease of use; PU: Perceived usefulness; FP: Frequency of reported use; Frequency of actual use; DP: Duration of reported use; DA: Duration of actual use; Final: Final exam score at the end of the semester.
Inspection of the squared multiple correlations suggested that in Time1, the combined contribution of perceived usefulness, computer self-efficacy and subjective norms to the variance of perceived ease of use is explained about 42%. The perceived usefulness is being the highest contributor of this explanation. The frequency and duration (reported and actual) of using computer use is explained by only about 5% of the students’ final score. Some of the associated t-values are not significant.

Table 3. Squared Multiple Correlation Time1

<table>
<thead>
<tr>
<th>Variables</th>
<th>PU</th>
<th>PEU</th>
<th>FP</th>
<th>FA</th>
<th>DP</th>
<th>DA</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squares</td>
<td>.169</td>
<td>.419</td>
<td>.057</td>
<td>.002</td>
<td>.036</td>
<td>.001</td>
<td>.046</td>
</tr>
</tbody>
</table>

PU: Perceived usefulness; PEU: Perceived ease of use; FP: Frequency of reported use; FA: Frequency of Actual use; DP: Duration of reported use; DA: Duration of Actual use; Final: Final exam score at the end of semester; R-square: Measure of the proportion of variance of the dependent variable about its mean that is explained by the independent variable(s).

Research Question 2

*How well does the Technology Acceptance Model (Time2) explain the Algebra course grades of African American students in a historically Black college?*

At Time2, the perceived usefulness was highly supported by computer self-efficacy (.366) and by subjective norms (.238). Like the results for the initial TAM, the results at Time2 suggests that students’ perception of math software’s usefulness did a
better job of explaining students’ perception of how easy the software were to use (.605) than either by computer self-efficacy (.214) or subjective norms (.122). Unlike the initial TAM, students’ attitudes were included in the TAM at Time2 to observe how well they were predicted by either student perception of the math software’s usefulness or the math software’s ease of use. Indeed perceived usefulness explained the variation in students’ attitudes (.320) more strongly than perceived ease of use (.099).

The frequency and duration of actual use was not supported by the attitude data while the frequency and duration of reported use was supported little by the attitude. Only the duration of reported use contributed to students’ final scores where as frequency of actual and reported use with the duration of actual use were of no important contribution to the final exam score. The associated t-values were not significant when the variables are supported little or none by the data. In accordance with the results, the relationships among those variables on the Time2 are illustrated as follows.
Table 4: Path Equations for Time2

<table>
<thead>
<tr>
<th>Equation</th>
<th>Variables</th>
<th>Coefficients</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 PU</td>
<td>.366CSE + .238SN</td>
<td>+ .746</td>
<td></td>
</tr>
<tr>
<td>2 PEU</td>
<td>.122SN + .214CSE + .605PU</td>
<td>+ .383</td>
<td></td>
</tr>
<tr>
<td>3 AT</td>
<td>.099PEU + .320PU</td>
<td>+ .841</td>
<td></td>
</tr>
<tr>
<td>4 FP</td>
<td>.113AT</td>
<td>+ .987</td>
<td></td>
</tr>
<tr>
<td>5 FA</td>
<td>-.057AT</td>
<td>+ .997</td>
<td></td>
</tr>
<tr>
<td>6 DP</td>
<td>.144AT</td>
<td>+ .979</td>
<td></td>
</tr>
<tr>
<td>7 DA</td>
<td>-.037AT</td>
<td>+ .999</td>
<td></td>
</tr>
<tr>
<td>8 FINAL</td>
<td>-.044FP + .025FA + .160DP + .045DA</td>
<td>+ .970</td>
<td></td>
</tr>
</tbody>
</table>

PU: Perceived usefulness; PEU: Perceived ease of use; AT: Attitude; FP: Frequency of reported use; FA: Frequency of Actual use; DP: Duration of reported use; DA: Duration of Actual use; Final: Final exam scores at the end of the semester

Inspection of the squared multiple correlations suggested that the actual use (duration and frequency) variable only explained about 3% of the variation in student final scores for the algebra course. About 16% of the variation in students’ attitude was jointly explained by perceived usefulness and perceived ease of use in Time2. Perceived usefulness, computer self-efficacy and subjective norms also jointly explained 62% of the variation of perceived ease of use. The following table showed the explained variance in the variables considered.
Table 5. Squared Multiple Correlation Time2

<table>
<thead>
<tr>
<th>Variables</th>
<th>PU</th>
<th>PEU</th>
<th>AT</th>
<th>FP</th>
<th>FA</th>
<th>DP</th>
<th>DA</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squares</td>
<td>.254</td>
<td>.617</td>
<td>.159</td>
<td>.013</td>
<td>.003</td>
<td>.021</td>
<td>.001</td>
<td>.030</td>
</tr>
</tbody>
</table>

PU: Perceived usefulness; PEU: Perceived ease of use; FP: Frequency of reported use; FA: Frequency of Actual use; DP: Duration of reported use; DA: Duration of Actual use; Final: Final exam scores at the end of semester; R-square: Measure of the proportion of variance of the dependent variable about its mean that is explained by the independent variable(s).

Figure 2: TAM 2

SN: Subjective norms; CSE: Computer self-efficacy; PEU: Perceived ease of use; PU: Perceived usefulness; AT: Attitude; FP: Frequency of reported use; Frequency of actual use; DP: Duration of reported use; DA: Duration of actual use; Final: Final exam scores at the end of the semester.
Research Question 3

*How well does the Technology Acceptance Model (Time3) explain the Algebra course grades of African American students in a historically Black college?*

In Time3, the computer self-efficacy (.370) and the subjective norms (.387) contributed almost the same amount to the perceived usefulness. Like the Time1 and Time2, perceived usefulness supported perceived ease of use the most (.558). The Computer self-efficacy (.272) and the subjective norms (.100) also gave additional support to perceived ease of use.

The perceived usefulness supported the attitude in a considerable amount (.531) and somehow the data of perceived ease of use did not support the attitude (-.037) as expected. The frequency of reported use was supported by attitude (.255) while the data of duration of reported use supported only by .091. The final grade was supported by the duration of reported use (.242) and then the contribution was also from the duration of actual use (.131) towards the final. The duration of actual use and the duration of reported use along with the variable of frequency of actual use had increased contribution in Time3 when compared to Time2. The results of contribution of variables in Time3 were illustrated as follows.
Table 6 Path Equations for Time3

<table>
<thead>
<tr>
<th></th>
<th>Equation</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PU = .370CSE + .387SN</td>
<td>.581</td>
</tr>
<tr>
<td>2</td>
<td>PEU = .100SN + .272CSE + .558PU</td>
<td>.352</td>
</tr>
<tr>
<td>3</td>
<td>AT = -.037PEU + .531PU</td>
<td>.747</td>
</tr>
<tr>
<td>4</td>
<td>FP = .255AT</td>
<td>.935</td>
</tr>
<tr>
<td>5</td>
<td>FA = .184AT</td>
<td>.966</td>
</tr>
<tr>
<td>6</td>
<td>DP = .091AT</td>
<td>.992</td>
</tr>
<tr>
<td>7</td>
<td>DA = .159AT</td>
<td>.975</td>
</tr>
<tr>
<td>8</td>
<td>FINAL = -.044FP - .041FA + .242DP + .131DA</td>
<td>.905</td>
</tr>
</tbody>
</table>

PU: Perceived usefulness; PEU: Perceived ease of use; AT: Attitude; FP: Frequency of reported use; FA: Frequency of Actual use; DP: Duration of reported use; DA: Duration of Actual use; Final: Final exam scores at the end of the semester

Inspection of the squared multiple correlations suggested that a substantial portion of each variable explained about 10% of the variation in student final scores for the algebra course. About 25% of the variation in students’ attitude was jointly explained by perceived usefulness and perceived ease of use in Time3. The perceived usefulness, the computer self-efficacy and the subjective norms also jointly explained 65% of the variation of perceived ease of use. The computer self-efficacy and the subjective norms together explained about 42% of the variation in perceived usefulness. The following table showed the explained variance in the variables considered.
Table 7. Squared Multiple Correlation Time3

<table>
<thead>
<tr>
<th>Variables</th>
<th>PU</th>
<th>PEU</th>
<th>AT</th>
<th>FP</th>
<th>FA</th>
<th>DP</th>
<th>DA</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squares</td>
<td>.419</td>
<td>.648</td>
<td>.253</td>
<td>.065</td>
<td>.034</td>
<td>.008</td>
<td>.025</td>
<td>.095</td>
</tr>
</tbody>
</table>

PU: Perceived usefulness; PEU: Perceived ease of use; FP: Frequency of reported use; FA: Frequency of Actual use; DP: Duration of reported use; DA: Duration of Actual use; Final: Final exam scores at the end of semester; R-square: Measure of the proportion of variance of the dependent variable about its mean that is explained by the independent variable(s).

SN: Subjective norms; CSE: Computer self-efficacy; PEU: Perceived ease of use; PU: Perceived usefulness; AT: Attitude; FP: Frequency of reported use; Frequency of actual use; DP: Duration of reported use; DA: Duration of actual use; Final: Final exam scores at the end of the semester.
Research Question 4

How well does the Technology Acceptance Model (Time4) explain the Algebra course grades of African American students in a historically Black college?

In Time4, the computer self-efficacy contributed more to perceived usefulness (.394) than subjective norms (.328) to the perceived usefulness suggesting that computer self-efficacy best predicts student perception of the usefulness of the math software towards the end of the semester. Like the Time1, Time2 and Time3, perceived usefulness supported perceived ease of use the most (.510) followed by the contribution from subjective norms (.273) and the computer self-efficacy (.191) which indicated that students’ perception about the software use was good towards improving their math performance. The students might have thought that the software will do their math work for them and they would not have to do much hard work. It must have come from their peers’ influence and their own judgment of computer efficacy.

The perceived usefulness supported the attitude in a considerable amount (.424) that suggested that their attitude towards using the math software was influenced by their perception of computer usefulness. But somehow, the data of perceived ease use did support the attitude (.062) only little indicating that the students realized at the end that the computer will not ease their work. The frequency of reported use supported by attitude (.284) and the data of duration of reported use were supported by attitude only by (.191). It was clear from the students’ reports that they have somewhat positive attitudes that the frequent use of the software will help them pass the test. But, they were not sure
about how long they would have to spend time using the computer software. The final grade was supported by the duration of actual use (.292) and then the contribution was also from the frequency of reported use (.165). The duration of reported use did not support (-.024) the final exam scores and the frequency of actual use even has increased contribution more than Time3. The results of contribution of variables in Time3 were illustrated as follows.

<table>
<thead>
<tr>
<th>Table 8: Path Equations for Time 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 PU = .394CSE + .328SN + .598</td>
</tr>
<tr>
<td>2 PEU = .273SN + .191CSE + .510PU + .311</td>
</tr>
<tr>
<td>3 AT = .062PEU + .424PU + .773</td>
</tr>
<tr>
<td>4 FP = .284AT + .919</td>
</tr>
<tr>
<td>5 FA = .123AT + .963</td>
</tr>
<tr>
<td>6 DP = .197AT + .961</td>
</tr>
<tr>
<td>7 DA = .197AT + .961</td>
</tr>
<tr>
<td>8 FINAL = .165FP + .074FA - .024DP + .292DA + .836</td>
</tr>
</tbody>
</table>

PU: Perceived usefulness; PEU: Perceived ease of use; AT: Attitude; FP: Frequency of reported use; FA: Frequency of Actual use; DP: Duration of reported use; DA: Duration of Actual use; Final: Final exam score at the end of the semester.

Inspection of the squared multiple correlations suggested that the combination of frequency and duration of actual and reported use together explained about 16% of the variation in student final scores for algebra course in Time4. About 23% of the variation in students’ attitude is jointly explained by perceived usefulness and perceived ease of
use in Time4. The perceived usefulness, the computer self-efficacy and the subjective norms also jointly explain 69% of the variation of perceived ease of use. The computer self-efficacy and the subjective norms together explained about 40% of the variation in perceived usefulness. The attitude only explained 8% of the variance in frequency of reported use. The attitude also explained 3% of variance in the duration of actual and reported use. The following table showed the explained variance in the variables considered.

Table 9. Squared Multiple Correlation Time4

<table>
<thead>
<tr>
<th>Variables</th>
<th>PU</th>
<th>PEU</th>
<th>AT</th>
<th>FP</th>
<th>FA</th>
<th>DP</th>
<th>DA</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squares</td>
<td>.402</td>
<td>.689</td>
<td>.227</td>
<td>.081</td>
<td>.015</td>
<td>.037</td>
<td>.039</td>
<td>.164</td>
</tr>
</tbody>
</table>

PU: Perceived usefulness; PEU: Perceived ease of use; AT: Attitude; FP: Frequency of reported use; FA: Frequency of Actual use; DP: Duration of reported use; DA: Duration of Actual use; Final: Final exam scores at the end of the semester; R-square: Measure of the proportion of variance of the dependent variable about its mean that is explained by the independent variable(s).
SN: Subjective norms; CSE: Computer self-efficacy; PEU: Perceived ease of use; PU: Perceived usefulness; AT: Attitude; FP: Frequency of reported use; Frequency of actual use; DP: Duration of reported use; DA: Duration of actual use; Final: Final exam scores at the end of the semester.

Research Question 5

*How do the results obtained from the Technology Acceptance Model (TAM) change over time?*

The results obtained for the TAM model found to be changed over time in the semester as the measures were administered at four different time periods. Table 10 displays how the beta coefficients change for different variables over time.
<table>
<thead>
<tr>
<th>Beta</th>
<th>From VAR</th>
<th>To VAR</th>
<th>Time1</th>
<th>Time2</th>
<th>Time3</th>
<th>Time4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CSE</td>
<td>PU</td>
<td>.181**</td>
<td>.366**</td>
<td>.370**</td>
<td>.394**</td>
</tr>
<tr>
<td>2</td>
<td>SN</td>
<td>PU</td>
<td>.312**</td>
<td>.238**</td>
<td>.387**</td>
<td>.328**</td>
</tr>
<tr>
<td>3</td>
<td>SN</td>
<td>PEU</td>
<td>.111**</td>
<td>.122**</td>
<td>.100**</td>
<td>.273**</td>
</tr>
<tr>
<td>4</td>
<td>CSE</td>
<td>PEU</td>
<td>.258**</td>
<td>.214**</td>
<td>.272**</td>
<td>.191**</td>
</tr>
<tr>
<td>5</td>
<td>PU</td>
<td>PEU</td>
<td>.462**</td>
<td>.605**</td>
<td>.558**</td>
<td>.510**</td>
</tr>
<tr>
<td>6</td>
<td>PEU</td>
<td>AT</td>
<td>.099</td>
<td>-.037</td>
<td>.062</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>PU</td>
<td>AT</td>
<td>.320**</td>
<td>.531**</td>
<td>.424**</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>AT</td>
<td>FP</td>
<td>.113</td>
<td>.255**</td>
<td>.284**</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>AT</td>
<td>FA</td>
<td>-.057</td>
<td>.184**</td>
<td>.123**</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>AT</td>
<td>DP</td>
<td>.144</td>
<td>.091</td>
<td>.191**</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>AT</td>
<td>DA</td>
<td>-.037</td>
<td>.159**</td>
<td>.197**</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>FP</td>
<td>FINAL</td>
<td>.096</td>
<td>-.044</td>
<td>-.044</td>
<td>.165**</td>
</tr>
<tr>
<td>13</td>
<td>FA</td>
<td>FINAL</td>
<td>-.253</td>
<td>.025**</td>
<td>.041</td>
<td>.074</td>
</tr>
<tr>
<td>14</td>
<td>DP</td>
<td>FINAL</td>
<td>.017</td>
<td>.160**</td>
<td>.242**</td>
<td>-.024</td>
</tr>
<tr>
<td>15</td>
<td>DA</td>
<td>FINAL</td>
<td>.382**</td>
<td>.045</td>
<td>.131</td>
<td>.292**</td>
</tr>
</tbody>
</table>

CSE: Computer Self-Efficacy; SN: Subjective Norms; PU: Perceived usefulness; PEU: Perceived ease of use; AT: Attitude; Final: Final exam scores at the end of semester.

*The TAM model assessed at Time 1 is different from all other models and therefore only shares a few estimates as indicated in the table.

** denotes when the t-test for the estimate is statistically significant (p ≤ .05).

From the above table of beta coefficients it was discovered that some independent variables changed steadily in their contribution towards dependent variables that are discussed as follows.

The computer self-efficacy had a steady increase in the beta to contribute to perceived usefulness starting from .181 (Time1) to .394 (Time4) over time suggesting that the computer self-efficacy best predicted students’ perception of the usefulness of the software for their success in the math course. The beta of subjective norms in Time1
increased consistently from .111 to .273 in Time4, but in Time3 it dropped down a little. This indicated that social pressure played an important role to go to the lab and use the software to get a better grade. Beta-8 increased steadily though out four time periods from Time2 to Time4 that means attitude had been increased continually for frequency of reported use. The attitude towards using the computer frequently increased significantly in students’ reports that suggested that they had a positive attitude towards the math software. The Beta coefficients of attitude also had steadily increased its contribution towards the duration of actual use from Time2 to Time3. From Time1 to Time2 the attitude supported the fact that more time they will spend in the computer the better result they will get in their math score.

Beta coefficients for frequency and duration of actual use had increased sufficiently from Time2 to Time3 that is directly contributing to the success of their mathematics score suggesting that the intensity and duration of time spent in the lab doing their math work had significant effect on their final scores. It was also found that the beta coefficients increased and then dropped in the periods Time2 to Time4 in some cases. The coefficient of perceived usefulness to perceived ease of use increased in Time3 and then dropped in Time4 indicating that students already realized that their judgment of how the software is going to ease their work is somehow getting wrong. The beta coefficient of perceived ease of use to attitude and the duration of actual use to final score variable also increased in Time3 and then dropped in Time4. It suggested that at this stage the students might have realized that the computer will not ease their work and will not do their math work for them. That might be the reason they did not use the software for a longer duration.
Perceived ease of use to attitude consistently dropped from Time2 to Time4. As the time passed the students somehow realized that the computer would not make their work easier for them. Several beta coefficients (SN and AT) dropped from Time2 to Time3 and then increased in Time4.

Comparing the contribution towards the Final score in Time2, Time3 and Time4, it was found that the Beta coefficients of frequency of actual and reported use, and duration of actual use had increased consistently in independent variables. It indicated that the frequent and long visit to the computer lab doing math homework using the computer helped them to achieve a better grade on the final exam. But the duration of reported use variable had increased from Time2 to Time3 and then dropped in Time4 which showed that the students realized that even if they are going to spend more time at the end of the semester that is not going to help them anymore towards getting a better grade. Maybe it was too late for them to try.

The squared multiple correlations, when compared in three time periods showed consistent improvement in the variables considered (PEU, AT, FP, DA and FINAL). The squared multiple correlations had increased from Time2 to Time3 and then dropped in Time4 for the variables PU, FA and DP.
CHAPTER V: DISCUSSIONS AND CONCLUSION

Learning is one of the most researched subjects in the history of education and psychology, and now this topic is being revitalized through the introduction of computers, software, and video tapes. Learning in computer situations is not uniform, but takes many forms (Waern, 1993). The term mental model has been frequently used to describe a user’s conception of a computer system. According to Waern, the mental model can be regarded as a construct, attributed to the user by researchers, based on observations of how the user interacts with and talks about the system. Understanding why people accept information technology is crucial to the design and planning of educational technology courses and curriculum.

Mathematics is an important subject in school or college curriculum and the importance of mathematics in this technological world is undeniable. The gap in achievement test scores among ethnic groups has been narrowed,(Cross, 1995; Gross, 1993; Jones, 1985) but still studies found that Asian and White students outperform the underrepresented minority groups in most important subjects especially mathematics.

There had been many factors contributing to the above statement but achievement in teaching and learning had been amazingly altered through the application of modern technology applied to different curriculum. Textbook learning is not enough for struggling students no matter to what ethnic group they belong. Technology has no doubt become an integral part of higher education. Students using computer software in mathematics have shown better attitude are more hopeful to achieve better grades.
Computer software offers immediate and personal feedback as well as privacy so that students can take their own time to get through the materials and practice as many times as they wish for a better understanding.

Technology Acceptance Model (TAM) is an information systems theory that models how users come to accept and use a technology. The model suggested that when users are presented with a new software package, a number of factors influence their decision about how and when they will use the system. The perceived usefulness and perceived ease of use are notably two important factors according to Davis (1989). Davis defined perceived usefulness as the degree to which a person believes that using particular system would enhance his or her job performance. The perceived ease of use is the degree to which a person believes that using a particular system would be free from effort (Davis, 1989).

The usage of technology in mathematics instructions showed positive relationships between the technology and achievement in mathematics if used properly. But, the influence of perception on using technology towards improving the performances in mathematics has not been evaluated. From previous discussion it was found that there is an ethnic gap in achievement scores, and African American students were behind in the success of mathematics.

Technology is integrated in many different ways to courses taught in school and colleges as an extra resource to help students’ achievement. It has become an important part to access information rapidly and visually (Smith, 2002). Now Computer Algebra System (CAS) has been a growing part of technology integrated curriculum in mathematics for secondary and post secondary schools. The computer software in
mathematics has been playing a positive role towards students’ understanding. Anxiety towards mathematics is a common problem for students who are slow in mathematics. Working on mathematics software designed to fit the content of the syllabus and textbook helps students to overcome the anxiety and see the problem from different angles explained through different examples. Software was designed so that they can generate as many examples as the students want on the specific topic or the problem. Teachers are not available to students at any time but the computers are suitable for students to access what they need, when they need. Effective use of technology makes a student centered learning environment and hands-on learning can solve the problem we are facing in schools and colleges towards mathematics.

TAM was initially designed to predict an end user’s acceptance or rejection of an information system project. The TAM was used for its capability of prediction. The researcher tested and expanded the TAM in a post secondary education setting for mostly African American students’ mathematics learning. To better explain students’ attitude towards the acceptance of technology, the subjective norms and computer self-efficacy were added to the hypothetical model, and the study was conducted to explain the acceptance of technology and if it has any bearings towards student’s achievement in mathematics.

Purpose of the study

The purpose of the study was to find out the effects of technology acceptance on post secondary African American students’ achievement in mathematics. Bethune Cookman College is a historically black four-year degree college, where students from
various parts of United States, Bahamas, and Virgin Island come to get a Bachelors degree. The college was chosen for this study for its predominantly African American population. According to the literature there were many studies conducted concerning mathematics achievement and technology assisted instruction, but very few studies were conducted on Black student’s attitude and acceptance of technology towards the achievement of mathematics.

Sample and data collection

The researcher purposively selected students of this study, as it was convenient to find a large number of students in one class. It was hard to get that many African American students for the particular study purpose; so the predominantly African American population provided a convenient environment for the researcher.

There were 327 students in an Introductory Algebra course who participated in the study in a voluntary basis. This course is a beginning algebra course for any major, and students are enrolled in this course according to their result in a placement test. The syllabus is designed so that the students have to use a computer for their homework in mathematics. There is a learning laboratory for mathematics where the computers with the math software set for the students to use for their math course. The instructors have access to information about the student’s progress from their work in the computer. The students can only use the computer by logging in and leave by logging out so that their actual use and duration of use are recorded and accessed by the instructor or lab manager.

The data were collected in the fall semester of 2004 through the questionnaire passed to 16 sections of the Introductory Algebra course. The same questionnaire was
given to students four times in the entire semester to see if their attitude had changed towards the acceptance of technology and how it was going to impact their success in mathematics achievement. A total of 327 students participated in a voluntary basis; of those 270 participated in Time1, 278 participated in Time2, 241 participated in Time3 and 237 students participated in Time4.

Instrumentation

Six instruments were used in the study: perceived usefulness, perceived ease of use, computer self-efficacy, subjective norms, attitude, actual use and Student Demographics. There were four items to measure perceived usefulness (1-4), nine items to measure Perceived ease of use (5-13), eight items to measure computer self-efficacy (14-21), four items to measure subjective norms (22-25), two items to measure actual use (frequency and duration) and attitude having one item scale. But some of the items were thrown away for example; the computer self-efficacy items (16 & 21) because they are not contributing to the factor extraction. The student demographics questions containing eleven items were to find out their gender, race, previous experience, choice and learning habits.

The study was conducted on an item scale level and was tested computing the sum of the scores of corresponding items. The first time (Time1) the questionnaire was administered, the attitude instrument was not included, as students were new to everything in the school and their attitude was not yet formed. They were in a neutral state to test out the college class, textbook and the new environment as they are fresh out of high school.
Design of the Study

The design of the study was based on path-analytic modeling. The causal relationship between the computer self-efficacy, subjective norms with perceived usefulness and perceived ease of use determined the effect on attitude which in turn influenced their reported and actual use of the computer to affect their final exam scores on the mathematics course for the semester. The actual use was determined by the frequency and duration of computer use which directly affected the final exam score as the outcome variable. Approximately every three weeks the questionnaire was administered to the same group of students in the same sections of this Introductory Algebra class. The lab report collected the duration and frequency of using mathematics work according to the syllabus and topics covered at the time. The students were informed about the questionnaire by the researcher, and the questionnaire was administered on four occasions to the students on a voluntarily basis.

Research Questions

There were five questions answered in this research study as follows:

- How well does the initial Technology Acceptance Model (Time1) explain the Algebra course grades of African American students in a historically Black college?
- How well does the Technology Acceptance Model (Time2) explain the Algebra course grades of African American students in a historically Black college?
• How well does the Technology Acceptance Model (Time3) explain the Algebra course grades of African American students in a historically Black college?
• How well does the Technology Acceptance Model (Time4) explain the Algebra course grades of African American students in a historically Black college?
• How do the results obtained from the Technology Acceptance Model (TAM) change over time?

This section presents the conclusion of the study and its significance through the above research questions.

Research Question 1

How well does the initial Technology Acceptance Model (Time1) explain the Algebra course grades of African American students in a historically Black college?

The Technology Acceptance Model (TAM) was used in the study to better explain the students’ attitude and its effect on the students’ final grade. The two variables added were computer self-efficacy and subjective norms to the original model of Davis (1989) as independent variables, and their effect was found out on the dependent variables perceived usefulness and perceived ease of use.

At Time1, students’ actual use of the computer in the math lab explained approximately 5% of the variance in their final exam scores. The perceived usefulness and perceived ease of use explained about 17% and 42% of the variance in students’ final score respectively. Based on the students’ report the frequency and duration of using a computer were almost same as the actual use of computer in the lab. It seemed at the
point students may be settling down, and they were disturbed by the hit of hurricanes in Florida in the fall semester back to back for that they have to leave the college for uncertain period of time. It had definitely an impact in their study and even thinking about using the computer to better their grades. It was too early for them to think about the future. The subjective norms contributed the perceived usefulness the most (31%) as their peers and friends influenced about the computer’s usefulness towards their grade. The students’ judgment of computer’s efficacy was also high, and they thought the computer might help them to earn a good score easily. The degree they believed the computer would enhance their math skills was 46% and in their judgment the computer would help (approximately 26%) by the influence of their peers (SN11%) predicted towards their thought that using the computer would make their job free of any effort, make their job easy and they would not have to study as much.

The duration and frequency of actual use of the computer in the lab did not receive support from their beliefs about computer in Time1. The final grade though influenced by the contribution of their duration of lab use (38%), the frequency of lab visits contributed less towards their success in the final math exam. This may be the reason why some students did not feel quite motivated to spend their time in the lab rather than spending more time with the class, teacher and textbook. The only significant influence was exerted by the perceived usefulness towards the perceived ease of use in Time1. In the beginning of the semester before the midterm, students did not realize the computer use might help them that Harris and Harris (1987) talked about the utilization of computer towards learning.
Research Question 2

How well does the Technology Acceptance Model (Time2) explain the Algebra course grades of African American students in a historically Black college?

In Time 2, the explained variance was approximately 3% in students’ final grade by the contribution from actual and reported use of the computer. The variance accounted for perceived usefulness was approximately 25% and for perceived ease of use it was approximately 62%. The attitude construct was included in Time2 to see how the students’ attitude was influenced by their perception. The students’ attitude was influenced by their perception (PU 32%) more than perceived ease of use (PEU 10%). Again, perceived usefulness is a strong predictor for their belief that the computer will do their work for them in Time2. The students’ report that they are going to use the computer came from their attitude that was approximately 11%. They somehow developed a negative attitude towards actually using the computer to improve their math performance.

The computer self-efficacy (37%) and subjective norms (24%) moderately predicted students’ perceptions about the usefulness of the computer. The students’ report about the duration of the computer use supported their final grade the most (16%) than their report about frequency of lab visit and actual intensity but frequency of lab visit were not significant.

After almost half of the semester passed, the students’ started to visit the lab more frequently, and it appeared their attitudes became more positive. Computer self-efficacy contributed 21% along with subjective norms (12%) to perceived ease of use. The
perceived usefulness again the strongest predictor towards the student’s perception that computer will free their efforts. They do not have to do hard work and math would be easier on the computer. Students’ judgment regarding their math work on the computer was misleading them. The social pressures from the class or dorm-mates motivated students only 12% (SN) that contributed towards the prediction for their belief that the computer system will enhance their math performance. Like Time1, perceived usefulness was the strongest predictor for both students’ attitude and beliefs about computer use.

Research Question 3

How well does the Technology Acceptance Model (Time3) explain the Algebra course grades of African American students in a historically Black college?

In Time 3, the variance explained was approximately 10% in students’ final grade by the contribution from Actual and Reported Use of the computer. The variance accounted for perceived usefulness was approximately 42% and for perceived ease of use was approximately 65%. The attitude is predicted by the students’ perception towards their actual use of the computer. The perceived usefulness supported the students’ attitude by 53%, which is quite an improvement than Time2. For some reason, the students of this introductory math class realized this time that the computer’s role in learning the math concepts and doing their homework is important and the perceived ease of use did not support this thought in Time3.
The variance explained by the perceived usefulness and perceived ease of use towards the students’ attitude for technology was 25%. The computer self-efficacy supported the same amount to perceived usefulness but the subjective Norm coefficients had increased its support from 24% to 39% support towards the perceived usefulness. This explained that students started to see that their classmates are spending more time doing their math homework or talking about their time spent for homework on the computers. It influenced the students in a positive way. Their perceived usefulness influenced their attitude positively (53%) while the drop in perceived ease of use showed that they slowly realized that the computers would not do the work for them.

Because of the positive attitude (25%), the students reported that frequency of lab visit is good and help them to increase their score that ultimately will improve their chance of passing the final exam. Frequency and duration of actual use of the computer significantly increased from Time2 to Time3. In Time3, the final grade was supported most by the duration of actually using the computer that had increased from 4% to 9%.

In Time3, the perceived usefulness is still the strongest predictor towards both students’ attitude and perceived ease of use. The subjective norms and computer self-efficacy played a positive role in students’ perception regarding computer use for their mathematics course. According to Mylona (1999), students’ beliefs about their capabilities to use technology determines their decision to participate in the course found to be true in Time3 study for African American students’ achievement in mathematics.
Research Question 4

How well does the Technology Acceptance Model (Time4) explain the Algebra course grades of African American students in a historically Black college?

In Time 4, the variance explained was approximately 16% in students’ final grade by the contribution from actual and reported use of the computer. The variance accounted for perceived usefulness was approximately 40% and for perceived ease of use was approximately 69%. The attitude is predicted by the students’ perception of both perceived usefulness and perceived ease of use. The perceived usefulness supported the students’ attitude by 42%, which is a drop from the contribution in Time3. Maybe as the students approach the end of the semester, their class tests did not encourage them to have positive attitude. Students already realized that there is no way to make up the lost time. Perceived ease of use was increased a little compared to Time3; it is not going to improve their mathematics scores. Contribution of subjective norms was dropped from Time3 to Time4 suggesting that peer pressure is not helping them towards the perceived usefulness of the computer.

Perceived usefulness did not contribute as much in Time3 to perceived ease of use indicating that the computer cannot do the math for them but they have to do those themselves towards their success in math course. But perceived usefulness had a significant impact towards students’ attitude, which ultimately contributes to their lab time. There was an increase contribution in attitude to the reported frequency of use of the computer lab. The frequency of lab visits was dropped while the duration of time spent in the lab was increased a little indicating that students tried to finish their home
work in the last minute by staying on the computer longer. So, the duration of actual use of the computer in the lab had doubled the contribution towards its share to final grade. It was found also that the duration of reported use supported final score more than it supported in Time3. Towards the end of the semester students realized they have to spend more time in computer to catch up with the homework otherwise it will be difficult for them to get a good grade. They did not spend enough time for their math work and they realize they might have to repeat the class otherwise.

**Research Question 5**

How do the results obtained from the Technology Acceptance Model (TAM) change over time?

The results obtained from the Technology Acceptance Model changed over four time periods in a semester when the questionnaire was administered to the students of a historically Black college regarding the computer use towards their introductory algebra class. It was found that there is an increase in the contribution of computer self-efficacy from Time1 to Time4 towards their perception that the computer would enhance their performance in math.

The students’ motivation towards doing their homework in computer increased from Time1 to Time2 and then dropped a little in Time3 but interestingly they were highly motivated to do their work in the computer in Time4. Students’ judgment about the computer was high in Time1, dropped in Time2, increased in Time3 and then dropped in Time4. It seemed that students’ had better judgment towards the use of computer in
Time1 because they were not exposed to the system at the time and believed it is going to be easy, but when they started doing the problems in the computer they found it is not that simple. In Time3, again students started believing they could do it; may be the chapters they understood better and thought doing in computer would be faster and easier. In Time4, they understood their beliefs or judgment about the computer is not right as they have to do their work themselves and it is not fun.

The students’ beliefs about the computer that it will enhance their job performance helped to increase their beliefs all through four time periods, and those beliefs lead them to think that using computer for their homework would be free from any effort on their part. There was significant improvement from Time1 to Time2 in perceived usefulness even if it dropped a little in other time periods like Time3 and Time4; still it is a lot higher than Time1.

Attitude towards the act is a function of the perceived consequences people associate with the behavior. In this study the researcher found that the students’ attitude towards actually using the computer for doing their homework had a significantly positive association with the report of frequently using the computer but the data is not supporting their actually using the computer for the purpose.

The most important finding was the duration of actual use of computer for mathematics homework contributed significantly towards their final exam score. The students’ of introductory algebra class understood that the more time they would stick with the computer, the more they would accomplish and their understanding of mathematical concepts, principles and properties played a positive part in their achievement of mathematics in the class.
The Significant Findings of the Study

1. The study using the African American students in the context of their mathematics achievement in an introductory algebra class did not support the Technology Acceptance Model (TAM).
2. Perceived usefulness was the most significant predictor of perceived ease of use of students’ using computer software to enhance their mathematics performance.
3. Subjective norms contributed to perceived ease of use and perceived usefulness to a statistically significant degree.
4. Computer self-efficacy supported perceived usefulness and perceived-ease-of- use to a statistically significant degree.
5. The students’ attitude towards using the computer reported was significant in Time3 and Time4.
6. The perceived ease of use is not the effective predictor of perceived usefulness rather perceived usefulness positively predicted perceived ease of use.
7. The duration of actual use of the computer in a single session contributed significantly towards their final score for achievement in mathematics, indeed far more so than the number of times a student visited the lab to use the software on the computer. The length of time spent using the math software in a single session had more impact on final exam scores than how many times the math software was used.

Over the past decade many studies have shown perceived usefulness as the strongest determinant of usage, according to Davis. Researchers found that employees
are more likely to use a technology if they believe that it is useful for their particular job. Several researchers have replicated Davis’s original study (Davis, 1989) to provide empirical evidence on the causal relationships that exist between subjective norms, self-efficacy, their perceptions about usefulness and ease of use, and actual system use. TAM was initially designed to find the acceptance or rejection of an information target system. In this study, computer technology was used towards the instruction.

According to the findings of the study, the African American students of the algebra class did not have a positive attitude towards actually using the computer for their math work. They did not actually use the computer because of their attitude that computer would not really improve their mathematics performances. The students did not like to spend their time in the computer, as they could not see the positive effect right away. In the beginning of the semester, they definitely thought that the computer would ease their work and as time progressed they started having a negative attitude. Maybe going to the computer lab was not that motivating for them. From the demographic report it was found that in Time1 and Time2 approximately 72% of students preferred the instructor face-to-face instead of interacting with a computer. In Time3 and Time4, the African American students’ preference to face-to-face interaction with Instructor increased from 72% to approximately 85%. According to some students’ additional comments, mathematics gets clearer when they learn face-to-face from the Instructor in a class.

The researcher added computer self-efficacy and subjective norms variables to see if these variables have any impact on their choice. Those influenced students’ perception about using the target system. Maybe there are more external variable to be added to the
question of technology acceptance to find if the students will be encouraged to use the technology to their advantage in mathematics.

Technology is the application of knowledge, tools, and skills to solve practical problems and human capabilities. According to this study computer self-efficacy is contributing a lot towards perceived usefulness and perceived usefulness is contributing to students’ attitude for actual use of the computer to their benefit. The duration of using the computer is coming from their attitude towards it. To maximize the performance of African American students using computer towards their achievement in mathematics, these following suggestions are added towards the improvement of curriculum and instruction.

- Computer skills are most meaningful when integrated with class projects in mathematics and other subject areas. This requires collaboration on the part of all teachers in computer assisted instruction (CAI). They will require knowledge and attitudes necessary to be collaborative workers, and ethical technology users.
- There should be workshops for both pre-service and in-service teachers regarding the use of computers in subject areas needed for the level of students.
- As notes in the Computer Algebra Systems part of this web page, very powerful tools exist for carrying out mathematical computations, manipulations, and procedures. Most schools are quite far from implementing routine use of such tools into their mathematics curriculum, instruction, and assessment.
- Computer-aided instruction has been shown to be an effective tool for mathematics instruction (Goldman & Pellegrino, 1987; Okolo, Bahr, & Reith, 1993). Using proper technology students enjoy learning more and make gains in
math performance. Babbitt (2003), suggested tips to guide teachers and parents in selecting instructional mathematics software in which the focus should be on instructional software such as concept development, drill and practice, tutorial and simulation software rather than just spreadsheets or graphic software (Babbitt, 1999).

- According to Babbitt (1999), the software in which number of problems and instructional levels can be modified will serve the needs of a wide range of students in a single classroom or an individual student over a long period of time. Some students are motivated by the speed response of the software where others became frustrated by time pressure. Having the ability to modify the response speed is important for achievement in mathematics (Babbitt, 1999).

- From the study it was found that the computer self-efficacy was increased steadily from Time1 to Time4. The mathematics course should be designed in such a way that the students have to do individualized or group projects in the computer for special credits applied to their final exam scores. It would motivate students to use the computer frequently and intensely as they know it would help their grades. If the work with their peers in the same projects they would be more enthusiastic to compete with other groups.

- The perceived ease of using the computer would directly affect their attitude towards doing mathematics would increase and the students would use computer more often and stay longer in using the computer.
Limitations

The results of the study were affected by many other factors involved in learning mathematics using the computer for the class. The results may not apply to other courses that using the computer to facilitate the instruction. A larger sample size may suggest any difference in the findings.

The availability of computers to students in the lab in their preferred time is a big negative factor in the institution. The lab hours were inconvenient for students to come and work. The lab is closed during holidays. If the students could have more access, that could have positive impact on the study. The software used had some negative implications for students’ working towards their homework problems. The researcher also found that the software was so designed that if the students could not solve the problem in the first three trials they had to start all over from the beginning with a new set of problems. These features of the software lead frustrations in students’ mind. Also, there were not enough computers available at a time for students to use for the purpose.

Further Research Recommendations

The Technology Acceptance Model was successfully expanded and explored for the variables influencing the computer use for African American students. The data were gathered over four time periods in the semester to see the increment in student’s attitude for technology acceptance.
The following are the recommendations for further research to the study:

1. The study should be done in other four-year college Introductory Algebra courses in order to test the validity and reliability of the research.

2. There should be a comparative study in respect to community college algebra students to compare the attitude of African American students using computer towards the mathematics performance.

3. There should be a comparative study between African American students and white students to see if the obtained result of this study would be similar or different in any respect of attitude towards the acceptance of technology.
APPENDIX A

QUESTIONNAIRE
# Student Computer Questionnaire

1. Please respond based on your perception about your use of computer for your MA 112 (Mathematics) Course.

2. Please use the rating scale in the right to respond.

**Instructions:** Please circle one answer for each statement below.

<table>
<thead>
<tr>
<th>START HERE</th>
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<tbody>
<tr>
<td>1. Using computer for my homework enable me to accomplish my task more quickly.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. Using computer would improve my mathematics performance.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. Using computer for my math work would increase my productivity.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. Using computer would make it easier to do my math work.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Learning to use computer for math would be easy for getting a good grade.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. If I will be skillful in using computer then I will be skillful in solving math.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. I will find computer easy to use for my math.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. Learning to use computer would be easy for me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td>9. I would find it easy to get computer to do what I want it to do.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. My interaction with computer would be clear.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. I would find computer to be flexible to interact with me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. It would be easy for me to become skillful at using computer.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. I would find computer easy to use.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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</tbody>
</table>

**Instructions:**
Based on your perceptions you are asked to respond about the use of computer for your math course using the same scale.

I feel confident ..........

<p>| | | | | | |</p>
<table>
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<tbody>
<tr>
<td>14. Doing well in Math course.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. Completing my Math homework.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
16. Understanding course material in Math class.

17. Reading text explanation about my math work.

CONTINUE HERE

Instructions:
Based on your perceptions you are asked to respond about the use of computer for your math course using the same scale.

I feel confident

18. Keeping track of my course work.

19. Logging on and off in the computer.

20. Reading the instructions for solving the math problems.

21. Sending or getting message from the Instructor.

22. My parents think I should use computer for my math work.

23. My Instructor thinks that I should use computer for my math course.

24. My peers think that I should use computer to do better in math class.

25. People who are important to me would think that I should use Computer for my math work if there is help.

26. In general how often do you log on to the computer for your Math class?

- Less than once a week
- Once a week
- Twice a week
- Three times a week
- More than three times a week

27. On average, how long do you stay in the computer each time you log on?
CONTINUE HERE

28. All things considered, my using computer in my course work is:

- Bad
- Good
- Foolish
- Wise
- Unfavorable
- Favorable

Instructions:
Based on your individual information, please select a most proper answer to each question.

29. What is your Gender?

- Male
- Female

30. What is your Academic status?

- Freshman
- Sophomore
- Junior
- Senior
- Other

31. What is your Age?

- Under 18
- 18
- 19
- 20
- 21
- Over 21
32. What is your Racial / Ethnic group?
   - Caucasians
   - African Americans
   - Pacific Islander
   - American Indians
   - Asians / Hispanics

33. Which one of the following major reason you are in this class?
   - The instructor
   - Classmates
   - The placement test
   - Others

34. Have you ever taken any class using computer prior to the current one?
   - Yes
   - No

35. In general how long have you used the computer?
   - Less than one year
   - 1 to 3 years
   - 4 to 6 years
   - Over six years

36. Which one of the following learning habits applies to you?
   - Do it at the last minute
   - Follow the schedule suggested by the instructor
   - Do it in advance

37. Do you have a computer to access in the place you study?
   - Yes
   - No

38. If available, would you choose a class using computer or face-to-face class?
   - A class using computer
   - A face to face class
39. Do you have resources that can help you with technical glitches in computer?

☑ Yes
☑ No

**Thank you for your time in completing this questionnaire.**

Please share any additional comments you have in the box provided below.
APPENDIX B

IRB LETTER
August 9, 2004

Sulaishanna Sen
1223 Ryan Street
Port Orange, FL 32129

Dear Mrs. Sen:

With reference to your protocol entitled, “The Effect of Technology Acceptance on Post Secondary African American Students’ Achievement in Mathematics: A Path Analytic Inquiry,” I am enclosing for your records the approved, expedited document of the UCFIRB Form you had submitted to our office.

Please be advised that this approval is given for one year. Should there be any addendums or administrative changes to the already approved protocol, they must also be submitted to the Board. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur. Further, should there be a need to extend this protocol, a renewal form must be submitted for approval at least one month prior to the anniversary date of the most recent approval and is the responsibility of the investigator (UCF).

Should you have any questions, please do not hesitate to call me at 407-823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,

Barbara Ward, CIM
Institutional Review Board (IRB)

Copies: IRB office
Dr. Stephen Sivco, College of Education; Educational Research, Technology & Leadership, ED 222Q
APPENDIX C

INFORMED CONSENT LETTER
INFORMED CONSENT LETTER OF VERBAL PRESENTATION

Verbal address to the students of MA 112 class in the fall semester:

My name is Sulakshana Sen and I am a mathematics instructor in Bethune Cookman College. I am working on my doctoral study: The Effect of Technology Acceptance on Post Secondary African American Students' Achievement in Mathematics: a Path Analytic Inquiry under the guidance of Dr. Stephen Sivo of the College of Education of University of Central Florida. You are being asked to participate in the study designed to understand the technology acceptance of perceived usefulness and perceived ease of use that has any effect on your achievement of mathematics. The research project is solely designed solely for research purposes, and no one except me will have access to your responses. All responses will remain confidential to the extent provided by law.

Two surveys are going to be administered in fall 2004. It will not take more than 30 minutes to complete each questionnaire. Your participation in this study is voluntary. You do not have to answer any question(S) that you do not wish to answer. Please be advised that you may choose not to participate in this research, and you may withdraw from this study at any time. There are no anticipated risks associated with participation. However, extra points will be added to your grade if your full participation in both of the questionnaires is verified.

For the improvement of mathematics education provided at Bethune Cookman College, your participation in this study is significant. Please help us to create a better learning environment for you in mathematics by proper access of technology.

If you have any questions or comments about this research, please contact me in my office (G S Room 6, Ext # 2321) or by Email sensu@cookman.edu. Questions or concerns about research participants' rights may also be directed to the UCFIRB office, University of Central Florida Office of Research, Orlando Tech Center, 12443 Research Parkway, Orlando, FL 32826. The phone number is (407) 823-2901.

Sulakshana Sen
Instructor of Mathematics
Bethune Cookman College
Daytona Beach

APPROVED BY
University of Central Florida
Institutional Review Board
CHAIRMAN

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APPENDIX D

PERMISSION LETTER FROM INSTITUTION
July 23, 2004

Dr. Ann Taylor Green
Provost/VP for Academic Affairs
Bethune-Cookman College
Daytona Beach, FL 32114-3099

Ref. Permission to conduct research

Dear Dr. Green:

I am happy to inform you that I have completed all the requirements for the doctoral studies at University of Central Florida, except the dissertation. My dissertation topic is: "The Effect of Technology Acceptance on Post-secondary African American Students' Achievement in Mathematics: A Path Analytic Inquiry". For this study, 'The Technology Acceptance model' can be used to find out the effect of 'perceived usefulness' and 'perceive-ease of use' of technology in Mathematics achievement of African American students in post secondary studies. I will use a path analytic inquiry of Structural Equation modeling for the survey information of our MA 112 students in the mathematics for the fall enrollment of Bethune Cookman College. The finding of the study will greatly influence and enhance the teaching and learning of mathematical concepts that enable them for a better performance in mathematics and help in higher retention of students.

The University of Central Florida Institutional Review Board (UCFIRB) requires that I get permission from Bethune-Cookman College to conduct this study on our campus. For this reason, I am requesting you to allow me to conduct the research to broaden our knowledge regarding the 'effect of technology acceptance' on instruction in general and understanding of mathematics in particular.

Thank you for your support in this important endeavor.

Sincerely,

Sudalshana Sen
Instructor of mathematics
School of General Studies


