THE EFFECT OF THE CARNEGIE ALGEBRA TUTOR ON STUDENT ACHIEVEMENT AND ATTITUDE IN INTRODUCTORY HIGH SCHOOL ALGEBRA

By

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(ABSTRACT)

The Third International Mathematics and Science Study (1995) and the National Assessment of Educational Progress results (1996) indicate that the United States has not reached the goal of being first in the world in mathematics and science achievement established by the Goals 2000 Act. Many states have adopted the National Council of Teachers of Mathematics standards for mathematics instruction, which call for the integration of computer technology, in an effort to improve international and national mathematics achievement results. Recent research (e.g., Anderson & Koedinger, 1995, Mann, Shakeshaft, Becker, & Kotkamp, 1999) has reported significant increases in student achievement in mathematics through the use of intelligent tutoring software such as the Carnegie Algebra Tutor. This study built upon this body research on computer technology and how it can be effectively integrated into classrooms to impact student achievement and attitude. In particular, the effect of the Carnegie Algebra Tutor on student achievement and attitude towards mathematics in an introductory high school Algebra course was examined.

The quantitative portion of the study used a non-equivalent control group design. The population of the study consisted of 445 students. Student achievement was measured using scale scores on the Virginia Algebra I SOL assessment with the Total

Mathematics portion of the Stanford 9 Ta as covariate. Student attitudes were measured using a shortened version of the Fennema-Sherman Mathematics Attitude Scales survey. Independent variables included the treatment condition, race/ethnicity, and gender. An ANCOVA was conducted to determine achievement effects, while ANOVA was conducted to determine attitude effects. The qualitative portion of the study consisted of student and teacher focus groups. It was through these focus group sessions that program implementation issues and cognitive and affective effects on students and teachers were examined.

Analysis revealed statistically significant mean achievement differences between Black (M=402.2) and White (M=395.7) students. Student focus group data revealed an overall positive experience for students. Emerging themes from the teacher focus group included alignment issues with the Carnegie tutor and the Algebra SOL, implementation concerns, student effects, and software issues. Based on these findings, implications of the results of this study, future avenues of research, and implementation suggestions are offered.

DEDICATION

This dissertation is dedicated to my wife Kassie, my son Ryan, and my daughter Taylor. I cannot express how much your love, support, encouragement and sacrifice have meant to me as I end this journey.

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CHAPTER I

THE PROBLEM AND ITS CONTEXT

> The present struggle for the very existence of our freedoms causes the need for the improvement of the instruction in science and mathematics to become increasingly important (U.S. Office of Education, 1953, p. 1).

Traditional roles in educational leadership focus on tasks such as defining the school mission, promoting quality instruction through teacher evaluation, maintaining high academic expectations, and developing a strong school culture (Marsh, 2000). In addition to these duties, school administrators of today cope with school performance measures, high stake instructional standards, customer satisfaction demands, increasing staff development needs and the rapid influx of computer technology. Perhaps the biggest challenge for the educational leader lies in the ability to break obsolete pedagogical practices within the school and replacing them with current, research based practices.

The pedagogical practices necessary for the successful integration of proven technology into all curriculum areas is one challenge facing educational leaders. The importance of this role is highlighted in the “Technology Standards for School Administrators” proposed by the Southern Regional Education Board in the fall of 1998 (Virginia Department of Education, 2000). In these standards, a key role for administrators is the ability to understand how technology can be effectively integrated into all aspects of teaching and learning. These standards dictate that in addition to the role of instructional leader, building administrators must also become technology leaders. The development of school technology plans, curriculum integration issues, budgeting for hardware and software acquisition, and the assessment and implementation of staff development needs become critical responsibilities of building administrators. The purpose of this research had been to explore the integration of technology into a mathematics classroom and the impact that the integration had on student achievement and attitude in mathematics.

An International Context

In 1957, the Soviet Union launched the Sputnik satellite, beating the United States into space. This event began a national educational reform movement in the United States that focused on the development and implementation of rigorous standards in mathematics and science. These standards led to rapid advances in technology-related fields and for the last 40 years these standards have been an integral part of school curriculums today. On July 4th, 1997, the United States successfully undertook the Pathfinder expedition to conduct a mobile exploration of Mars. This type of project would appear to confirm the country's place as a world leader today in space technology and validate the mathematics and science standards that exist in school curriculums. However, with the beginning of the 21st century the status of the United States as a world leader in science and mathematics is still being questioned. Results from the Third International Mathematics and Science Study (TIMSS), which was administered in 1995 to students from 41 different countries, showed that students from the United States were performing below international averages in eighth grade mathematics and science. In a report from the National Center of Education Statistics (NCES), the authors stated that "At the fourth grade, United States students were above the international average in both science and mathematics. In the eighth grade, United States students scored above the international average in science and below the international average in mathematics. At the end of secondary schooling, United States performance was among the lowest in both science and mathematics, including among our most advanced students" (NCES, 1999, p.1). These results caused the National Education Goals Panel (NEGP) to question the United States status as a leader in the areas of mathematics, science, and technology (NEGP, 1998). Specifically, the NEGP questioned the United States status as “a leader fifty years from now given our students current level of skill and training” (NEGP, 1998, p.1). The NEGP also questioned whether current instructional practices and curricula were adequately preparing students to meet the mathematical and scientific demands of the 21st century. The idea that students from the United States lag behind international competitors is not a new concept and can be traced back almost 20 years.

The 1995 NCES report and subsequent challenges brought forth by the NEGP echoed the earlier sentiments of the National Commission on Excellence in Education (NCEE). In 1983 this commission referred to the United States as a “nation at risk” and reported that student mathematics and science skills were insufficient to keep pace with global competitors. In response to the patterns in student performance reported by the NCES, the President and the nation’s Governors convened in 1990 and agreed that improvement in student achievement in mathematics and science achievement was a top national priority. Specifically, goal 5 stated that: “By the year 2000, United States students will be first in the world in mathematics and science achievement” (NEGP, 1998, p.1). The 1995 TIMSS showed that this goal had not been reached (Wilson & Blank,1999). In addition to below average performance of eighth grade students, the report also showed that 87% of instructional lessons in mathematics in the United States that were examined during the TIMSS received the lowest possible rating for lesson quality (NEGP, 1998). International comparisons have been a driving force behind both national and statewide initiatives to raise academic standards and improve student achievement.

A National Context

In 1994 the Goals 2000: Educate America Act was signed into law. This legislation was designed to support and encourage state reform efforts in the areas of rigorous standards development, achievement accountability, and curriculum alignment with national standards such as those recommended by the NCTM. The majority of states have completed and implemented content standards and implemented state-wide assessment programs. Results from the 1996 National Assessment of Educational Progress (NAEP) revealed that from 1990 through 1996, 27 states made significant improvement in the percentage of students that could be classified as proficient in mathematics. While this is a positive trend, other data from the NAEP indicated areas of mathematical instruction that needed improvement if assessment results from the United States were to become more internationally competitive. These results showed that eighth grade students were at the international average in the areas of pattern, relations, and functions, but scored poorly in the areas of measurement and problem solving (Wilson & Blank, 1999). While eighth grade students did not perform well on basic mathematical concepts as measured by the 1996 NAEP, improvement was made in the area of algebra. It is important to note that most of the improvement was in basic algebraic concepts such as simple equations and linear equations. Only 4% of eighth grade students showed the ability to perform complex algebraic problems (Wilson & Blank).

Prompted by results from the 1995 TIMSS and the 1996 NAEP, President Clinton gave a directive to the Department of Education and the National Science Foundation on March 6th, 1997. These organizations were charged with developing an action strategy that would challenge state and local education agencies to examine existing curricula and instructional practices in an effort to raise academic standards. Included in this action strategy was a focus on efforts to improve instructional practices through the effective integration of technology into the classroom (Clinton, 1997). Recommendations from the NEGP had included the implementation of tougher standards in state mathematics curricula that would mirror those developed in 1989 by the National Council of Teachers of Mathematics (NCTM).

National Council of Teachers of Mathematics Standards

The 1989 NCTM Standards were designed to ensure quality, indicate goals, and promote change in the way students in the United States were being taught mathematics (Standards 2000 Writing Group). A variety of factors led to the development of these standards. Two major factors were the release of the Nation at Risk report by the National Commission in Excellence in Education (1983) and the Educating America for the 21st Century report by the National Science Board Commission (1983). These reports characterized the typical mathematics curriculum in the United States as inadequate for preparing students for the information age of the 1990's (Romberg, 1998). These reports also revealed that 70% of all high school students were not exceeding a typical two- year program of mathematics beyond Algebra and Geometry.

Additional weaknesses in mathematical instructional practices were identified in the 1975 report on elementary mathematics instruction conducted by the National Advisory Committee on mathematics Education and the National Survey of Current Practices conducted by the National Science Foundation (NSF) in 1978. These studies reported that mathematics instruction in the United States was dominated by teacher-directed instruction followed by pencil and paper activities (Romberg,1992). Fey's 1979 synthesis of the NSF results, review of literature, and analysis of case studies confirmed these findings (Romberg, 1992; Hiebert, 1999). The vision revealed in the 1989 standards was based on the findings of these reports as well as the work of Pólya, who in the 1950s pushed for less traditional drill related activities and the inclusion of more relevant problem solving activities in mathematics classrooms (Hiebert). These standards called for a shift from conventional teacher-directed activities to student-directed and inquiry-based types of activities. To accomplish this shift, the 1989 NCTM standards called for students to "learn to use the computer as a tool for processing information and performing calculations to investigate and solve problems" (NCTM Standards, 1999, p.6). The role of technology in mathematics instruction was echoed even louder with the release of the 2000 Standards. The 2000 NCTM standards state that "technology is essential in teaching and learning mathematics". The use of technology allows students time to "focus on decision making, reflection, reasoning, and problem solving" (NCTM Standards, 2000). This integration of technology into mathematics is a constant theme throughout the 2000 NCTM standards and is especially prevalent in the area of Algebra.

The Algebra Standard

A typical mathematics curriculum in the United States separates ninth grade students into one of several categories. At this grade level students will usually take some form of general math or pre-algebra, algebra, or geometry (Gamoran & Hannigan, 2000). Algebra is often viewed as both the backbone and gatekeeper course to higher mathematics courses. The NCTM place such a high emphasis on student mastery of algebraic skills that the 2000 NCTM standards have called for a vertical integration of algebra into all grade levels beginning with pre-kindergarten. This curriculum alignment would allow students entering the middle grades and high school to begin using advanced algebraic skills such as the analyzing and developing of algebraic models. The study of algebra emphasizes the mathematical relationships between variables. It is through the study of these relationships that students develop the ability to solve problems and analyze situations using mathematical models. Students that successfully complete

Algebra rather than a general mathematics track are more likely to pursue advanced mathematics and science courses (Gamoran & Hannigan).

Following NCTM recommendations, many states and local school districts have mandated algebra as a requirement for graduation. Many states have also implemented some form of state assessment program to insure that students are learning the required material. North Carolina, Tennessee, Arizona, and Louisiana are examples of states that have moved in this direction. Results from the 1996 National Assessment of Educational Progress (NAEP) indicated that states that had fully adopted and integrated the NCTM standards showed the largest gains. Michigan, North Carolina, and Texas registered a 12 to 17 point improvement in average scale scores over the previous assessment. The 1996 NAEP State Assessment Program revealed that Virginia was below the national average in eighth grade mathematics performance. Virginia had a student average of 270 compared to the national average of 271. Although the state showed a five-point increase in average scale scores, 20 other states outperformed Virginia on the NAEP.

A State Context

In response to national policy and assessment trends, the Commonwealth of Virginia began a statewide reform movement in all core subject areas. In the area of mathematics, the Board of Education integrated NCTM standards into the state mathematics curriculum. These standards, described in the Virginia Standards of Learning (SOL), are evaluated through standardized tests in grades 3, 5, and 8. At the secondary level, end-of-course tests are administered in mathematics classes beginning with Algebra I. The goal of these tests is to insure that students possess the necessary mathematical knowledge to “pursue higher education, compete in a technologically oriented workforce, and to be informed citizens” (Board of Education, 1995, p.9). Alignment with the NCTM standards is further evidenced by the goals of the SOL for Mathematics which also include the need for technology integration into the classroom:

> Graphing utilities, spreadsheets, calculators, computers, and other forms of electronic information technology are now standard tools for mathematical problem solving in science, engineering, business and industry, government, and practical affairs. Hence, facility in the use of technology must be an integral part of teaching and learning (Virginia Board of Education, 1995, p.9).

In addition to the SOL, the State adopted revised graduation requirements that would reflect a more rigorous curriculum and require students to reach higher levels of achievement. Under the Regulations Establishing Standards for Accrediting Public Schools in Virginia (1997), all students beginning with the class of 2002 would be required to pass Algebra I in order to graduate. In addition, students must earn a “verified” credit in mathematics by passing one mathematics SOL test to receive a standard diploma and two verified credits in mathematics for an advanced diploma. These new Standards for Accreditation (SOA) also placed responsibility for student achievement on individual schools. Seventy percent of eligible students must pass in each of the four content areas or a school may lose accreditation. In the area of mathematics, this means that seventy percent of the combined students taking Algebra I, Geometry, and Algebra II must pass the respective SOL assessments in these courses to meet the seventy percent core requirement. These new graduation requirements and changes in accreditation make the need for curricula changes, instructional practices and the effective integration of technology into the classroom necessary if all schools and students are to meet these new requirements.

An example of the State’s priority on technology integration was the development and implementation of the Technology Standards for Instructional Personnel by the Department of Education in 1997. These standards required local school divisions to certify that all personnel were proficient in the technology skills necessary to implement the SOL. The importance of technology integration was further evidenced when the 2000 General Assembly revised the Standards of Quality (SOQ) to require local school boards to integrate computer and related technology into the existing curriculums. The revisions to the SOQ's were reinforced by a memorandum to all division superintendents from the Superintendent of Public Instruction. From this memorandum the role of technology integration was evident:

> "The teaching and integration of computer and related technology objectives should be the shared responsibility of teachers of all disciplines. Computer and technology skills are essential components of every student's education and opportunities for students to acquire necessary skills for academic success should be maximized. The use of technology, integrated across the curriculum, will provide numerous opportunities for students' use of existing and emerging technology tools for communication, productivity, management, research, problem solving, and decision making" (Superintendent Memo No. 158, 2000).

Issues concerning the development and implementation of rigorous academic and technology standards have been left to school policy makers; however, governmental officials, local educational administrators, and taxpaying citizens want evidence of the effects of technology on student achievement in order to justify the large fiscal commitments necessary to fully integrate technology into the classrooms (Means, Blando, Olson, & Middleton, 1993).

Statement of the Problem

Even with the strong movement at the national, state, and local level to integrate technology into the curriculum, a single question remains unanswered. Does technology, specifically the use of computers and the choice of software utilized, improve student achievement and attitude in mathematics? Traditional studies, such as those compiled in the meta-analysis of Kulik and Kulik (1991) and Christman, Lucking, and Badgett (1997), attempting to answer this question have attempted to isolate a technology program or treatment from other intervening variables in an effort to determine the impact of that technology component on student achievement. These studies have utilized a variety of research designs and methodologies and findings of these studies have produced mixed results. Isolation of the technology component as the sole factor resulting in an increase or decrease in achievement is difficult as multiple intervening variables such as teacher differences and individual student characteristics can interact to confuse the impact that technology may have on achievement (Means, et al., 1993). Thus, this study attempted to answer the question of whether technology integration, specifically the Carnegie Algebra Tutor, had a positive effect on student achievement and attitude in mathematics.

The Argument Against Technology

Clark (1983) argued against studies attempting to isolate technology from other intervening variables, as he believed that it was the content of the message not the medium by which the message was delivered that would effect achievement. Hagler and Knowlton (1987), who also believed that these traditional designs were flawed and should not produce statistically significant results as they are comparing two medians of the same message, supported his ideas. Using this argument, a teacher could lecture on an algebraic concept in one class and deliver the same message using a computer tutorial program in another. Student learning of equivalent material would take place in both cases; therefore any study attempting to measure changes in achievement between the classes should show no significant differences

The ongoing exponential advances in computer hardware and software as well as the volume of information made accessible through the Internet have created an educational environment of computer interactivity rather than information delivery (Pea, 2000). This makes it necessary to revisit the debate between the validity of traditional studies and Clark's argument. These advances provide students with tools and information far beyond the capabilities that were studied in commonly cited research. How effective computers can be in increasing student achievement will be an evolving question. Rapid advances will require ongoing evaluation of hardware and software in an effort to determine the cost effectiveness of implementation.

Computer Technology in Virginia

Virginia is currently in the process of integrating computer technology into the public school curriculum. To meet the call for higher standards in mathematics and the integration of technology into the classroom, the Virginia Department of Education implemented the Six-Year Educational Technology Plan for Virginia in 1996. Goal two of this plan is entitled “Technology-Based Instruction”. This goal focuses on the integration of multimedia computers into classrooms to promote inquiry-based learning. This goal follows the recommendation of the President’s Committee of Advisors on Science and Technology (PCAST) to emphasize learning with technology rather than about technology (PCAST, 1997). Funding from the state level has been provided to school localities to promote this Technology Plan the last three fiscal years by providing funding for the acquisition of computer hardware and infrastructure. School districts must supplement state funding with local dollars to fully integrate technology into their curriculums. How and where computers are placed into the instructional program is left to the discretion of the school district.

According to PCAST’s 1997 report, most schools place the majority of their computers in computer labs rather than individual classrooms. While this structure is done in an effort to maximize usage of the hardware, it does make the daily integration of computer technology into the classroom more difficult. The school district in which this study was conducted conformed to the usage of a computer lab structure as the primary method of integrating technology into the classroom. Teachers from all core subject areas use this lab as the primary vehicle by which to integrate computer technology into their classrooms. The primary focus of this study is in mathematics, specifically in the area of Algebra.

Mathematics and Computer Technology

Results of the TIMSS and NAEP studies as well as federal and state initiatives have heavily emphasized the importance of improving mathematics education. Picciotto and Wah (1993) refer to Algebra I as a gateway course to higher levels of mathematics. It is also viewed as a key indicator to student success in college. Students that take Algebra and one other college preparatory course in mathematics during high school are twice as likely to complete college. The state of Virginia also places a high priority on the improvement of student achievement in Algebra. This is evidenced by the fact that all students must successfully complete Algebra I as well as receive a verified credit in Algebra I by passing the Algebra I SOL assessment as a minimum requirement for graduation.

As schools in the State of Virginia attempt to improve student achievement in mathematics as measured by the algebra SOL assessment, the role of computer technology on student achievement will be an ongoing issue. What role will computers play in the classroom? What is the best way to optimize the effect of computers on student achievement? What software yields the most promising results? Answers to these types of questions will require ongoing research into the effects that computer technology has on student mathematics achievement and attitude.

Significance and Purpose of the Study

Spending on educational technology climbed from 2.1 billion dollars in 1991-92 to an estimated 6.2 billion dollars in 1999-00. This spending has produced significant positive effects on student achievement in all major subject areas (Siven-Kachala & Bialo, 2000). According to the PCAST report (1997), less than .01% of all these educational expenditures are used to determine the effectiveness of educational practices or programs. This same committee recommended that large-scale research into the effectiveness of computer technology be conducted in typical classroom settings. Honey, McMillan, and Carrigg (1999) also called for large-scale longitudinal studies conducted within school settings. This study built upon the body of previous research that currently exists on computer technology and how it can be effectively integrated into the classroom to impact student achievement and attitude. In addition, this study provides data by which generalizations to similar student populations can be drawn (Gall, Borg, & Gall,1996). The rapid growth and advancement of computer hardware and software will require ongoing research into this area. In particular, this research offers an evaluation of the effectiveness of the Carnegie Algebra Tutor software on student achievement in two lower-level classes entitled the Introduction to Algebra and Algebra X classes as measured by the Virginia Standards of Learning Assessment in Algebra I. The effect of this software on student attitudes towards mathematics was also examined. Given the existing body of research that shows a high correlation between achievement and attitude, data from this study may have significant fiscal implications as decisions are made on whether to provide funding for additional computer labs necessary for the expansion of this program to all Algebra I students. The discrepancy between minority and non-minority students' scores on the 1996 NAEP mathematics state report for Virginia as well as the Algebra I SOL necessitate research into programs that have the potential to close this achievement gap. Achievement gaps between male and female mathematics problem solving ability as reported in the 1996 NAEP also warrant further research. In addition, this study may yield strategies and recommendations obtained from focus groups to improve the usage of computers within this type of curricula format from both a teacher and student perspective.

Limitations and Delimitations of the Study

Research studies conducted on intact classrooms and in natural school settings cannot approach true experimental conditions and therefore contain limitations within the research design that hinder the researcher's ability to generalize results to populations other than those being studied. These limitations are factors in the experimental design, such as a subject's race/ethnicity or gender that are not under the control of the researcher. The choice of the research design was based on attempts to minimize the effect of uncontrollable intervening variables on the outcomes of the study.

Factors such as student gender, race/ethnicity, and innate ability are intervening variables that impact the external validity of this study. Teacher effects on students in both the control and experimental groups can interact to confound results. These effects may include: (1) teacher's quality of implementation of the treatment condition, (2) content knowledge, (3) quality of instructional delivery, (4) student rapport, and (5) classroom discipline. All or any of these teacher effects can interact with the treatment condition to mask or exaggerate results of the study.

Another concern of this researcher was the use of multiple schools, which in turn meant multiple teachers in the implementation of the treatment variable. Teacher effects on the quality of implementation of the treatment variable can pose a serious threat to ecological validity and hinder accurate generalizations of the treatment conditions. Teacher effects were explored in detail during the teacher focus group conducted at the conclusion of the study.

Certain parameters or constraints, such as choice of instrumentation, are knowingly entered into the research design. These parameters are referred to as delimitations and also serve as threats to the external validity of the study. The choice of grade level and subject area for this study fell into this category. The decision to use ninth-grade algebra is a delimitation within this design that is supported by the literature. The choice of instrumentation used to measure the treatment condition was another common delimitation. The Stanford 9 TA and the Fennema-Sherman Mathematics Attitude Scales were chosen due to the strong reliability and validity data reported as well as for their established usage in educational research. The Virginia Algebra SOL assessment was chosen because of its recent implementation and the high stakes placed on it by the Virginia Legislature.

The use of these three instruments, especially the Algebra SOL assessment was an area of concern for this researcher. The inability to review this assessment and examine its alignment with the treatment condition placed a potential threat to the internal validity of the study. This instrument may not adequately measure possible achievement gains made by the treatment condition in student problem solving skills.

The use of this researcher as the interviewer in the teacher focus group is another delimitation of the study. The researcher's role as an administrator in the school division in which the teacher focus group participants were employed creates the potential for participants to withhold information in the focus group session that may have been revealed had a neutral interviewer conducted the session.

Another delimitation of any research design is the choice of treatment condition utilized in the study. The Carnegie Algebra Tutor was chosen for its potential impact on student problem solving skills as well as the literature supporting its alignment with NCTM standards.

Theoretical Context of the Study

A model for the integration of computer technology into a mathematics curriculum can be rooted in one of several established models of learning theory. The particular learning theory depicted by any model is based on how the computer is used in the classroom setting. Bagley and Hunter (1992) indicate that computer technology can be used as (a) the primary instructional device, (b) a supplement to another instructional strategy, or (c) as a tool for active learning. The type of computer application a teacher utilizes within the classroom can be linked to a behaviorist theory of learning, a cognitive model of learning, or a combination of the two. An examination of these learning models will provide a pre-study framework from which to analyze the impact that technology integration will have on student achievement in algebra.

Behaviorist Learning Theory

Instructional strategies in the classroom that are based on traditional Behaviorist learning theories have their origin in B.F. Skinner's early experiments in animal learning. His experiments led him to believe that learning was a progression of behaviors that utilized a variety of stimulus and response activities to promote the obtainment of a basic skill or a desired learning outcome (Cooper, 1993). Basic skills, facts, or other types of learning goals would become part of the learner's knowledge base through ongoing reinforcement or feedback that built upon previous reinforcements and feedbacks (Figure 1). Computer-assisted instructional activities often integrated into classrooms under a behavioral framework would include drill and practice activities and simplistic tutorial programs. Computer activities would be used to reinforce concepts already learned in the classroom. Roblyer (1997) points to the emphasis of the behavioral learning model on the obtainment of isolated facts that reinforces the use of traditional teaching practices such as lectures, skill worksheets, and standardized assessment practices. These teaching practices primarily promote low-level thinking, such as rote memorization rather than upper-level thinking skills such as problem solving and synthesis

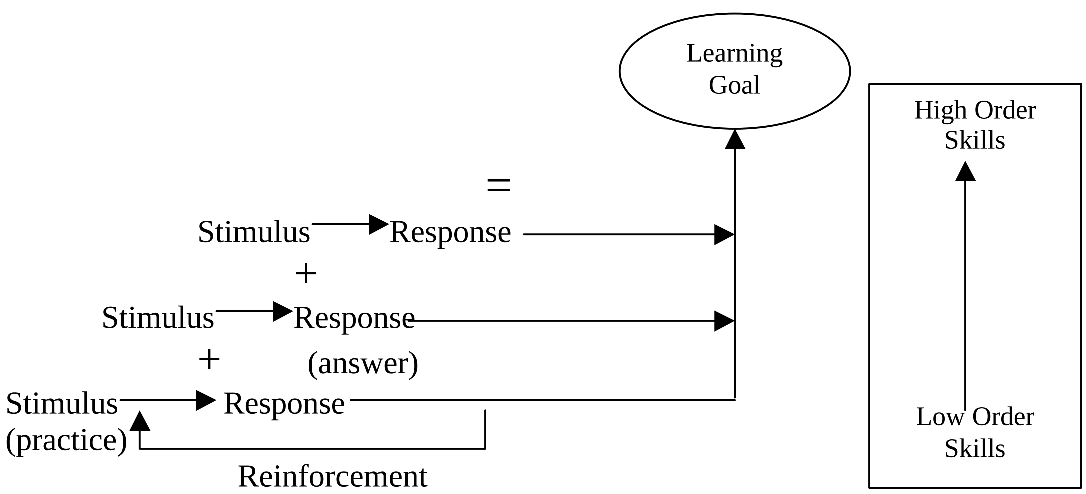


Figure 1. A behavioral model of learning.

Cognitive Learning Theory

Recognizing that many behaviors could not be observed or accounted for by a simple stimulus-response model, efforts began to focus on why and how unobservable behaviors occurred. Proponents of this concept led to a variety of models classified under Cognitive Learning Theory. One of the founding fathers of Cognitive Learning Theory was Gagné (1977). He built upon the behaviorist model by adding a “processing” or cognitive component to Skinner’s model. In his model, each individual learner processed information differently based upon a variety of factors including prior knowledge level and innate ability. Within this framework, Gagné believed that students progressed through a “learning hierarchy” created by the processing and accumulation of basic skills (Roblyer, 1997). Tennyson (Roblyer, 1997) added to Gagné’s processing component by identifying various aspects of individual “processing” which included a working memory and a long term memory that contained the context, skills, and strategies that learners would use to organize information. Under this model, long-term and short-term memories are brought together to process received information in an effort to achieve a learning goal (Figure 2). (Impara & Plake,1998).

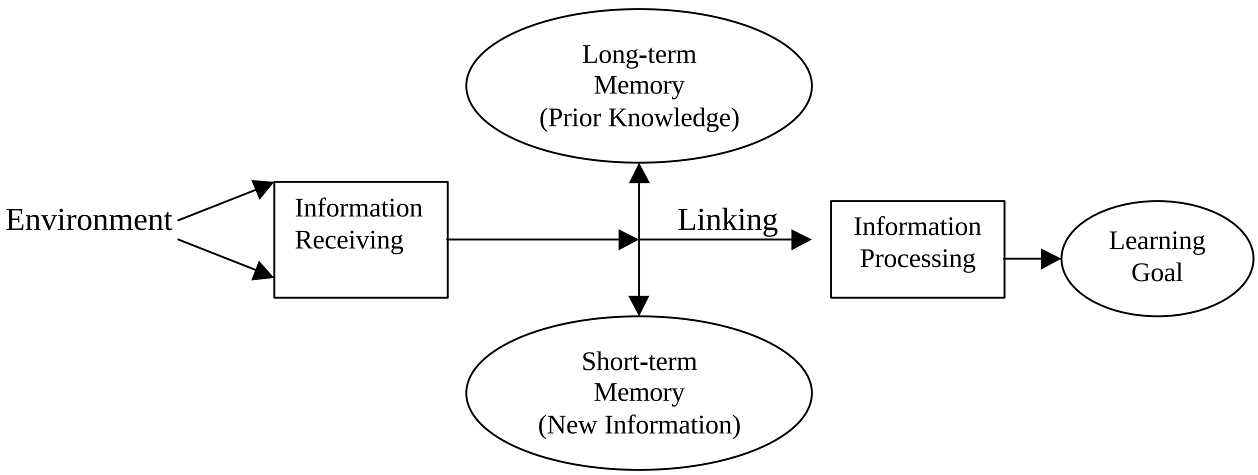


Figure 2. A cognitive model of learning.

According to Gagné, basic skills allowed a student to interact with instructional activities and apply prior knowledge that could be transferred to the new learning situation in order for learning to occur.

A particular branch of Cognitive Learning Theory, commonly referred to as the Constructivist Model, began as learning theorists attempted to respond to weaknesses of the Behaviorist and early cognitive models. Critics pointed to the inability of these early models and the instructional approaches attributed to them to actively engage students in the learning process and promote the development of problem solving skills. Early foundations of the constructivist model go back as far as John Dewey who felt that effective learning occurred when activities were made relevant to the learner. This relevance aided the information processing component of the standard cognitive model but providing a smoother connection between long-term and short-term memory linking (Figure 3). Dewey’s idea was also a foundation of Piaget’s belief that relevant learning enabled the learner to view knowledge as a “tool” for assimilating new information (CTGV, 1990). The framework of the Constructivist Model as it exists today, is centered on motivating students to “construct” their own learning. As stated in the NCTM standards, learners should be able to construct their own meaning by connecting new information with their own prior knowledge. Current instructional practices that utilize graphing calculators to promote student linking of algebraic concepts are typical of the constructivist approach. Learning strategies that focus on active participation, personal discovery, and problem solving characterize this model. Cooperative learning and the use of portfolio assessment are common practices. Computer activities characteristic of the constuctivist model would include project presentations, simulations, interactive multimedia activities, intelligent tutoring systems, and Internet research.

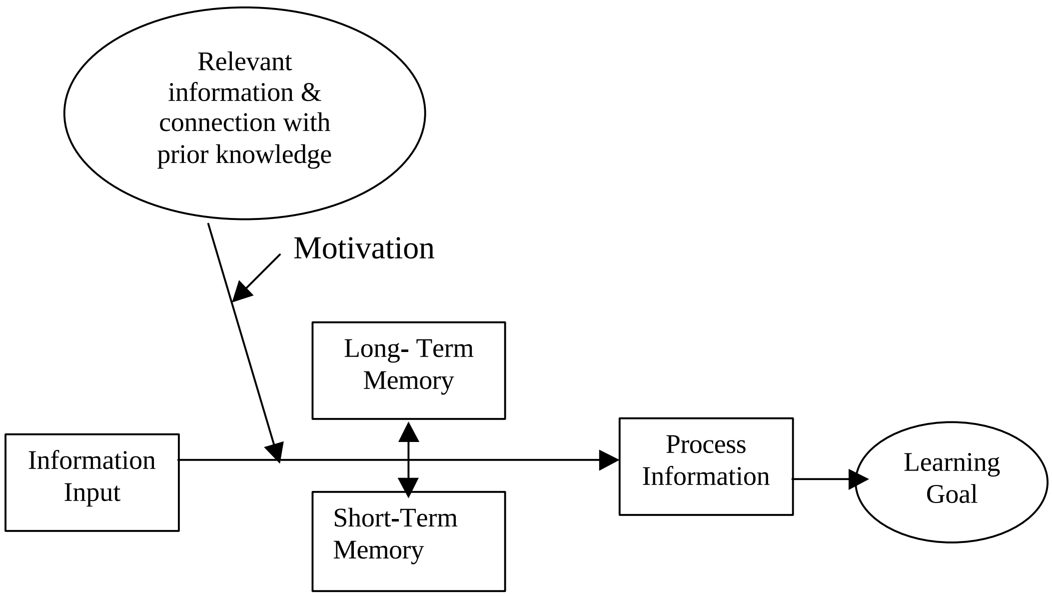
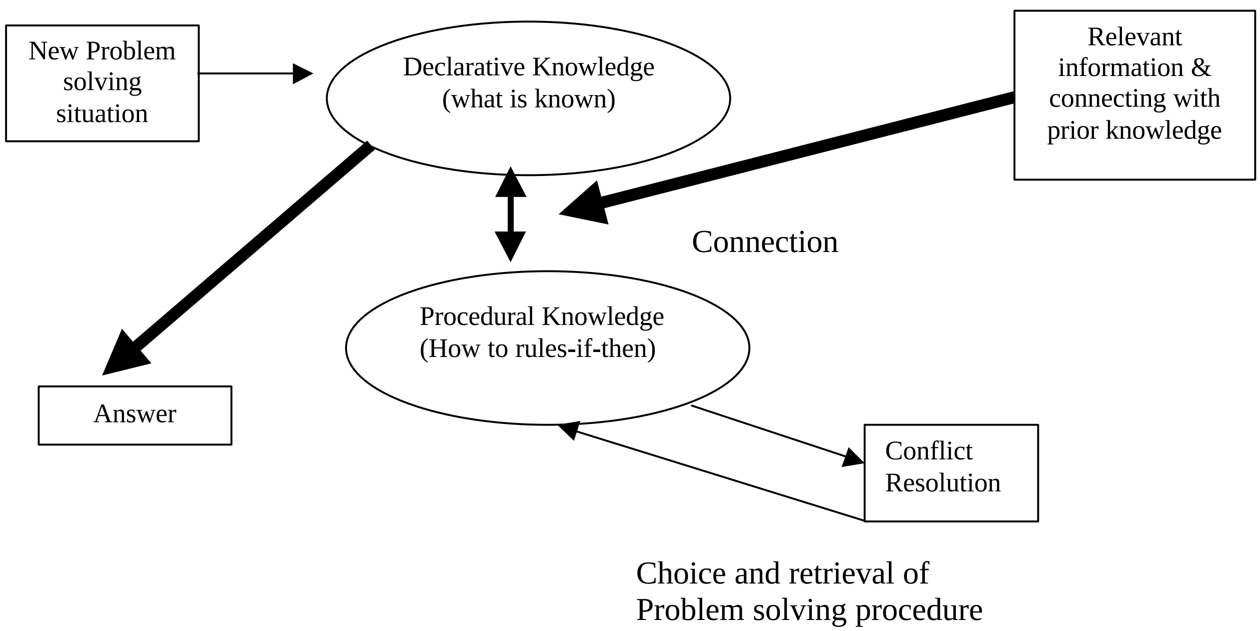


Figure 3. A constructivist model of learning.

Anderson's Adaptive Character of Thought (ACT) theory (Koedinger, 1998) is one example of a constructivist approach to learning. This model proposes that the obtainment of a cognitive skill is dependent upon ones declarative knowledge, that is what one already knows, as well as their procedural knowledge, that is their ability to use what they know. Under this model, relevant prior knowledge allows a more efficient mechanism for choosing an appropriate problem solving process from procedural knowledge in an effort to derive an answer to a proposed problem (Figure 4). The ACT theory further proposes that procedural knowledge can only be learned by doing and cannot be learned by listening or watching. It is obtained by engaging in relevant and constructive problem-solving activities and then strengthened through practice (Anderson, Corbett, Koedinger, and Pelletier, 1999). This theory is the framework behind several intelligent tutoring systems, in particular the Carnegie Algebra Tutor that is being utilized in this study.



<u>Figure 4.</u> The Act model of learning.

<u>A Theoretical Model</u>

Reigeluth (1991) suggests that the best instructional approach to maximize learning would be one that found the appropriate balance between the two models. He goes on to state that different learning situations would require different types of instruction. Roblyer (1997) also suggested that the most efficient instructional strategy, including the use of computer technology, would be a framework in which the strengths of both models were integrated into the classroom as dictated by individual student learning styles or desired learning outcomes.

Tennyson (Roblyer, 1997) stated that 30% of learning should be spent on the acquisition of basic skills while 70% should be spent on developing cognitive processes. It is not a matter of which model, but rather how to integrate the best of both models into a rich, inquiry based curricula. As mentioned by Roblyer (1997), the role of the teacher is to determine the best mix of strategies that would optimize student achievement and attitude.

This theoretical model consists of both a behavioral and cognitive framework based upon Anderson's ACT theory. In keeping to the recommendations for instructional reform in mathematics as called for by the NCTM standards, it is important to implement an active learning, inquiry-based approach that effectively integrates computer technology into the classroom. It is also prudent to recognize the state and national emphasis on standardized assessment, and include a directed component that will insure the acquisition of essential knowledge and skills in algebra. Figure 5 displays the interaction between the computer treatment, intervening variables, and the influence of both behavioral and cognitive theoretical learning models.

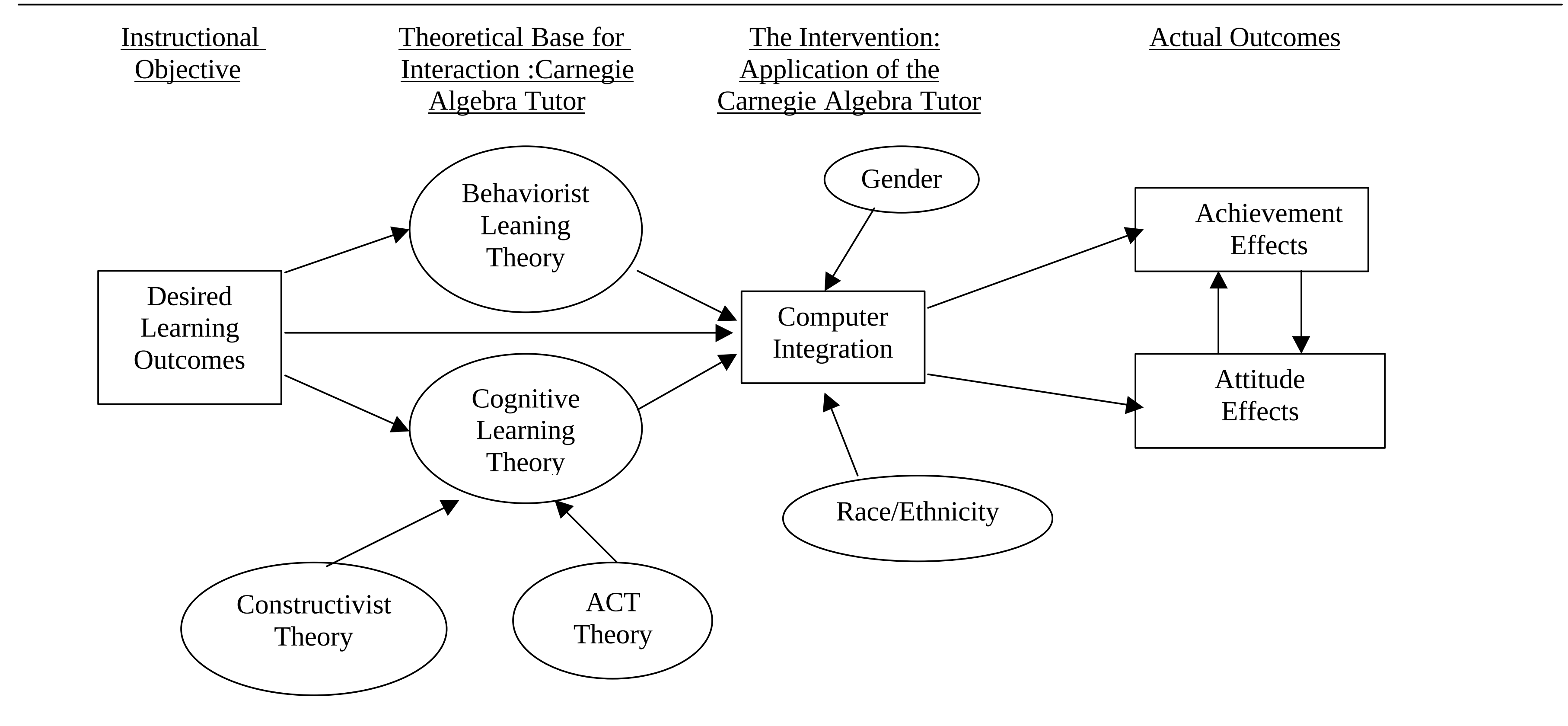


Figure 5. A Theoretical approach to the effective integration of computer technology into an Algebra classroom.

Definition of Terms

Table 1 shows the constitutive and operational definitions of mathematical achievement and attitude towards mathematics, which will be used as dependent variables within this study. Definitions for the independent variables associated with mathematics achievement and attitude: computer technology treatment, ethnicity, and gender are also located in Table 1.

Table 1

Constitutive and Operational Definitions of Variables in the Study

	Variable	Constitutive	Operational
Dependent	Mathematics Achievement	The ability to perform basic algebraic functions as outlined by the Algebra SOL standards	Mean scale score on the Algebra I SOL Assessment
	Mathematics Attitude	Student's attitude toward success, confidence, effective motivation, and perceived usefulness of mathematics	Mean score on the Fennema-Sherman Mathematics Attitude Survey
Independent	Computer Treatment	Students were assigned to either a control or experimental computer group	Participation or nonparticipation in the Carnegie Algebra Tutor program
	Race/Ethnicity	Student demographic information	Race/Ethnic code reported on the Stanford 9-TA
	Gender	Student demographic information	Student gender reported on the Stanford 9-TA

Research Questions

The following research questions were used to guide the quantitative and qualitative portions of the study. These questions were divided into three main categories to aid in the organization and presentation of the results. The three categories are: (a) achievement, (b) attitude, and (c) explanatory.

Question 1: Is there a significant interaction between treatment groups, (those who receive the treatment and those who do not), race/ethnicity, (white or black), and gender with respect to Algebra I SOL total raw scores after controlling for pretest differences on the Stanford 9 TA?

1A: Is there a significant interaction between treatment groups, (those who receive the treatment and those who do not), and race/ethnicity with respect to Algebra I SOL total raw scores after controlling for pretest differences on the Stanford 9 TA?

1B: Is there a significant interaction between race/ethnicity, (white or black), and gender with respect to Algebra I SOL total raw scores after controlling for pretest differences on the Stanford 9 TA?

1C: Is there a significant interaction between treatment groups, (those that receive the treatment and those that do not), and gender with respect to Algebra I SOL total raw scores after controlling for pretest differences on the Stanford 9 TA?

1D: Is there a significant difference between student groups, (those who receive the computer treatment and those who do not), with respect to Algebra I SOL total raw scores after controlling for pretest differences on the Stanford 9 TA?

1E: Is there a significant difference between race/ethnicity, (white or black), with respect to Algebra I SOL total raw scores after controlling for pretest differences on the Stanford 9 TA?

1F: Is there a significant difference between genders with respect to Algebra I SOL total raw scores after controlling for pretest differences on the Stanford 9 TA?

1G: What is the correlation between the total mathematics portion of the Stanford 9 TA and the Algebra I SOL?

Question 2: Is there a significant interaction between treatment groups,(those who receive the treatment and those who do not), race/ethnicity, (white or black), and gender with respect to mean scores on the Fennema-Sherman Mathematics Attitude Survey?

2A: Is there a significant interaction between student groups, (those that receive the treatment and those that do not), and gender with respect to mean scores on the Fennema-Sherman Mathematics Attitude Survey?

2B: Is there a significant interaction between student groups, (those that receive the treatment and those that do not), and race/ethnicity with respect to mean scores on the Fennema-Sherman Mathematics Attitude Survey?

2C: Is there a significant interaction between race/ethnicity, (white or black), and gender with respect to mean scores on the Fennema-Sherman Mathematics Attitude Survey?

2D: Is there a significant difference between student groups, (those who receive the computer treatment and those who do not) with respect to mean scores on the Fennema- Sherman Mathematics Attitude Survey?

2E: Is there a significant difference between race/ethnicity, (black or white), with respect to mean scores on the Fennema-Sherman Mathematics Attitude Survey?

2F: Is there a significant difference between genders with respect to mean scores on the Fennema-Sherman Mathematics Attitude Survey?

Question 3: Do students feel that the Carnegie Algebra Tutor had a significant impact on their achievement and attitude in mathematics?

Question 4: Do teachers feel that the Carnegie Algebra Tutor had a significant impact on student achievement and attitude in mathematics?

Question 5: What implementation differences existed that may confound statistical results?

Organization of the Study

This report is divided into five chapters. Chapter I includes a description of the following: (a) the problem and its context, (b) the statement of the problem to be studied, (c) the purpose of the study, (d) the theoretical framework of the study, (e) definitions that will be used throughout the study (f) the research questions that will be answered by the study, and (g) limitations and delimitations of the study.

Chapter II consists of a literature review of studies relative to the use of computer technology in the classroom and variables associated with the effective implementation of computer technology into the curriculum. The chapter begins with a review of meta-analysis that provide an overview of the effects of computer technology on student achievement and attitude towards mathematics. Following this discussion, reported studies are presented as following under a behavioral or cognitive theoretical framework.

The methodology utilized in the study is discussed in Chapter III. The study contains both a quantitative and qualitative component. A description of the population, design, instrumentation, data collection procedures, and method of analysis used in the quantitative portion is included in the first half of the chapter. Focus group procedures and questions utilized in the qualitative portion are found in the second half of the chapter.

The results of the study are presented in Chapter IV. Descriptive statistics and results of the quantitative analyses are discussed within the context of each of the research questions and further expanded upon in Chapter V. Emerging themes revealed through data analysis of focus group interviews will also be discussed.

Chapter V is the final chapter of the study. It includes a summary of the study and a discussion of conclusions made based on the results of the study. Findings from the qualitative portion are used to explain quantitative findings. This chapter also includes implications for future research.

CHAPTER II

A REVIEW OF LITERATURE

The purpose of this study was to explore the effect of computer technology, specifically hardware that utilizes the Carnegie Algebra Tutor software, on student achievement and attitude towards mathematics with an emphasis on Algebra. This review of literature explores related studies by first discussing several meta-analyses that provide an overview of the effects that computer technology has on achievement. Following the theoretical framework of this study, the subsequent sections discuss individual studies that could be classified into either a behavioral or cognitive instructional model. The final sections of the review focus on variables that are analyzed in this study and a discussion of the studies that indicated the importance of these variables to the study of computer technology and its effect on achievement.

Trends Revealed through Meta-Analysis

Meta-analysis is a statistical procedure developed by Glass (1978) that allows for the examination of the results from multiple studies of a single subject in an effort to look for trends or patterns that are not easily revealed by looking at individual studies. Using this procedure, the results from an individual study are assigned an effect size (ES) which is a value assigned to the effectiveness of the treatment condition (Roblyer, 1985). This value is actually a “standardized mean difference between a pair of treatment conditions” (Glass, McGraw, and Smith, 1981, p.102). Effect sizes from each study are statistically compiled and analyzed for trends or patterns. Cohen (1977) provides a widely accepted scale for rating the significance of a reported effect size. Using his model, an effect size between .2 and .499 would be considered small while effect sizes between .5 and .799 would be viewed as moderate. An effect size of .8 or greater would be considered large. Cohen’s classification will be utilized throughout this review to discuss the relevance of reported findings. Siven-Kachala and Bialo (2000) offer another scale for drawing comparisons between reported findings. An effect size of .3 means that 60% of the experimental group scored higher than the average student in the control group. An effect size of .7 would indicate that 75% of the experimental group scored higher than the average student in the control group. This scale provides another view by which meta-analysis can be used to compare studies.

An early meta-analysis by Kulik (1981) examined the effects of computer-assisted instruction on achievement across all grade levels. Kulik reported overall effect sizes for elementary schools, secondary schools, and colleges as .4, .3, and .1 respectively. While this study reported a positive effect on achievement, the variety of curriculum areas and grade levels included in the analysis showed the need for a more focused meta-analysis. In a follow-up study, Bangert-Drowns, Kulik, and Kulik, (1984) focused their analysis on the elementary school level. The overall effect size for the 51 studies was .47 for students receiving computer-assisted instruction (CAI). This value confirmed their previous findings of .4 reported for elementary schools. In this study, Kulik, et al. also compared studies that examined the effects of CAI and those that examined the effects of computer-enriched instruction (CEI). Kulik described computer-enriched activities as those that consist mostly of simulation applications. The reported effect size for CEI was only .07 compared to .47 for CAI. The difference between these findings pointed to the need for examining the type of computer activities that were being utilized under the name of “computer-assisted instruction”.

Glass (1982) examined studies that could classify the type of computer usage in the classroom as either a supplement for instruction or as an attempt to substitute instruction with the computer. Studies that used the computer as a supplement reported effect sizes for elementary students' level of achievement in mathematics computation, mathematics concepts, mathematics applications and overall mathematics achievement as .71, .09, .26, and .35 respectively. Studies that used the computer as a substitute reported effect sizes for the same categories as .45, .10, .10, and .22 respectively. The strong effect size reported for mathematical computation highlighted the idea that the effectiveness of computer technology may be closely linked to how the technology is used in the classroom and for what instructional purpose.

Kulik and Kulik (1991) examined 254 studies that utilized some form of end-of-treatment examination across all subject areas. While the scope of this study was large, it did produce several interesting findings. Students that received CAI scored .3 standard deviations higher than students did in control groups. The study also showed that the effect size for CAI treatments that utilized duration periods of less than four weeks was higher (ES = .42) than those that were greater than four weeks (ES = .26). This finding brought into question the Hawthorne Effect and the impact of participation in an experiment on experimental designs. When looking for trends over time, Kulik et al showed that the effect size for studies between 1966 and 1975 was .24 while it was .36 for studies between 1974 and 1984. It was proposed that this increase was due to the increasing advancements in computer hardware and software.

Kulik's findings were confirmed in a review of 12 meta-analytical studies, based on 546 individual studies conducted by Schacter and Fagnano (1999). They reported effect sizes ranging from .25 to .57 in studies that were conducted between 1981 and 1991. Students utilizing some form of computer instruction performed between the 56th and 72nd percentile compared to students who performed at the 50th percentile in non-computer classes.

In an attempt to focus on specific uses of computer-assisted instruction, Kulik (1994) conducted a meta-analysis of 97 different studies and reported an overall effect size of .32. He categorized the type of computer usage as either tutoring (n = 58), managing (n = 10), simulation, (n = 6), enrichment (n = 5), programming (n = 9), or Logo (n = 9). The reported effect sizes for these categories were .34, .28, .34, .35, .38, and .56, respectively. Perhaps more significant than the modest effect size was the large number of studies that were using CAI in low-level tutorial activities typical of the drill and practice concept found in behavioral learning models. This clearly points to the dominance of the directed instructional model during this time frame.

Fletcher-Flinn and Gravitt (1995) examined 120 studies conducted on all subject areas between 1987 and 1992 and reported overall effect size of .33 for students receiving CAI. This study indicated that CAI did not have a significantly stronger effect on any one particular subject area, however mathematics had the highest overall effect size (ES =.32). Fletcher-Flinn et al. also reported that there was not a statistically significant difference in effect size for studies that controlled for teacher differences by having the same teacher provide instruction for both the control and experimental group. Studies that used the same teacher had an effect size of .23 while those that did not had an effect size of .30.

Similar effect sizes to those of Kulik and Kulik (1991) and Fletcher-Flinn and Gravitt (1995) were reported in an analysis of 40 studies conducted after 1990 by Fazal (Siven-Kachala & Bialo, 2000). This analysis showed that studies of drill and practice applications produced and effect size of .34, while stronger effect sizes for other types of computer applications such as simulations (.69) and advanced tutorials (.49).

The moderate effect that CAI appeared to have on student achievement in the above mentioned studies was contradicted in a broad, multi-subject meta-analysis performed by Christmann, Badgett, and Lucking (1997). The overall effect size for studies between 1984 and

1995 was only .187. This finding certainly did not support Kulik and Kulik's (1994) belief that effect size would show an increase over time due to technological advances, however it is consistent with Clark's belief. When looking at effect sizes for the years 1992, 1993, 1994 and 1995, Christmann, et al. reported effect sizes of -.455, .156, -.118, and -.327, respectively. While these findings indicate a negative effect of CAI on achievement, it is important to note that only nine studies were included from the years between 1992 and 1995. Also significant are the beliefs of Clark (1987) and Hagler and Knowlton (1987) who proposed that inconsistent and insignificant differences in student achievement should be expected in these types of studies.

King's (1997) analysis of 30 studies involving college mathematics also showed a decrease in overall effect size (ES = .22) from Kulik and Kulik's (1991) overall effect size of .42. This study did reinforce the need for research into particular uses of CAI as a significant difference was reported between student's level of mathematics conceptual achievement (ES = .20) and their level of procedural achievement (ES = .03).

The use of meta-analysis provides an opportunity to look at overall trends and patterns in the use of computer technology and its effect on student achievement. It is important to recognize that these analyses include a variety of research designs as well as a variety of computer uses within the classroom. Generalizations as to the effectiveness of computers should not be made on the results of this type of analysis alone. The next two sections of this review will examine individual studies that could be classified into either the directed or constructivist model of instruction.

Computers within a Behavioral Framework

As shown in Kulik's (1994) meta-analysis, the majority of studies available for review were conducted using instructional designs classified as drill and practice or tutorial activities that typify instructional practices that reinforce memorization and basic skill mastery. These practices are common with instructional practices heavily influenced by behavioral learning models. Students typically interact with a computer in a question-answer-feedback format that mirrors Skinner’s stimulus-response model.

Several studies provide examples of the behavioral influence that commonly exists in the classrooms of today. Becker (1990) conducted a national study on the effects of using computers in mathematics in grades five through eight. This study, involving 2,919 students in 96 classes reported effect sizes that ranged from .03 to .18. Teachers reported that the majority of the computer time was occupied by drill and practice activities. The small effect sizes are consistent with trends shown in meta-analyses. In another study showing the behavioral influence, Fletcher, Hawley, and Piele (1990) reported significant differences in third and fifth grade problem solving ability (F [1,35] = 4.55, $p > .05$) and total mathematics ability (F [1,38] = 5.91, $p > .05$) when utilizing drill and practice sessions.

Clariana (1996) conducted a study on the effects of a computer integrated-learning system on fifth grade mathematics achievement. Using this type of program, students interact with a computer to accomplish specific objectives from a standard curriculum. The computer keeps a record of student progress. This type of structured learning environment is also typical of a directed model. Clariana reported median effect sizes of .13 for computational ability and .33 for application ability. Again, these effect sizes are small and consistent with meta-analysis results.

Wenglinsky’s (1998) analysis of the 1996 NAEP Mathematics Assessment shows that it is no surprise that the majority of available studies are dominated by instructional activities heavily based in behavioral models. Elementary teachers reported that 90% of the computer applications used in their classrooms consisted of low-level drill and practice activities and learning games. Only 10% of the computer use was dedicated to the upper-level activities, such as simulation and discovery learning, which are highly endorsed by the NCTM standards. Eighth grade teachers reported similar usage trends. Sixty-three percent of total computer time was spent on drill and practice or learning games, while 27% was spent on application activities and 9% on discovery learning.

Wenglinsky's findings are consistent with an analysis of the 1996 NAEP State results for Virginia which shows the types of uses and how often computers are used in the classrooms. Thirty-five percent of Virginia's eighth grade teachers reported that they did not use computers in their mathematics classrooms. Drill and practice activities and playing mathematics or learning games constituted another 39% of reported computer use throughout the state. When asked how often computers are used in the classroom, 63% of eighth grade teachers reported that they hardly ever or never used a computer. Twenty-nine percent reported using a computer once or twice a month. Only 8% of the teachers in Virginia reported using a computer more than once a week in the classroom. Why do these large-scale studies indicate that classroom instruction is heavily influenced by behavioral learning models?

Several factors can be attributed to the apparent behavioral domination. First, the availability of computer software that emphasizes higher order thinking skills is very limited and secondly, according to the PCAST report (1997), teachers receive very little training in how to use computers as tools in their classrooms. These two factors alone drive teachers who are willing to experiment with computers in their classrooms towards behavioral models that reflect low training needs and minimal implementation requirements. These factors may account for the apparent resistance to integrating computer technology into the classroom as well as resistance to making curricula changes put forth by the NCTM as indicated by Wenglinsky's analysis.

Computers within a Cognitive Framework

As advances in software design allow for more complex applications, studies classified under a cognitive framework are beginning to emerge. Trends previously discussed from the 1996 NAEP reveal that teachers have not made a shift from the traditional teacher-directed model of instruction to a student-directed model of instruction that would typify the constructivist framework. The use of video systems such as the Jasper Woodbury Problem Solving Series developed by the Cognition and Technology Group at Vanderbilt (CTGV, 1993) showed positive results in improving student problem solving and solution development skills. This type of application is being incorporated into computer software programs.

Hypermedia is one type of computer usage that can fall under this category. Using hypermedia, students explore relevant information through the use of electronic links that can include text, graphics, sound, and video (Defrieze, 1998). Liao (1998) performed a meta-analysis on this form of computer usage and reported an overall effect size of .48. Using Cohen's scale (1977), this effect sizes approaches a moderate effect on achievement.

Studies conducted during the late 1950s and early 1960s indicated that individual tutoring produced significant learning gains (Shute & Psotka,1996). A recent trend in educational software is the development of intelligent tutoring software. This software typically contains a database of potential problem solving steps as well as possible errors for each mathematical problem presented to a student. The tutor tracks the students answer, provides assistance as needed based on the students method of solving the problem, and documents the student's mastery of each specified objective. Software tutorial programs of this nature are found to be superior to other types of tutorial programs (Siven-Kachala & Bialo, 2000).

The Carnegie Algebra Tutor was a collaborative effort between researchers from the Carnegie Mellon Institute and mathematics teachers from the Pittsburgh School District that focused on the development of relevant problem solving skills and the development of a curriculum aligned with the NCTM standards. In a study involving 3 Pittsburgh Public High Schools during the 1993-94 school year, Koedinger and Anderson (1995) reported that ninth grade Algebra students using the tutor performed 15% higher on standardized tests than students who did not use the tutor. A quasi-experimental design involving 470 students and 10 teachers in an experimental group was compared to 120 students and 3 teachers in a control group. Students spent 25 of 180 class sessions using the tutoring software. The Iowa Algebra Aptitude test, a Math SAT subset test, and two author-designed tests aligned with NCTM reform objectives were utilized for assessment purposes. Students in the experimental group scored significantly higher on the Iowa Aptitude test (SD = .19) than those in the control group (SD = .17). On the Problem Situation Test, students in the experimental group were able to answer almost twice as many problems (39%) than students in the control group (22%).

A longitudinal study recently completed in West Virginia (Mann, Shakeshaft, Becker, and Kotkamp, 1999) reported significant increases in student achievement on the Stanford 9 TA Achievement test after a statewide implementation of hardware and software acquisition designed to promote problem solving and higher order thinking skills similar to the Carnegie software. This study involved 950 5^{th} graders from 18 different schools. Students spent approximately one plus hour per week using either the IBM Basic Skills Courseware or the Jostens Learning System. Mann et al reported that 70% of the variation in student test score performance was explained by factors external to the school. This would mean that a school might impact 30% of the variation in student achievement. Results from the author's regression analysis indicated that the technology initiative accounted for 11% of the variation in student basic skills gain scores. The greatest amount of explained variation was found in the lower achieving students.

The next portion of this literature review will consist of a discussion of studies that present race/ethnicity, gender, and student attitude towards mathematics as significant intervening variables that impact student achievement. They will be discussed within the context of mathematics achievement.

Other Intervening Variables

An examination of specific intervening variables may help explain differences in achievement in mathematics. Integration of computer technology into an inquiry-based mathematics curriculum is viewed as a means by which differences between these variables and their impact on achievement can be reduced.

Attitude

The study of student attitudes towards mathematics and the impact that attitude has on achievement has been heavily researched. The number and types of mathematics courses selected by students as well as the likelihood of pursuing mathematics related careers has been linked to positive attitudes towards mathematics (Haladyna, Shaughnessy, & Shaughnessy, 1983). In addition, numerous studies have reported a positive correlation between attitudes towards mathematics and achievement in mathematics (Simonson & Maushak, 1996).

Student attitude towards mathematics is a complex construct that has been measured in a variety of ways throughout the literature. Most research has used the variables measured in a study as the basis for defining student attitude towards mathematics. Haladyna et al. (1983) indicate that this construct is actually a complex interaction between various external and internal factors unique to each student. External factors such as gender, social background, and student aptitude are commonly used variables throughout the literature. Internal factors are frequently the subject of experimental manipulation and have traditionally consisted of affective constructs such as student's beliefs and feelings about mathematics. Reyes (1984) identified confidence in learning mathematics, mathematics anxiety, and the perceived usefulness of mathematics as the most frequently studied affective variables associated with student achievement in mathematics. Most research centers around manipulating these affective constructs in an effort to alter a student's attitude towards mathematics as well as achievement in mathematics and then examined results across the various external factors.

A student's confidence in learning mathematics is a construct found throughout the research on attitude towards mathematics. Confidence is linked to an individual's perceived self-concept and has been shown to have a positive relationship with mathematics achievement (Reyes, 1984). Fennema and Sherman reported a correlation of .40 between achievement and their Confidence Scale. Armstrong reported similar correlations between .42 and .48 in a study of 12th graders (Reyes). Meyinsse and Tashakkori (1994) reported that affective variables, including a self-concept component, explained a significant portion of variation (r2 = .39) in student mathematics achievement.

Closely related to confidence and self-concept is Bandura's concept of self-efficacy. Defined as the confidence that one has in their own ability (Pajares & Kranzler,1995), self-efficacy studies have become common in affective research. Attitudinal studies containing a confidence construct have produced similar findings to self-efficacy studies. Randhawa, Beamer, and Lundberg (1993) reported that self-efficacy shared 41.6% common variance with mathematics attitude and indicated that self-efficacy and attitude had similar predictive power for mathematics achievement. Pajares and Kranzler also reported a strong correlation(.61) between self-efficacy and measures of self-concept and confidence.

The interrelatedness of self-efficacy and attitude can also be observed when examining the instruments used to measure the two constructs. For example, Pajares and Kranzler utilized the Mathematics Confidence Scale to access 329 secondary students self-efficacy in mathematics. This confidence scale was highly correlated (.57) with the Confidence Scale of the Fennema-Sherman Mathematics Attitudes Scales. Both constructs are important aspects of affective research and can and often are used interchangeably in affective research. It is important, therefore to carefully define the constructs used to measure affective variables in order to compare measures of attitude with student achievement in mathematics.

While positive correlations between attitude towards mathematics and achievement in mathematics have been frequently reported (Reyes, 1984), the strength of that relationship is not clear. A meta-analysis performed by Ma and Kishor (1997) reported correlations from zero to above .40. While most of these effect sizes are small to moderate, Ma and Kishor reported a trend indicating stronger effect sizes between grades 7-9 (ES= .25) than in grades 1-4 (ES=.03) and grades 5-6 (ES= .14). This indicates that the attitude toward mathematics at this grade level may significantly impact student achievement. Since Algebra I is taught predominately in the ninth grade in Virginia, curricula changes that promote a more positive attitude towards mathematics may realize more significant increases in achievement than at other grade levels (Reese, Jerry and Ballator, 1997).

Race/Ethnicity

Several studies indicate the significance of race/ethnicity on student achievement. In an analysis of 1992 NAEP Trial State Assessment data, Franks, DeVaney, Weerakkody, and Katayama (1996) showed that as the proportion of minorities increased, overall student achievement in a school decreased. He also reported that as computers were made more available, these differences between minorities and non-minorities decreased. Meyinsse and Tashakkori (1994) also reported that student performance was significantly related to ethnicity.

The 1996 NAEP State Results for Virginia revealed significant discrepancies between the performance of White (M=279) and Black students (M=244) and White and Hispanic students (M=258) on the mathematics assessment. White students data from the 1999 Stanford 9 State Assessment Program confirm the NAEP results. White students outperformed Black students in mathematical problem solving (70 to38), mathematical procedures (51 to 27), and total mathematical ability (63 to 33). Similar trends are revealed in the 1999 Virginia Algebra I SOL with White students having a higher pass rate (62% to 36%) than Black students.

The 1996 NAEP also revealed ethnic differences in the usage of computers in the classroom. The data indicated that White students spent 31% of computer time on simulation and application activities compared to 14% for Black students. Similarly, White students spent 30 % of computer time on low-level drill and practice activities compared to 52 % for Black students (Archer, 2000).

Other ethnic disparities exist in factors linked to student achievement. Black students opt out of advanced-level science and mathematics courses at a much higher rate than White students (Brunner, Bennett, & Honey, 2000). Tapscott (2000) believes that society is rapidly segregating along ethnic and information lines. The rate of computer ownership is 36% lower for Black students after controlling for family income (PCAST,1997). As technology is infused into the schools and becomes integrated into all curriculum areas, schools will become focal points for reducing the gaps between the “computer haves” and the “have nots”.

Gender

Gender differences across curricula areas have been heavily researched. Meta-analysis by Friedman (1989) and Hyde, Fennema, and Lamon (1990) confirm that any gender differences in mathematics achievement that exist are small and decreasing with time. While overall effect sizes reported in these studies are negligible, gender differences began to appear in high school. Females appear to perform mathematics computation better than males (ES =-.14), while males tend to do better on problem-solving applications (ES=.08). While these effect sizes are small, opportunities exist to close the gender gap between computation and problem solving by utilizing computer technology within the constructivist framework.

While achievement differences appear to be declining, there remain significant differences in the types of mathematics and computer related courses selected as well as significant differences in students’ confidence in mathematics. Fennema and Sherman (1986) reported that males in secondary mathematics courses showed greater confidence than females in their ability to learn mathematics. This confidence may be a significant reason for the disproportionate number of females that do not elect to take upper level mathematics courses such as trigonometry, pre-calculus and calculus (Leder, 1990). According to Kirkpatrick and Cuban (2000), the gap in confidence widens with age as females spend less time on computers than males. The infusion of technology into schools may provide a mechanism for increasing the confidence level of females thereby increasing the number that advance into advanced mathematics and computer courses.

Chapter II Summary

The majority of studies on the effects of computer technology on student achievement in mathematics show very small but positive results indicating that computer technology can improve achievement. Critics of these studies argue that the small or insignificant findings are the result of comparing different mediums of the same message. Data supports the fact that teachers nationwide and in the state of Virginia are not utilizing computer technology to its potential. Computers are not being used at all or are being used mostly within a behavioral instructional framework that stresses rote memorization and the mastery of specific and isolated skills. Few studies exist that examine computer technology implemented within a cognitive framework perhaps because the majority of teachers do not operate their classroom within this framework. Teachers may be uncomfortable within this framework and therefore resist moving from a teacher-centered environment to a student-centered environment.

CHAPTER III

METHODOLOGY

This chapter includes the methodology used in this study. The first section includes a detailed description of the population that was studied and a description of the research design employed. As this study utilized both a quantitative and a qualitative component, the instrumentation and techniques used for data analysis in each component are presented under separate quantitative and qualitative sections.

Population

This study involved seven high schools in a large, urban school system consisting of 77,500 students in grades K-12. There area total of ten high school sites in the district that house approximately 22,000 students. Minority students account for 33.5 % of the total student population. Of that total, 25% are African-American students. Approximately 10% of the students across the division have been identified as gifted and 13% receive special education services. One school opted to not participate in the program and two schools did not keep students in the Carnegie Algebra Tutor program together for all three semesters resulting in contaminated populations. For this reason these three schools were not included in the study. One school declined to participate in the survey and focus group sessions. While attitude data was not obtainable, this school's achievement data was included in the data analysis. The target population included all students who completed Introduction to Algebra during the 1999-2000 school year and then finished their Algebra I requirement by passing Algebra X during the fall 2000 semester. These two courses are part of the district's core curriculum and are a slower paced version of the standard Algebra I course offered within the school district's traditional mathematics sequence (see Appendix A for recommended course sequence). This course uses the same textbook and follows the same curriculum as Algebra I but students have three semesters rather than two to master the objectives (see Appendix B for pacing guide). Students typically enrolled in this class are those who have struggled at lower levels of mathematics and have been recommended for this course by their previous mathematics teacher.

Of the 77,500 students in this school division, approximately 5,500 will take Algebra I. There are approximately 2,900 mathematics students who enroll in Introduction to Algebra and then complete their Algebra requirement by taking Algebra X within this school district each year. The sample population consisted of approximately 445 students who enrolled in Introduction to Algebra during the 1999-2000 and then completed Algebra X during the fall of the 2000-2001 school year at the seven schools used in the study. This sample meets the sampling size criteria established by Krejcie and Morgan (1970) needed to generalize experimental results to the larger population.

Students at all seven schools were randomly assigned to available classes through a computer-scheduling program. The subjects used as the sample population for this study consisted of all students who enrolled in and completed the Introduction to Algebra, Algebra X, the Stanford 9 TA and the end-of-course Standard of Learning Test in Algebra I at the seven schools. Intact classes were taught within a 90-minute A/B block schedule format at five of the schools. One school operated on a traditional 50-minute, 7-bell schedule.

Permission to conduct this study in this school district was granted from the district's Office of Accountability (see Appendix C). After reviewing the Application for Approval of Research Involving Human Subjects, approval was also granted by the Virginia Polytechnic Institute and State University Institutional Review Board (see Appendix D).

Tables 2 compares school passing rates on the Algebra I SOL, average SAT mathematics scores, and percentile ranks on the Stanford 9 TA. Table 3 represents the change in the number of students in the treatment condition for each school. The figures in this table represent students that failed the course at the end of the second semester, left the school division, or otherwise failed to continue with the third semester of the program. Table 4 provides an overview of pertinent demographic data for each school. Stanford 9 TA and Algebra I SOL assessment data as well as other achievement and descriptive data provide a means by which populations involved in the study can be compared with other populations that may be considering employing the Carnegie Algebra program.

Table 2

Comparison of Schools on Passing Rates for Algebra I SOL, Average Mathematics SAT Scores, and Percentile Ranks on the Stanford 9 TA Assessment

	Algebra I SOL			Stanford 9 TA	# Tested SAT	SAT Math
School	1998	1999	2000	1999	1999	1999
1	34.45	60.53	93.88	68	325	536
2	14.70	52.84	67.86	58	231	525
3	8.73	52.80	59.24	47	148	465
4	10.81	31.92	39.88	55	300	475
5	29.87	42.07	54.43	61	335	517
6	14.92	41.89	52.78	62	211	479
7	18.36	38.69	65.17	58	241	488
8	12.95	45.03	87.08	54	325	468
9	24.00	64.69	91.60	56	384	480

.Note. Even though six schools participated in all aspects of the study, comparison data for all schools in the district are included in the table.

Table 3

Change in Number of Students in Carnegie Sections in Each School.

School	Number of Carnegie Students [a] 1999-2000	2000-2001	Difference	Mortality (%)
1	41	14	27	66
2	54	49	5	9
3	59	31	28	47
4	97	54	43	44
5	100	50	50	50
6	68	28	40	59
7	43	35	8	19
TOTAL	462	261	201	44

Note. Comparison data for the school that did not participate in the survey and focus group portion of the study is included in this table.

[a] The values describing the change in number of students in the Carnegie sections in each school from the 1999-2000 school year to the 2000-2001 school year include students that failed the first two semesters and had to subsequently repeat the Introduction to Algebra course, moved from the school, transferred to another class, or otherwise left the treatment group. The failure rate at the end of the first two semesters across the entire school division for the treatment group was 31.5% compared to 38.0% for all traditional Introduction to Algebra classes.

Table 4
Comparison of the Schools Demographic Student Variables

School	Size (n)	White (%)	Black (%)	Other (%)	Free or Reduced Lunch (%)	Special Education (%)	Gifted (%)	Advanced Diploma (%)
1	2,150	83	12	5	12	6	17	58
2	1,800	77	19	4	16	11	15	51
3	1,780	46	39	15	27	12	7	37
4	2,000	81	13	6	5	7	11	57
5	2,300	76	14	7	7	9	14	66
6	2,130	67	23	10	18	11	15	56
7	2,270	71	21	8	11	14	19	52
8	2,520	54	29	17	13	9	9	60
9	2,250	56	29	15	11	11	13	65

Research Design

This study utilized Campbell and Stanley’s (1963) nonequivalent control group design. According to Stanley and Campbell this is "one of the most widespread experimental designs in educational research" and is an effective design when the "control and experimental groups do not have pre-experimental sampling equivalence" (p. 47). Stanley and Campbell indicate that this condition exists in school classrooms, as they are "naturally assembled collectives" (p.47). For the purpose of this study, intact classes utilizing the Carnegie Algebra Tutor from each of the six schools (n = 229) were used as the experimental group while randomly selected intact classes not utilizing the Carnegie Algebra Tutor (n = 216) served as the control group. Students at all six schools were randomly assigned to these classes using a computer-scheduling program. Use of the nonequivalent control group design adequately controls for the effects of history, testing, instrumentation, and maturation on internal validity (Stanley and Campbell, 1963). Since students were randomly assigned to classrooms rather than placed in these classrooms based on pretest scores, the effects of statistical regression should also have been minimized.

Treatment

The focus of the experimental treatment centered on the Carnegie Algebra Tutor and it’s impact on student mathematics achievement and attitude. This curriculum and accompanying software is a technology-based approach by which students utilized an intelligent-tutoring system to solve real world problems using their knowledge of algebraic concepts in a self-paced, learn-on-your own environment.

Each high school in the district secured a volunteer mathematics teacher who was willing to forego the traditional curriculum and fully implement the Carnegie program. Each teacher participated in an intensive three-day training program on how to implement the curriculum and operate the computer tutor. Teachers agreed to spend 40% of class time on the computer and 60% of class time receiving instruction outside the computer lab. The school district's mathematics coordinator was responsible for monitoring each schools participation and implementation.

Classes that incorporated the Carnegie Algebra Tutor were considered the experimental group. These classes received instruction following only the Carnegie curriculum; however, teachers monitored progress towards the SOLs as the Carnegie Algebra Tutor had been aligned with the Virginia Algebra SOLs (see Appendix E for alignment matrix). Duration of the treatment was three academic semesters beginning in the fall of 1999 and concluding at the end of the fall 2000 semester. Classes that did not utilize the Carnegie Algebra Tutor were referred to as the control group. These classes did not utilize computers or the tutoring software and received traditional instruction guided only by the textbook and city curriculum.

Quantitative Data Collection

There were three data collection components to the quantitative design. First, all students were administered the Stanford 9 TA during the first week of October as part of the state testing program. This test served as a proxy pretest (Cooke and Campbell, 1979). Raw scores from the Total Mathematics portion of this test were used to control for initial differences between the control and experimental groups. Second, students took the Virginia Standard of Learning Assessment for Algebra I at the conclusion of the Algebra X course. Students' scale scores from this test were used to determine if there were differences between experimental and control groups' level of achievement after controlling for initial differences on the Total Mathematics portion of the Stanford 9 TA. Third, four scales of the Fennema-Sherman Mathematics Attitude Scales were administered to both control and experimental schools at the conclusion of the course to determine if students that underwent the treatment had more positive attitudes towards mathematics. A numerical score for each student was calculated by totaling the survey responses for each scale and dividing by the number of questions. The total score for each student indicated the student's attitude towards mathematics with higher scores indicating a more positive attitude towards mathematics.

Instrumentation

The Stanford 9 TA . Berk's review (Impara & Plake, 1998) described the Stanford Achievement battery as one of the most widely used measures of student achievement. The test was originally developed in 1923 and this latest version was updated based on a 1995 random stratified samples of 250,000 students in an effort to align the test with national standards proposed by organizations such as the National Council of Teachers of Mathematics. It is a timed test that consists of 30 questions in the area of problem-solving and 20 questions in the area of mathematics procedures. Students have 29 minutes to complete the problem-solving portion and 20 minutes to complete the procedure portion.

Content validity was established by a panel of content experts, editors, measurement specialists, and teachers. A test question bias analysis was conducted by a panel of minority-group educators as well as an analysis using Mantel-Haenszel statistics. Construct validity was established by calculating correlations between the Stanford 9 TA and the Otis-Lennon School Ability Test but as mentioned in Berk's review, correlations with other major achievement test are absent. Berk states in his summary that "schools searching for an up-to-date achievement assessment series should give the Stanford 9 TA serious consideration" (p.928).

Haldyna's review of the Stanford 9 TA is in agreement with Berk's as he reports that this version "provides high quality information about student achievement" (Impara & Plake, 1998, p.928). He indicates that reliability coefficients for the multiple-choice parts of the test are consistently high with Kuder-Richardson Formula 20 (KR-20) coefficients ranging from .61 to .88. A specific coefficient for the mathematics portion was not reported.

To further establish concurrent validity with respect to this study, this researcher performed a correlation analysis between the Stanford 9 TA and the Virginia Algebra I SOL assessment taken by Algebra X students during the fall of 1999. This population consisted of students that had taken the same course prior to the beginning of the study. The Total Mathematics portion of the Stanford 9 TA had a significant correlation of .38 with the Algebra I SOL while the Mathematics Problem Solving portion of the Stanford 9 TA had a significant correlation of .43 with the Algebra I SOL. The population that completed Algebra X and the Algebra SOL in the fall of 2000 had a similar correlation of .36 for the Total Mathematics and .41 for the Mathematics Problem Solving portion of the Stanford 9 TA. As a result of this validation, it was determined that the Total Mathematics portion of the Stanford 9 TA would be used in this study.

The Algebra I SOL. The quantitative portion of the study utilized the Virginia Standards of Learning Assessment in Algebra I to measure student achievement. The Algebra I SOL assessment consists of sixty questions. Ten of the 60 questions are field-test items that are not part of the students score. There are 12 questions in the areas of expressions and operations, 12 questions dealing with relations and functions, 18 questions on equations and inequalities, and eight questions concerning statistics. The test is not timed and all questions are in a multiple-choice format (see Appendix F).

A Content Review Committee composed of Virginia teachers with expertise in that subject area judged content validity. Questions that survived the scrutiny of the Content Review

Committee were field tested in the subsequent test administration. Questions from the field test were analyzed through a variety of traditional item statistics including frequency distributions, and item difficulty and item discrimination statistics (Virginia Department of Education, 2000). Question bias was measured using the Mantel-Haenszel Alpha. A Bias Review Committee provided an additional review of each item.

Concurrent validity was examined by comparing SOL tests to the Stanford 9 TA and the Literacy Passport Tests through Spearman Rank Order Correlation Coefficients. The Spearman Coefficient between the Grade 11 Stanford 9 TA and the Algebra 1 SOL was .53. Test reliability was measured using the Kudar-Richardson Formula #20 (KR-20). KR-20 values range from 0 to .99. The higher the value the greater the reliability with a minimum score of .85 serving as a baseline (SOL Validity and Reliability Information, 1999). The KR-20 coefficient for the Algebra I SOL was .88.

The Fennema-Sherman Mathematics Attitude Scale. This attitude scale is one of the most frequently used instruments for measuring affective variables in mathematics (Mayer & Koeler, 1990). Mulhern and Rae (1998) refer to it as one of the most prominent tools for measuring attitude and affect. It was developed in1976 and consists of nine, Likert-type scales that measure various attitudes related to the learning of mathematics. Items are placed into one of the following scales (a) confidence in learning mathematics, (b) perception of mother's attitude toward one as a learner of mathematics, (c) perception of father's attitude toward one as a learner of mathematics, (d) students perception of teacher's attitude toward one as a learner of mathematics, (e) usefulness of mathematics, (f) effectance motivation, (g) attitude toward success in mathematics, (h) mathematics as a male domain, and (i) mathematics anxiety (Broadbooks, Elmore, Pederson, & Bleyer, 1981).

The authors established content validity by independently developing questions and then judging the validity of the other's items. A total of 173 items were selected for the initial instrument. This instrument was administered to 367 mathematics students in grades 9-12 in a middle class, suburban high school (Fennema and Sherman, 1986). The instrument was reduced to 12 items per scale with six items stated positively and six stated negatively. A revised version was administered to four Madison, Wisconsin high schools. Split-half reliabilities were calculated for each scale. The coefficients ranged from a low of .86 to a high of .93.

Broadbooks et al. (1981) conducted a construct validation study of these scales to determine the extent to which the scales assessed student attitudes toward mathematics. A factor analysis was conducted on responses from 1,541 junior high students on eight scales. The mathematics anxiety scale was not used as it was highly correlated with the confidence scale (.89). The analysis revealed two factors, which accounted for 68.7% of total variance in student attitudes toward mathematics. Broadbooks et al. indicated that the first factor focused on the perceptions of others, while the second factor focused on aspects related to individual feelings. The authors concluded that there was “evidence to support the theoretical structure of the Fennema-Sherman Mathematics Attitudes Scales" (p.556).

Mulhern and Rae (1998) conducted a validity analysis of the nine scales on 196 secondary students in the Republic of Ireland. They reported almost identical Cronbach alpha coefficients as those reported in the original Fennema and Sherman study in 1978. Coefficients for each scale in this study ranged from a low of .83 to a high of .91. The authors also attempted to create a shortened version of the attitude scales. There was no difference between alpha coefficients of the nine scale version and that of the shortened version. This version utilized the Attitude Towards Success Scale, Confidence in Learning Scale, Usefulness of Mathematics

Scale, and Effectance Motivation Scale (see Appendix G). The alpha coefficient was .96 for the full nine scale version and .93 for the shortened version indicating that use of fewer scales should not lower reliability of the instrument. Table 5 presents a summary of internal consistency coefficients between the original Fennema-Sherman study in 1976 and the study conducted by Mulhern and Rae in 1998.

Table 5

Internal Consistency Coefficients for the Fennema-Sherman Mathematics Attitudes Scale.*

Scale	Fennema-Sherman (1996) Split-half Reliability Coefficients	Mulhern and Rae (1998) Cronbach Alpha-Coefficients	Mulhern and Rae (1998) Shortened version Cronbach Alpha-coefficients
Attitudes toward success in Mathematics	.87	.84	.87
Confidence in Learning Mathematics	.93	.91	.93
Effectiveness Motivation	.87	.86	.88
Usefullness of Mathematics	.88	.88	.88
Total Scale	Not Reported	.96	.93

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A numerical score for each student was calculated by totaling the student's response points from all 48 items. Each item may have a low value of 1 and a high value of 5 resulting in a range of possible scores from a low of 48 to a high of 192. There were four total scales utilized in the study. Each scale contained 12 items for a total of 48 items. The total score for each student indicated the student's attitude towards mathematics at the conclusion of the course. The higher the score the more positive the student's attitude towards mathematics. Total scores for the nine schools were be compared to determine if there is a difference between students in the experimental group and those in the control group.

Qualitative Data Collection

The quantitative portion of this study was designed to determine whether or not the Carnegie Algebra Tutor had a statistically significant effect on student achievement as measured by the Virginia Algebra I SOL Assessment. While the quantitative methodology used attempted to minimize a large portion of the intervening variables that can confuse the results of the study, it is impossible to completely control all variation in a complex environment such as a classroom. In an effort to explore some of these intervening variables and their effect on the study, the qualitative portion of the study incorporated which consisted of focus group interviews. Morgan (1988) stated that focus groups are an effective tool for interpreting quantitative research outcomes.

Methodology

The focus group interviews consisted of five student focus groups and one teacher focus group. Each group consisted of six to ten participants. The purpose of these focus groups was to generate a list of emerging themes, strategies, and recommendations from both a student and teacher perspective for the effective integration of the Carnegie Algebra Tutor into the mathematics curriculum. Questions addressed in both focus groups could be classified into one of three domains: (a) implementation, (b) cognitive, and (c) affective.

A preliminary focus group was conducted at one school in order to field test and modify questions as needed prior to conducting the actual focus groups. Separate student focus groups were conducted five of the schools participating in the study. A total of 47 students participated in the focus group sessions. A convenient sampling process was used to select students that were part of the experimental group. This sampling technique is common for focus groups (Shandasani & Stewart, 1990). Classroom teachers assisted in selecting and scheduling students from their classes willing to participate in the interview process.

The nominal group process was used to conduct the student focus groups. Van de Ven (1974) reported that this process produces more unique ideas and a higher quantity of items than the Delphi process or interacting group process. He also reported that groups using the nominal process expressed a higher level of satisfaction with this process than with the Delphi process. Shandasani and Stewart (1990) also point to the nominal group process as an effective and structured process that avoids the influence of group opinion commonly associated with the use of students in a group interview.

<u>Research Questions for the student focus groups.</u> The following questions and prompts were used to obtain student perceptions of the Carnegie curriculum and software:

- Describe typical weekly activities in your mathematics class.
- Describe the strengths of the Carnegie Algebra Tutor as a tool for teaching you mathematics?

- Describe the weaknesses of the Carnegie Algebra Tutor as a tool for teaching you mathematics.
- Lets discuss how you feel about the Carnegie curriculum and tutor. Was it a positive or negative experience? Why?
- How would you compare the last three semesters of mathematics with your previous mathematics classes?
- How would you change your Algebra experience to make it more effective?
- Is there anything else about your experience with the Carnegie program that you would like to share that we have not yet touched upon?

Data collection and analysis for student focus group. Participants in the study were asked specific questions concerning the Carnegie Algebra Tutor program. Students were given an opportunity to record their responses to each question. Using a round-robin format, each participant was asked to list one response. This response was recorded on a flip chart. Each participant was asked to state a different response. If a student did not have a response, they passed their turn to the next participant. This procedure was followed until all participants had exhausted their lists. An identical process was followed for each question. The end product of this portion of the focus groups was a list of student generated perceptions of the Carnegie Algebra program as they related to the three identified domains.

The second phase of the student focus group involved prioritizing student responses. Students were asked to take the generated lists from the first phase and prioritize the top four items from each question. Each participant was asked to rank the importance of each response with number one being the top choice and number four being the lowest. Each participant submitted this list to the researcher. Each response earned a point. A ranking of responses was generated based upon the accumulation of points. Results of these focus groups were used to explain findings from this study.

Research Questions for the teacher focus group. A teacher focus group was conducted at one high school at a specified date. The teacher focus group had an unstructured interview response format. This was because teachers with a vested interest in the achievement outcomes of their students would likely be less swayed by the opinion of dominant participants. By allowing a freer interaction than the nominal group process used with students, there would be a greater likelihood that deeper and more significant issues important to the teachers would emerge (Shandasani & Stewart, 1990).

The following domains and prompts were used to obtain teacher perceptions of the Carnegie curriculum and software:

- Tell me about a typical week in your mathematics classes.

  Probe: Implementation, Time per week on computer, NCTM alignment, SOL alignment, student attitudes, student achievement
- Contrast how your Carnegie classes differed from your other classes taught this year or in the past.

  Probe: Why do you think these differences were significant?
- Tell me how you feel about the Carnegie curriculum and tutor. Was it a positive or negative experience?

  Probe: What factors were most important in making the experience positive or negative?
- How would you describe the tutor’s ability to assist with the learning of complex problem solving skills?

Probe: relevance to students, depth of questions

- If you could change your Algebra teaching experience in any way, what would you change?
- Is there anything else about your experience with Carnegie that you would like to share that we have not yet touched upon?

Data collection and analysis for teacher focus group. All teachers that participated in the Carnegie program were invited to participate in the teacher focus group. This number of teachers allowed for the six to eight participants recommended by Shandasani and Stewart (1990) for the effective operation of a focus group session. This focus group was given preplanned questions that were asked of the entire group but the response process was not as controlled as with the nominal group process utilized in the student focus group. This process allowed for deeper understanding and discussion of issues important to the teachers.

A questioning guide was used to cover questions of specific concern to this researcher. An audio recording was used to develop a transcript of the interview session (see Appendix H). This transcript data was coded and chunked utilizing the Constant Comparative method (Maycut & Morehouse (1994). Miles and Huberman's (1994) raw data matrix was used to partition and present the data. Direct quotes were placed into cells according to their relevance to the three domains as well as any emerging themes that arose from the interview process.

CHAPTER IV

RESULTS OF THE STUDY

Research questions used to guide the study were divided into three categories: (a) achievement, (b) attitude, and (c) explanatory. Within this chapter, results of this study are presented using the same organization. Descriptive and inferential statistics are presented for the achievement and attitude categories. A series of raw data matrixes developed from student and teacher focus group questions is presented for the explanatory category. Presentation of this data is used to answer each research question from the respective category.

Achievement

A 2 X 2 X 2 (Treatment Condition X Race/Etnicity X Gender) Analysis of Covariance (ANCOVA) was used on pretest Stanford 9 TA Total Mathematics scale scores and posttest Algebra I SOL scale scores to answer each of the research questions within the achievement category. Mean substitution was used to maximize the amount of usable data. Twenty-seven of the 445 records had missing Algebra I SOL values. There were 51 missing values for the Total Mathematics portion of the Stanford 9 TA. Table six presents a summary of descriptive statistics for the independent variables for the pre-test Total Mathematics portion of the Stanford 9 TA and the Algebra I SOL.

Table 6

Pre- and Posttest Descriptive Statistics as a Function of Treatment Condition, Race/Ethnicity, and Gender

	Pretest (Stanford 9 TA)			Adjusted Posttest (Algebra I SOL)		
Source	n	M	SD	n	M	SD
Treatment Condition						
Carnegie Algebra Tutor	229	674.8	24.4	229	397.9	32.9
Traditional Curriculum	216	673.6	21.9	216	400.0	29.1
Race/Ethnicity						
White	309	677.3	24.1	309	395.7	31.0
Black	136	667.4	19.3	136	402.2	31.3
Gender						
Male	230	674.7	25.6	230	397.4	32.5
Female	215	673.7	20.4	215	400.5	29.5

The main research question driving the achievement portion of the study involved the second-order interaction among the independent variables (treatment condition, race/ethnicity, and gender) as they related to the dependent variable (mean scale scores on the Algebra I SOL assessment) after controlling for initial differences on the Total Mathematics portion of the Stanford 9 TA. An analysis of first-order interactions was also conducted between the treatment condition and race/ethnicity, the treatment condition and gender, and race/ethnicity and gender utilizing the same dependent variable and covariate relationship. The ANCOVA revealed no significant first- or second-order interactions with the independent and dependent variables.

A main effects analysis indicated that the mean scale scores on the Algebra I SOL after controlling for initial differences on the Total Mathematics portion of the Stanford 9 TA for the treatment group ($\underline{M}$= 397.9, $\underline{SD}$= 32.9) and the control group ($\underline{M}$= 400.0, $\underline{SD}$= 29.1) were not significantly different. Mean scale scores on the Algebra I SOL for male students ($\underline{M}$= 397.4, $\underline{SD}$= 32.5) and female students ($\underline{M}$= 402.2, $\underline{SD}$= 29.5) were also not statistically different. However, mean scale scores on the Algebra I SOL for White students ($\underline{M}$=395.7, $\underline{SD}$=31.0) and Black students ($\underline{M}$=402.2, $\underline{SD}$= 31.3) were significantly different, $\underline{F}(1,436) = 4.79$, $\underline{p} < .05$.

Table 7

Analysis of Covariance of Posttest Algebra I SOL Scores as a Function of Treatment Condition, Race/Ethnicity, and Gender, with Pretest Stanford 9 TA Scores as Covariate

Source	df	Ss	MS	F	p
Covariate	1	72263.3	72263.3	89.400	.001*
Treatment Condition (TC)	1	439.3	439.3	.543	.461
Race/Ethnicity (R)	1	3871.1	3871.1	4.790	.029*
Gender (G)	1	868.6	868.6	1.070	.301
TC x R	1	565.6	565.6	.700	.403
TC x G	1	5.4 E-^{03}	5.4 E-^{03}	.001	.998
R x G	1	1.2 E-^{02}	1.2 E-^{02}	.001	.997
TC x R x G	1	1976.6	1976.6	2.450	.119
Within	436	352479.1	808.4		
Total	445	70797235.3			

Note. *$p < .05$.

While no statistically significant interactions among the independent variables on the dependent variable (Algebra I SOL) were revealed, differences did exist within the sample population. Table 8 provides a summary of descriptive statistics describing differences between the experimental and control groups for both the dependent and independent variables. The most apparent differences are found between White (M= 393.4, SD= 32.5) and Black students (M=402.4, SD= 33.9) in the experimental group, female students in the experimental group (M= 396.2, SD= 32.5) and in the control group (M= 401.4, SD= 26.2), and between total mean scores in the experimental group (M= 396.3, SD= 32.9) and in the control group (M= 399.1, SD= 29.1).

Table 8

Descriptive Statistics for the Experimental and Control Groups

	Experimental Group			Control Group		
Source	n	M	SD	n	M	SD
Stanford 9 TA	204	674.9	25.8	190	673.6	23.3
Algebra I SOL	229	397.9 (396.3)	32.9	216	400.0 (399.1)	29.1
Attitude	150	138.9	16.2	151	138.6	15.6
Gender						
Male	124	396.3 (396.4)	32.3	106	398.5 (396.6)	31.9
Female	105	399.4 (396.2)	32.5	110	401.5 (401.4)	26.2
Race/Ethnicity						
White	160	393.4 (395.4)	32.5	149	398.0 (399.5)	29.4
Black	69	402.4 (398.2)	33.9	67	402.1 (398.2)	28.7

Note. Mean substitution was used for missing data. Values in parenthesis represent unadjusted means.

Attitude

At the conclusion of the course, students were asked to complete a shortened version of the Fennema-Sherman Mathematics Attitude Survey. One school chose not to participate in this portion of the study, which accounts for the difference in sample size between attitude and achievement variables. A 2 X 2 x 2 (Treatment Condition X Race/Ethnicity X Gender) Analysis of Variance (ANOVA) was used to determine differences between the independent variables on the Fennema-Sherman Mathematics Attitude Survey. Table nine presents descriptive data from the attitude portion of the analysis.

Table 9

Fennema-Sherman Mathematics Attitude Survey Descriptive Statistics as a Function of Treatment Condition, Race/Ethnicity, and Gender

Source	n	M	SD
Treatment Condition			
Carnegie Algebra Tutor	150	138.9	16.2
Traditional Curriculum	151	138.6	15.8
Race/Etnicity			
White	193	138.5	14.9
Black	108	139.2	17.7
Gender			
Male	152	139.4	17.9
Female	149	138.0	13.7

Three levels of analysis were examined using the ANOVA. Second-order interactions, first-order interactions, and main effect relationships among the independent variables (Treatment Condition, Race/Ethnicity, and Gender) on the dependent variable (mean scores on the Fennema-Sherman mathematics Attitude Survey) were explored for statistical significance. The analysis revealed no statistically significant interactions or main effect differences among the variables indicating that the Carnegie Algebra Tutor did not make a difference in student attitudes as measured by the Fennema-Sherman Mathematics Attitude Survey.

Table 10

Analysis of Variance of Fennema-Sherman Mathematics Attitude Survey Scores as a Function of Treatment Condition, Race/Ethnicity, and Gender

Source	df	ss	MS	F	p
Treatment Condition (TC)	1	1.479	1.479	.006	.939
Race/Ethnicity (R)	1	65.438	65.438	.256	.613
Gender (G)	1	187.052	187.052	.732	.393
TC x R	1	122.416	122.416	.479	.489
TC x G	1	57.892	57.892	.227	.634
R x G	1	33.052	33.052	.129	.719
TC x R x G	1	872.115	872.115	3.413	.066
Within	293	74869.425	255.527		
Total	301	5868646.00			

Explanatory

Data from both student and teacher focus groups was tabulated to help explain quantitative findings. Tables 11 –17 include the top responses from each question presented during the student focus groups. Forty-seven students from five different schools participated in separate student focus groups. It was the intent of the researcher to use all high schools in the focus groups, however responses and emerging themes became repetitive after the third school. After emerging themes and responses became repetitive, two additional schools were included in the focus groups to add to the reliability of the data. The following tables show the responses that were listed as the most significant as well as the number of accumulated points for each question. The statements with the most points would indicate the highest rated response for each question. Each table therefore represents a ranked list of responses that students felt were the most significant.

Table 11 indicates student responses to the question asking them to describe a typical week in their mathematics class. This question was designed to explore consistency in the implementation of the Carnegie Algebra Tutor. Traditional activities, such as class work and the explanation of problems, received the majority of the student points. Carnegie Algebra Tutor activities must have accounted for a large portion of class time as indicated by the second highest point total.

Table11

Most Frequent Responses to Student Perception of Typical Weekly Activities in Mathematics Class

Response	Accumulated Points	Frequency %
1. Class work related activities • Individual Practice Worksheets • Reviewing problems • Working on warm-up problems • Group work	61	44.2
2. Carnegie Computer activities	34	24.6
3. Homework	22	15.9
4. New lesson/instruction • Lecture on an objective • Taking notes • Copy examples	15	10.9
5. Graphing calculator activities	6	4.4

Table 12 contains the data for student responses to the strengths of the Carnegie Algebra Tutor. All of the responses concerning strengths of the program centered on the assistance and reward system provided by the tutor as well as the fact that students worked individually and at their own pace to solve problems.

Table12

Most Frequent Responses to Student Perception of Strengths of the Carnegie Algebra Tutor as a Tool for Teaching Mathematics

Response	Accumulated Points	Frequency %
1. The Help feature	24	19.7
2. The program makes you solve problems on your own	19	15.6
3. The reward bar/skill meter	12	9.8
4. The program leads you through each step of a problem	11	9.0
5. The graphing activities	11	9.0
6. The solver	8	6.6
7. It is easier to learn on the computer	7	5.7
8. It is challenging	6	4.9
9. It stops you when you make a mistake	6	4.9
10. It shows you how to do formulas	5	4.1
11. You can visualize it	4	3.3
12. It allows for group work	4	3.3
13. You can't skip a problem	3	2.5
14. You can go at your own pace	2	1.6

Table 13 presents the weaknesses of the Carnegie Algebra Tutor from the student perspective. The main response centered on students dislike for loosing reward points for using the Help feature, providing wrong answers, or taking too long to complete a question. The second highest total was from the number of questions and levels students had to work through to prove their mastery of a concept. One response of interest was the students perception that the format for Carnegie questions was not similar to the format for questions on the Algebra I SOL assessment.

Table13

Most Frequent Responses to Student Perception of the Weaknesses of the Carnegie Algebra Tutor as a Tool for Teaching Mathematics.

Response	Accumulated Points	Frequency %
1. Lose reward for wrong answers, using help, or taking too long	21	17.1
2. To many problems and levels	18	14.6
3. Explanations can be confusing or difficult	15	12.2
4. Answers have to be too specific	12	9.8
5. The program sometimes rejects correct answers	11	8.9
6. It is boring	9	7.3
7. It is hard on the eyes	8	6.5
8. It won't always give help when you need it	8	6.5
9. Material was not on the SOL test	7	5.7
10. I get tired of reading	6	4.9
11. The problems are too difficult	6	4.9
12. You have to got through too many steps for an obvious answer	2	1.6

Students were asked to rate their experience over the three semesters spent learning Algebra with the Carnegie Algebra Tutor as either positive or negative and then provide a reason for their response. Students overwhelmingly rated their experience as positive and included reasons ranging from the individualized instruction provided by the tutor to not having to carry a textbook.

Table14

Most Frequent Responses to Student Perception of the Carnegie Algebra Tutor Experience

Response	Accumulated Points	Frequency %
1. You solve problems on your own and at your own pace	26 (+)	23.1
2. There is no textbook to carry	25 (+)	22.1
3. The program made math easier	19 (+)	16.8
4. Breaking down word problems helped me understand them better	16 (+)	14.2
5. Using the computer was a fun way of learning	11 (+)	9.7
6. It helped me with my weak points	6 (+)	5.3
7. Not enough explanation on mistakes	6 (-)	5.3
8. Didn’t like going back and forth between computer and class	4 (-)	3.5

Note. Students were asked to classify their Carnegie experience as positive (+) or negative (-) and the reasons they gave it a (+) or a (-).

Data in Table 15 represents a comparison between student perceptions of previous mathematics classes and their Carnegie mathematics class. Students' recognized that the mathematical concepts at this grade level were more difficult to master than earlier grade levels but also felt that the Carnegie Tutor program provided a positive learning environment and was an effective method for learning algebra. One significant category of student response was the idea that enrollment in this course carried a stigma with it that made students feel uncomfortable or inadequate. Students' felt that being forced into this perceived special class showed the rest of the school that they were poor mathematics students and needed a special program to make them successful.

Table 15

Most Frequent Responses to Student Comparison of Last Three Semesters with Prior Mathematics Classes

Response	Accumulated Points	Frequency %
1. This math class is easier and more fun	22	21.8
2. We have a lot more work to do	19	18.8
3. This class is harder	14	13.8
4. I learn more and grasp the material better	11	10.9
5. It is more hands-on	8	7.9
6. It is something different from using textbooks	6	5.9
7. It was embarrassing to be in this class because it has a stigma to it	6	5.9
8. I wish we had the computer in earlier grades	5	5.0
9. The pace is too slow	4	4.0
10. The computer gives you more answers to choose from	3	3.0
11. It is better than taking notes	3	3.0

Students were asked to describe changes needed in their Algebra experience to make it more effective. Table 16 shows that students felt the need for more time and help in order to master the concepts.

Table16

Most Frequent Responses to Student Perception of Needed Changes in their Algebra I Experience

Response	Accumulated Points	Frequency %
1. Slow down and give more time to advance	18	22.3
2. Need more explanation and/or review	16	19.8
3. Give less homework	11	13.6
4. Give fewer quizzes	8	9.9
5. Be able to study for tests on the computer	7	8.6
5. Do regular class or Carnegie the whole block	7	8.6
6. Have more interaction with other students	4	4.9
7. Have personal practice workbooks	4	4.9
8. Be able to take computer work home	3	3.7
9. Do more related activities	3	3.7

The final question asked in the student focus group was one designed to give students the opportunity to put forth any issues they wanted to discuss that were not covered by the focus group scripted questions. Table 17 contains the summary of these responses. The highest point totals were those stating the positive role the Carnegie Algebra tutor played in their mathematics class. A significant point is the reappearance of the students' perception that a stronger link needs to be made between the Carnegie program and the type of questions students are presented on the Algebra I SOL.

Table17

Most Frequent Responses to Student's Unshared Experiences

Response	Accumulated Points	Frequency %
1. I like it and think it is pretty good	23	39.6
2. It's fun and a new way of learning	11	19.0
3. Shorten the number of sections in each level	9	15.5
4. It should be taught to everybody	8	13.8
5. Types of questions need to be better linked with the SOL	7	12.1

The second portion of the explanatory portion of the study consisted of a teacher focus group. Teachers that taught the Carnegie Algebra Tutor in five of the schools participated in the focus group interview session. Direct quotes taken from the session transcript provide the data found in Tables 18 through 21. These direct quotes comprise the data that was chunked and analyzed for emerging themes. Four main emerging themes became apparent through this process. These themes were: (a) the relationship between the Carnegie Algebra Tutor and the Virginia Algebra I SOL; (b) implementation issues; (c) the impact of the Carnegie Algebra Tutor on student achievement; and (d) software issues. The four main categories were subdivided by significant themes that emerged within each category to form a matrix. Each matrix is presented as a separate table.

Table 18 presents data on teachers' perception of the Carnegie Algebra Tutor as it relates to the Virginia Standards of Learning assessment for Algebra I. Overall, teachers felt that they had to spend a great deal of class time providing students with SOL- style instruction which took away from the amount of time students were able to utilize the program. Feeling that the Carnegie Algebra Tutor would not adequately prepare students for this high-stakes SOL tests, all teachers involved in the focus group deviated away from the program to reach a comfort level with the amount of preparation for the SOL assessment provided to the students.

Table 18

Teacher Perceptions of the Carnegie Algebra Tutor as it Relates to the Algebra SOL Assessment

1. Carnegie format as it relates to the Algebra SOL	• You spend so much time re-teaching • You have to give the students SOL-style questions • My students did not understand traditional style worksheets • My students know a lot of algebra, but they were not prepared to pass the SOL • I would like to see more of an integration between traditional format and Carnegie • I was told that this course would prepare students for the SOL, but it doesn't. If I had known that, I would have started reviewing for the SOL in September • I think my kids were prepared, but I didn't do a lot of Carnegie this semester • I ended up doing two to three weeks of drill and we did warm-up problems every single day • There is no traditional multiple choice format • There is no way you can just do Carnegie alone because there are no multiple choice types of questions
2. Carnegie alignment as it relates to the Virginia Algebra SOL	• They say it's there and it's mentioned once but it's not really covered in a way that I would say it's covered, so I'd say it's misleading • There are some standards that are not in the program • You get better with any resource over time; a lot of the problems are so repetitive that you pick out what you need and skip the others • I used my SOL blueprint as a bible. You have to know what is in there and what is not

	• Carnegie should be on optional class, it’s not fair for the students to be in this format and yet have to pass a traditional standardized test • It would be great if this class were offered without SOLs attached to it • I would try and cram much more into the first two-thirds than I did so that I would have more time for review this semester • I thought the test we viewed was geared towards the Carnegie stuff with all the word problems • I looked and said “oh my gosh look at all the word problems” • I don’t think it prepares them for the test like it should have, and I didn’t know I needed to put as much in as what I should have done, so I think they would have been more prepared if I would have known that I needed to put a whole lot in before I go into it • I took 60 multiple choice questions from each reporting category with every SOL and just went over them;a lot of the students were lost and tuned me out • I got terrified when it got to be like a month from the SOLs • A sheet comparing the Carnegie and SOLs was sent out and there were a lot of blanks, now they are putting in the missing stuff with the appendix

Table 19 presents data categorized as implementation issues concerning the Carnegie Algebra Tutor. Teachers were consistent with the amount of time they allocated to the program, which recommends that students spend approximately 40% of class time on the computer interacting with the tutor program. All teachers made the effort to reach this level with the exception of the time taken to devote to SOL preparation towards the close of the third semester. Teacher selection for participation in this program was a major area of contention. Teacher volunteers were initially asked to participate in the training and implementation of the program. In four schools the original teacher did not continue with the program, which forced another teacher to come in midway through the program. It was obvious that different levels of computer expertise and comfort with the software were evident across the teacher group.

The method by which students were put into the program was another area of teacher concern. As previously mentioned, teachers volunteered to implement the program. Whichever students were randomly assigned to that teacher were the ones put into the program. Teachers felt that students should have been able to volunteer for the class in order to cut down on the student feelings of resentment that were mentioned in both the teacher and student focus groups. An area of discussion closely related was room scheduling. Teachers felt that this course should be scheduled into a room with adequate resources so that the computers could be integrated into the daily routine without having to move the class to another room.

The selection of this level of Algebra as the course that would implement the program versus the traditional Algebra I was also discussed. This course is taught in a three-semester format. Teachers felt that the third semester was spent preparing for the Algebra SOL assessment and failed to move students forward with new algebraic topics. Another concern was the fact that many students (n=23) registered for this course were also receiving special education services. It was pointed out that some of these students came with reading deficiencies that created an additional hurdle for these students based on the heavy influence of word problems contained in this program. It was noted that several students had to be removed from the program as their reading level deficiency caused them to fall further behind other classmates.

Table 19

Implementation Issues from the Teacher Focus Group

1. Time spent on computer	• Maybe 20 to 30% that they actually worked on the computer • Even when the computers went down I tried to make up the time some other time so I pretty much think we got our 20% • Mine pretty much got 40% • I was consistent with how often, but it wasn't 40% • I gave 40% of time to get in there, but the kids did not get 40% time on the computer; our computers are really messed up and the computer itself is just down or broken. We've had monitors go out and all kinds of crazy things have happened
2. Teacher selection and training issues	• I think its wholly unfair to give this program to a new teacher • You have to be like dancing with your tap shoes on the whole day • You'll probably work harder in the computer lab than what you do in the classroom • I came in a level 15 at the beginning of the year not really knowing what I'm doing in the first place • I'm not that good with computers first of all; I'm one of those people who was afraid of a computer until a couple of years ago, so its just been a real challenge for me • I took over this class from somebody else so I took all the problems that she had and all the attitudes that the kids had for her and the whole thing so I haven't had a very good experience this year • I think it needs two teachers • I started working through those problems on the computer in the time that I had because it was really frustrating me • I'm telling you I was ready to leave; at the beginning of the year I was really frustrated and my kids were frustrated, too • It should be someone that has a little more experience • I think it takes a very strong teacher who has a good sense of their teaching self to teach Carnegie, because you have to adjust and modify so much than when you are in a traditional curriculum • It really does kind of force you to think about how you teach and its hard to step back from that traditional model when that's what you've been practicing for years
3. Room selection and scheduling	• We actually have a Carnegie lab. We don't go to the main computer lab used by the entire school • Last year it took us five minutes at least to get from the portable to the computer lab • Every teacher that teaches this ought to be allowed to teach it in the computer lab

4. Student scheduling	• Some of them are on the computer really fast and some of them get no computer time at all during class • Some of them tell you I didn't want to be in this class and I don't like the computer • I think we should explain to the kids what they are going to be doing and say, do you think you would like to do something like this • Because of the level of kids you get in Introduction to Algebra and Algebra X, you've got a special education class, whether you want it or not • A lot of the Carnegie kids were misplaced, and some of those kids pitched a screaming fit because they had to go back to Carnegie • I don't think we should make them • The parents were concerned about the geometry SOL. They said if there was not a geometry Carnegie then they wanted their son out of the class
5. 3- Semester Intro versus 2- Semester Alg. I	• The Algebra taught over three semesters, I think has to go • Algebra X is like re-teaching Algebra I so they can work on SOLs • Its too hard for Introduction to Algebra • I like it with Introduction to Algebra, but I think it should be more of an average Intro • I have been doing inclusion…and I have a major population of special education kids • A couple of kids had to be taken out because they had a third grade reading level • We really enjoy each other. Its funny because they are going on and they don't want to • You also build a bond with a kid, especially if you have them the second year

The data in Table 20 represents the teacher's perceptions of the impact that the Carnegie Algebra Tutor had on the students. Several significant points came to the forefront. First was the over-reliance on the help feature. Teachers felt students repeatedly used this feature rather than find a solution on their own. This phenomenon may explain why students in the student focus group felt that too many problems were required before they could advance to another level. The program acknowledged that the request for help indicated the student had not mastered the concept and therefore required additional problems of the student. The student wanted the program to solve the problem for them and move them forward to the next level. The second point discussed was the work ethic of the student population. Teachers felt that students were not putting the effort into the problems that it took to master them and wanted the answers given to them. While the teachers felt that students did not put forth the effort that they wanted to see, they did feel that their students became better problem-solvers using the software than they would have in a traditional classroom.

Table 20

Teacher Perceptions of the Carnegie Algebra Tutor's Impact on Students

1. Work ethic	• I have one kid… he pressed the Help button 284 times on one problem • I started the semester by telling them that if you press Help your gold bars are going to start to disappear; and that was good and they didn't press Help, but I was going insane • And then you have those that don't want to press help… they'll just sit there until you come around • They get help 84 times in one problem because all they do is go in and hit the Help button until it gives them all the answers and they put it in and they go on; they have no clue what they did. • At some point they have to do the work • This year I have X and I have Carnegie X. They don't do work….These kids we need to motivate them in some other way. The computers are not working because I think on the evaluation it says has it worn off?, the novelty of it? Yes! It wore off in September. • I'm finding that I believe these kids would get the same grades if they were in Carnegie or in regular • The other strength that I think is good for this level of kid is that the homework is short • I have a bunch of failures because they won't do the work • It has helped them mathematically think more traditional stuff is easy… but I'm worried about them in geometry, sitting there an hour and a half
2. Problem solving	• It definitely gives them a lot of problem solving. I'm just finding that they can problem solve on the computer but they still can't do it in the classroom • I did give a quiz in which the kids did better on the word problem section than the just basic computation • The students get to problem solve and they just pick it up so much easier now • I like the problem solving and I also like the fact I'm on block, so every class period, the last half I go to the computer lab and it gives the kids a break…kind of gives somewhat of a change of pace; something new to focus on • I think the program expects the students to have a certain level of insight and it won't let them proceed without that level of insight
3. Group work	• We tried to jump into group work from day one and we had to back off of it and not do group work for awhile • I have trouble with group work • I jumped right into group work the first day like we were told to and

	unfortunately…I ended up not doing it • I don't even do pairs because you have some who just like the Help button. They know how to play the game
4. Other characteristics	• I think a really major strength is the total integration because you're not doing just things in isolation • I had a high failure rate, but I think I would have had a higher failure rate had I been teaching a traditional class and I would have lost a lot more earlier, that would have just totally zoned out on me and just sat there the rest of the year • I don't have as many problems with the kids as I have in a traditional classroom on block

Table 21 identifies several issues that teachers had with the actual software. An upgrade in the program was blamed for creating some problems for the teachers. A sense of frustration and loss of confidence in the program was evident from the discussion. The word "bugs" was commonly mentioned. Several examples are mentioned in the matrix and reflect tensions that these bugs created.

Table 21

Teacher Perceptions of Software Issues

1. Bugs	• They had to re-write the language it was in and when they did that I think they screwed up a lot; there were bugs last year, but this new version has a whole lot more bugs • The program has a lot of bugs • The software drives me crazy…there's one where the help is wrong • You are used to something being wrong so you immediately go something's wrong with the program and then you realize the kid is doing the problem wrong • My teacher tool kit freezes and it loses names into cyber space
2. Difficulty with problems	• I get the kids saying "if the teacher don't know what to do, how are we supposed to know what to do"? • The upper levels in the quadratics we're at a point now I can't even figure out the answer and they're not in the solution books • If it doesn't like the equation you are putting in, even if it's correct, it doesn't let you put in the equation. It says it's not appropriate or it's inefficient • I was telling the kids that the computer was wrong so I was advancing them

Chapter IV Summary

The first section of this chapter presented quantitative findings on the effects of the independent variables race/ethnicity, gender, and treatment on the dependent variables (Algebra I SOL assessment and a shortened version of the Fennema-Sherman Mathematics Attitude Scales). ANCOVA revealed statistically significant differences between White and Black students on the Algebra I SOL assessment after adjusting for initial differences on the Total Mathematics portion of the Stanford 9 TA. ANOVA revealed no statistically significant differences in student attitudes towards mathematics as measured by the Fennema- Sherman Mathematics Attitude Scales.

The second portion of this chapter presented results from the five student focus groups as well as the teacher focus group. Findings from the student focus groups revealed an overall satisfaction with the Carnegie Algebra Tutor. Individualized assistance and self-paced instruction were strong points of the tutor. Student concerns focused on the reward system and the amount of work required to advance to higher levels. The teacher focus group revealed major themes in the areas of Algebra I SOL alignment, implementation, impact on students, and software issues. Sub themes revealed included student time on the computer, teacher selection and training, scheduling, student work ethic, problem solving, and software bugs.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to explore the effect of the Carnegie Algebra Tutor on student achievement and attitude towards mathematics with an emphasis on Algebra. Meta-analysis on the effectiveness of computer technology by Kulik and Kulik (1991) and Christmann, Badgett, and Lucking (1997) revealed moderate gains in student achievement. Studies utilized in these analyses were dominated by traditional instructional practices common in Behavioral Learning Theory. Recent research (Anderson & Koedinger, 1995, Mann, Shakeshaft, Becker, & Kotkamp, 1999), into constructivist instructional practices common in Cognitive Learning Theory, has reported significant increases in student achievement through the use of intelligent tutoring software such as the Carnegie Algebra Tutor. The theoretical model used as the foundation for this study followed the beliefs of Tennyson (1990) who stated that 30% of learning should be spent on the acquisition of basic skills while 70% should be spent on developing cognitive processes. This model consisted of both a behavioral and cognitive framework based upon Anderson's ACT theory.

The research design utilized a mixed methods format in that both quantitative and qualitative designs were used to address the research questions. The dependent variables used in the quantitative portion of the study were student scale scores on the Algebra I SOL assessment and student raw scores on a shortened version of the Fennema-Sherman Mathematics Attitude Scale. Independent variables included the treatment condition, race/ethnicity, and gender. Student scale scores on the Total Mathematics portion of the Stanford 9 TA were used as a covariate. Focus groups with student representatives from several different schools and a teacher focus group comprised the qualitative portion of the study. The subsequent sections within this chapter will provide a summary of the methodology utilized, a summary of findings, a discussion of conclusions based on limitations and delimitations of the study, and areas for future research.

Methodology Summary

Prior to the start of the 1999-2000 school year students who registered for Introduction to Algebra were randomly assigned to classes by a computer-scheduling program. At the beginning of the 2000-2001 school year students participated in the administration of the Stanford 9 TA as part of the Commonwealth of Virginia's assessment program. It was also at this point in time that the school division in which this study was conducted purchased the Carnegie Algebra Tutor in an effort to improve student performance on the Algebra I SOL assessment. One teacher volunteer was secured from each high school to participate in the training and implementation of the Carnegie program. As part of the program requirements, students spent 40% of class time interacting with the computer-tutoring program. Students spent three semesters in this program culminating at the end of the2000-20001 fall semester with the administration of the Algebra I SOL assessment.

A non-equivalent control group design was utilized as the structural framework for the quantitative portion of the research. The number of students participating in the Carnegie Algebra Tutor varied at each high school. For every class utilizing the program, a class of similar size from the same school was selected as a control group. Using this pairing format, 229 students formed the experimental group while the control group consisted of 216 students. Stanford 9 TA Total Mathematics scale scores were obtained for each student and used as a covariate on student's Algebra I SOL scale scores. A 2 X 2 X 2 ANCOVA was conducted on the Algebra I scores to determine whether there was a statistically significant difference between experimental and control groups. Gender differences as well as race/ethnicity differences were also examined. In an effort to determine the impact of the Carnegie Algebra Tutor on student attitude towards mathematics, each student was also asked to complete a shortened version of the Fennema-Sherman Mathematics Attitude Survey. A total of 301 students, 150 in the experimental group and 151 in the control group, returned the survey. A 2 X 2 X 2 ANOVA was conducted on survey total scores to determine if there was a statistically significant difference between the attitudes of students in the experimental group and those of the control group. Gender as well as race/ethnicity differences were also examined.

To complete the qualitative component, student and teacher focus groups were conducted. Forty-seven students from five different schools were asked to record and to prioritize responses to preset questions pertaining to their Carnegie Algebra experience. Each response that was classified as a high priority response earned a point. A data matrix presented each question's priority responses and the number of points each response accumulated. The teacher focus group was conducted at the conclusion of the study. Teachers were given a similar set of questions pertaining to their experience with the Carnegie Algebra Tutor. The constant comparative method was used to chunk and code the transcript data from this focus group session. Emerging themes were presented in a series of raw data matrixes.

Results Summary

The main research question examined in the achievement portion of the study involved the second-order interaction between the independent variables (treatment condition, race/ethnicity, and gender) as they related to the dependent variable (mean scale scores on the Algebra I SOL assessment) after controlling for initial differences on the Total Mathematics portion of the Stanford 9. A 2 X 2 X 2 ANCOVA revealed no significant second-order interactions. Similarly, the analysis also revealed no significant first-order interactions between the independent and dependent variables. A main effect analysis indicated no significant differences between the treatment and control groups or between male and female students on the Algebra I SOL assessment. The analysis did reveal significant main effect differences between Black students (M=402.2) and White students (M=395.7). Non-significant mean differences also existed between Black students (M=402.4) and White students (M=393.4) in the experimental group. Female students (M=401.4) outperformed male students (M=398.5) in the control group as well as in the experimental group (M=399.4 and 396.3, respectively). Overall female students (M=400.5) outperformed male students (M=397.4) on the Algebra I SOL assessment.

Second-order and first-order interactions as well as main effect relationships between the independent variables (Treatment Condition, Race/Ethnicity, and Gender) and the dependent variable (mean scores on the Fennema-Sherman Mathematics Attitude Survey) were examined in a 2 X 2 X 2 ANOVA. The analysis revealed no statistically significant interactions or main effect differences between the independent variables and student scores on the Fennema-Sherman Mathematics Attitude Survey.

Student focus group data indicated that students considered the Carnegie Algebra Tutor a positive experience. Rationale for the positive experience centered on the Carnegie Algebra Tutor's ability to provide individualized instruction and present mathematics in a way that students could understand. The Help and reward bar were features strongly endorsed by the students; in fact, the most commonly mentioned weakness of the program was students' dislike for losing rewards for wrong answers or using the Help feature. Even with the strong endorsement for the Carnegie Algebra Tutor, students still felt the need for more explanations and slower paced-instruction.

Emerging themes from the teacher focus group revealed four main categories. These themes were: (a) the relationship between the Carnegie Algebra Tutor and the Algebra I SOL assessment; (b) implementation issues; (c) the Carnegie Algebra Tutor's impact on student achievement; and (d) software issues. Regarding the relationship between the Carnegie Algebra Tutor and the Algebra I SOL, teachers responsible for implementing the Carnegie Algebra Tutor expressed a lack of confidence in the alignment of the tutor's curriculum with that of the Algebra I SOL assessment. Another significant concern was the difference between the curriculum question format of the tutor and that of the Algebra I SOL assessment. These two major concerns were evident in the amount of time teachers spent planning and delivering SOL-based lessons outside the Carnegie curriculum for fear of students' lack of preparation for the Algebra I SOL assessment.

Several themes emerged in the area of the program implementation. It was evident that the recommended amount of time was spent on the tutoring program by most of the teachers. Major concerns centered on teacher selection and training. Securing a teacher volunteer from each school did not necessarily guarantee the strongest teacher. Teachers expressed that the requirements of blending the Carnegie Algebra Tutor with the Algebra I SOL assessment required an experienced teacher. The fact that four teachers did not continue with the Carnegie Algebra Tutor after the first year indicates that the volunteer process was not effective in securing this caliber teacher. Teacher training became a major issue as four schools had to bring in new teachers for the final semester. These teachers felt that they were not properly prepared to enter the program that far into the curriculum.

Another concern emerging in the area of implementation was the selection of students. As students were randomly assigned to classes and teachers by a computer- scheduling program prior to the start of the first semester of implementation, a student scheduled into the implementing teachers class became part of the Carnegie Algebra Tutor cohort. Students were not permitted to move out of the program. This practice resulted in resentment from some students and higher levels of frustration for teachers. The decision to use the lower level class of Algebra I (referred to as Introduction to Algebra) versus the traditional two-semester Algebra was also an area of concern for the teachers. An issue was raised concerning the reading levels of several students placed in a program in which the curriculum was based predominantly on students learning math through real-life scenarios and having to read these scenarios and pull out the mathematics concepts necessary to solve the problems. This problem was highlighted by several of the teachers who had a high number of special education students placed in their classes. In one school the Carnegie classes also served as the inclusion classes for special education students and contained approximately 25 special education students. The decision to include the special education students in the Carnegie class was an individual school decision. Approximately 30 special education students were included in the treatment group of the study. These students were hand-scheduled into these classes and were not accounted for in the initial design of the study.

The impact of the Carnegie Algebra Tutor on student achievement was another theme that materialized from the teacher focus group. While most teachers felt that the program effectively improved the student’s ability to solve mathematical problems, concerns were raised on the apparent lack of motivation and work ethic displayed by many of the students. An over-reliance on the Help feature or on the teacher’s individual assistance was the basis for this belief. Teachers felt that many of the students at this level did not push themselves to solve the problems and relied on the above-mentioned items to solve the problem for them. The use of group work was also an area of concern. Group work was to play a significant part of the Carnegie Algebra Tutor. Teachers expressed that they had a great deal of difficulty implementing effective group work into the daily class structure, indicating that training in this area may be as important as that for the tutoring software itself.

The final emerging theme from the teacher focus group centered on software concerns. Problems with the software created a high level of frustration for both teachers and students. While a great deal of time was not spent discussing this theme within the focus group sessions, the intensity of this topic was evident. Lost data and incorrect responses from the Carnegie Algebra Tutor created an atmosphere of uncertainty in the classroom and resulted in a lack of confidence in the Tutor with both teachers and students.

Conclusion

The validity of any conclusion as to the effectiveness of the Carnegie Algebra Tutor and its impact on student achievement and attitude in an introductory high school algebra course must be linked to the limitations and delimitations of the research design. The choice of instrumentation utilized in the study was the most significant delimitation in the research design. While the use of the Algebra I SOL assessment was justified due to the high-stakes placed on it by the Virginia Board of Education and its role in determining school accreditation and student graduation, serious concerns as to the Carnegie Algebra Tutor's alignment and question format with this assessment tool exist. Significant achievement gains made by students using the Carnegie program may have been masked by a lack of alignment between the program and the Algebra I SOL assessment. While this misalignment may exist, it is important to note that significant gains were made in closing achievement gaps between Black and White students utilizing the Carnegie program. Black students had lower mean scores on the Stanford 9 pre test

(M=667.4) than did White students (M=677.3). Posttest Algebra I SOL scores showed a different trend. Black student had higher adjusted mean scores (M=402.2) than did White students (M=395.7). This finding alone is significant due to the achievement gaps reported between White and Black students on the 1996 NAEP and the 1999 SOL assessment. These results are important to educators faced with raising achievement standards for all students when different student groups with different innate ability exist within the same school.

The Fennema-Sherman Mathematics Attitude Survey has a strong history of effectively measuring student attitudes towards mathematics. The lack of statistically significant or non-significant findings using this instrument may have been more of a reflection of the student population than of the instrument itself. The absence of student choice for participation in this program as well as the theme of feeling stigmatized by being forced to be in the program that was mentioned in the student focus groups may have masked attitude changes toward mathematics that may have occurred in those students that truly enjoyed participating in the Carnegie mathematics curriculum.

Many external factors that cannot be directly controlled by the research design pose limitations on the validity of a study. Two of these significant factors were accounted for in this design by measuring the effect of gender and race/ethnicity on students' achievement and attitude towards mathematics. Differences in students' innate ability are another significant factor threatening the internal validity of the study. Student's innate ability in mathematics was controlled by using students' scale scores on the Total Mathematics portion of Stanford 9 TA as a covariate on students' scale scores on the Algebra I SOL assessment. The most significant limitation impacting the validity of this design was the teachers' effects on student outcomes. As evidenced in the teacher turnover as well as other data from the focus group data matrixes, inconsistencies appeared in how teachers were selected and trained. Teacher's content knowledge, quality of delivery, or overall strength compared to other teachers was not accounted for during the implementation phase of the Carnegie program. While these teacher effects were not controllable with this research design, the use of focus groups did reveal whether many of these effects did exist within the study. Enough data was obtained from the focus groups to determine that some of these effects did exist and could have interacted to mask results of the study.

In summary, there were important achievement gains that materialized from this study. Black students outperformed White students on the Algebra I SOL assessment after controlling for initial differences on the Stanford 9 TA. In light of national trends in achievement levels of minority students this finding alone is significant. Several limitations and delimitations of the study were discussed. Controlling for these limitations and delimitations, further achievement and attitude gains may be revealed.

Implications for the School System

The Virginia Beach City Public School system in conjunction with the City of Virginia Beach has embraced an aggressive plan for integrating technology into existing curriculums. Fiscal resources have been dedicated to the wiring and networking of all schools, as well as for the purchasing and replacement of computers and related technology on a five-year cycle. Each teacher has a computer in the classroom as well as access to a computer lab. The Virginia Beach City Public School system has made a commitment to purchase software that can be effectively integrated into the classroom in an effort to improve student achievement. Additional fiscal resources have been allocated for technical support to implement, organize, and maintain this plan.

This study found that implementation of the Carnegie Algebra Tutor in the Introduction to Algebra and Algebra X classes produced some positive achievement outcomes. In addition, training and implementation issues revealed in the student and teacher focus groups may have produced classroom situations that hindered or masked other possible achievement and attitudinal outcomes. The teacher turnover and frustration could have been a direct result of selection and training. This study suggests that the current philosophy of Virginia Beach City Public Schools concerning the training and implementation of computer related technologies might not meet the needs of the teachers responsible for the successful integration of computer technology into the classroom.

This study reveals that the successful integration of computer technology into the classroom may require a reevaluation of the school division's commitment to the technology initiative in several areas. First, ongoing training and support is critical. A pre-implementation in-service program alone is not sufficient. Classroom teachers need ongoing technical support as well as the opportunity for collaboration with fellow teachers using the same program to discuss common issues, problems, and solutions. Secondly, the selection of experienced teachers is critical. This may necessitate financial incentives to entice the strongest teachers to attempt these new programs. Third, the school division must commit to the hardware requirements and technical support necessary to integrate technology into the classroom. Virginia Beach City Public Schools has rapidly moved forward in this area however, the recently created computer resource teacher position must become more involved in the selection, training, and integration of new computer technologies. Finally, with the large fiscal impact that technology initiatives have on the school division's budget, Virginia Beach City Public Schools needs to make the commitment to ongoing research into the effectiveness of all implemented programs. This may include additional staff needed to conduct field studies that evaluate multiple factors related to all technology integration initiatives.

Areas of Future Research

One area of future research would be to conduct a follow-up study using the same instrumentation but correcting initial implementation problems revealed in the focus group sessions. Addressing the teacher and student selection concerns would provide the greatest opportunity for adequately evaluating the effectiveness of the Carnegie Algebra Tutor. Correcting software issues and reevaluating the training in light of the software problems, as well as addressing the concern of implementing the group work component of the program may also provide a more accurate evaluation. The use of classroom observations would further strengthen the qualitative aspect of a follow-up study.

Given the significant findings concerning achievement gains made by Black students, a detailed study involving schools with high numbers of minority students could further validate the reported findings. These high minority schools could implement the program to involve more teachers and a greater number of students. Teachers using the Carnegie Algebra Tutor in all four or five classes they teach would create a situation in which the only preparation the teacher had would be the Carnegie classes. Given average class sizes of 20 to 25, this would give a teacher a total of 100-125 students from which to obtain data. Teacher effects would be more controlled under this type of study as teacher differences could be compared within the same school versus comparison with all schools as was done in this study.

The impact of this program on special education students also deserves further study. Special education students were included in the population of this study. Using a students' special education status as an independent variable and performing a separate analysis of the impact of using the Carnegie program as part of an inclusion model and comparing achievement data with special education students that do not use the Carnegie program would allow for analysis of a student sub-group similar to the analysis conducted within this design to determine the impact of the Carnegie program on student achievement and attitude with gender and race/ethnicity as independent variables.

The teacher focus group revealed a lack of confidence in the alignment of the Carnegie Algebra Tutor with the Algebra I SOL assessment. A study that examined the relationship between the Carnegie Algebra Tutor and the Algebra I SOL assessment would provide strong data for examining any cause and effect relationship that might exist. This type of study combined with a follow-up study would provide a more objective evaluation of the effectiveness of the Carnegie Algebra Tutor.

The final area of future research would be to replicate this study using traditional Algebra classes and comparing results between a regular Algebra class and those of the introductory level Algebra class. Implementation issues would still need to be addressed prior to conducting the study however, differential effects may be revealed between the levels of Algebra that are taught using the Carnegie tutor.

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Appendix A

Mathematics Course Sequence

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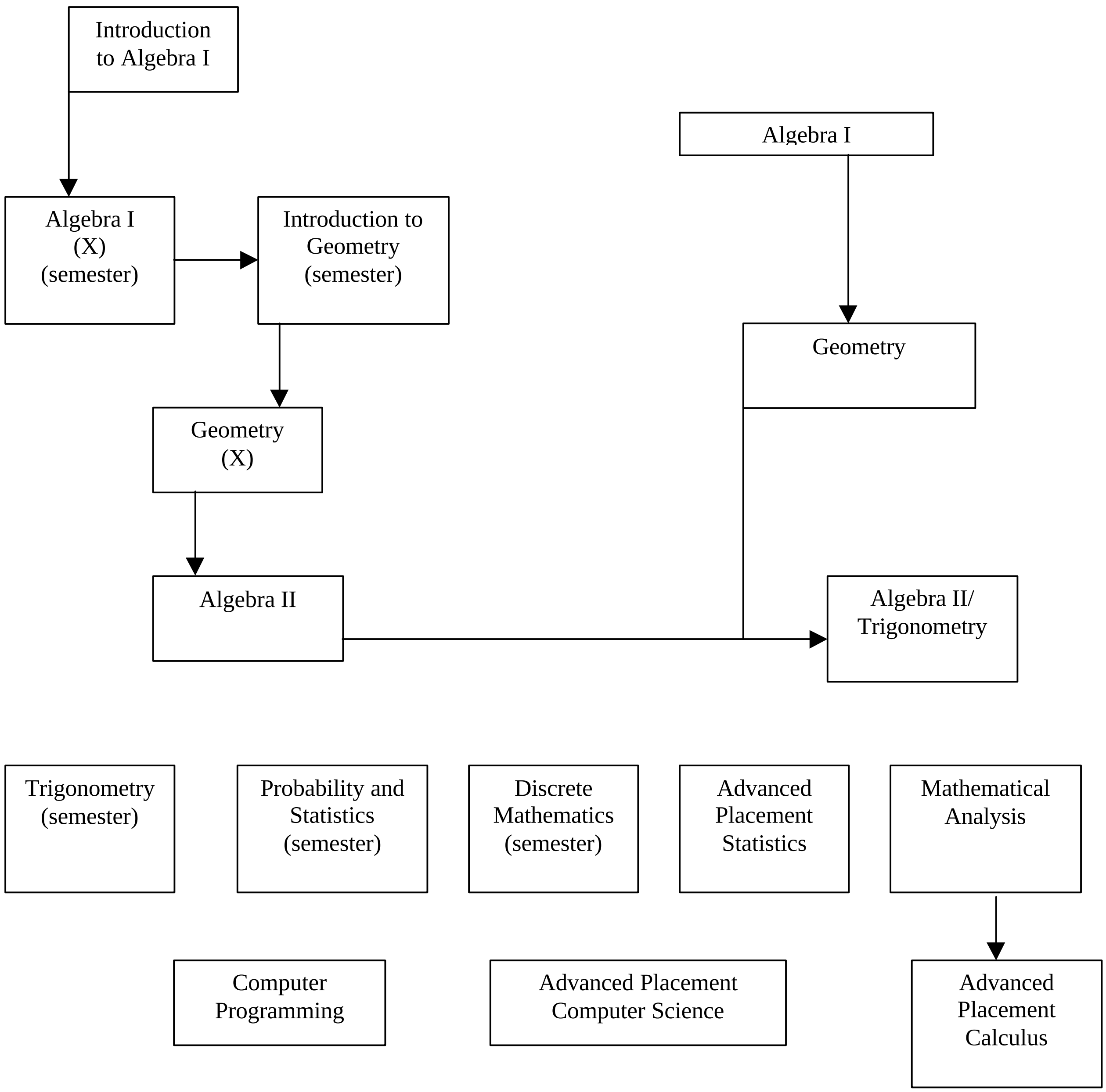
VIRGINIA BEACH CITY PUBLIC SCHOOLS
AHEAD OF THE CURVE



Appendix B

Algebra I, Introduction to Algebra and

Algebra X Pacing Guide

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ALGEBRA I		
Teaching Sequence and Pacing Guide		
Unit		Suggested Pacing
1	First Degree Equations	4 Weeks
2.	Relations, Functions, and Graphs	7 Weeks
3.	Inequalities in one variable	2 Weeks
4.	Systems of Linear Equations	3 Weeks
5.	Operations with Monomials	2 Weeks
6.	Quadratic Equations	4 Weeks
7.	Polynomials	5 Weeks
8.	Matrices and Statistics	2 Weeks
9.	Rational Expressions and Equations	3 Weeks
10.	Linear and Quadratic Inequalities	2 Weeks

INTRODUCTION TO ALGEBRA I		
Teaching Sequence and Pacing Guide		
Unit		Suggested Pacing
1.	First Degree Equations	6 Weeks
2.	Relations, Functions, and Graphs	10 Weeks
3.	Inequalities in one variable	3 Weeks
4.	Systems of Linear Equations	5 Weeks
5.	Operations with Monomials	4 Weeks
6.	Quadratic Equations	6 Weeks

ALGEBRA I (X)		
Teaching Sequence and Pacing Guide		
Unit		Suggested Pacing
7.	Polynomials	7 Weeks
8.	Matrices and Statistics	3 Weeks
9.	Rational Expressions and Equations	4 Weeks
10.	Linear and Quadratic Inequalities	3 Weeks

Appendix C

School Division Permission Letter

January 4, 2000

Mr. John E. Smith
Frank W. Cox High School
2425 Shorehaven Drive
Virginia Beach, Va 23455

Dear Mr. Smith:

This letter serves as school division approval of your project, “The Effect of the Carnegie Algebra Tutor on Student Achievement and Attitude in Introductory High School Algebra.” As always, the final decision to participate rests with the principal. If you have any questions, I can be reached at 427-4381. Good luck with your study.

Sincerely,

E. Sidney Vaughn III, Ed.D.
Research Specialist

ESV/mm

Cc: Donald E. Stowers, Assistant Superintendent for High School Education
Perry B. Pope, Principal, Frank W. Cox High School
Nancy C. McClure, Coordinator for High School Mathematics

Appendix D
Letter of Informed Consent

MEMORANDUM

TO: John E. Smith
1508 Beaver Dam Rd.
Chesapeake, Va.23322

Stephen Parson
ELPS 0302

FROM: David M. Moore

DATE: 20 December, 2000

SUBJECT: Expedited Approval- “The Effect of the Carnegie Algebra Tutor on Student Achievement and Attitude in Introductory High School Algebra.” – IRB #00-428

This memo is regarding the above-mentioned protocol. The proposed research is eligible for expedited review according to the specifications authorized by 45 CFR 46.110 and 21 CFR 56.110. As Chair of the Virginia Tech Institutional Review Board, I have granted approval to the study for a period of 12 months, effective today.

Approval of your research by the IRB provides the appropriate review as required by federal and state laws regarding human subject research. It is your responsibility to report to the IRB any adverse reactions that can be attributed to this study.

To continue the project past the 12-month approval period, a continuing review application must be submitted (30) days prior to the anniversary of the original approval date and a summary of the project to date must be provided. My office will send you a reminder of this (60) days prior to the anniversary date.

Cc: file
M.D. Alexander

Appendix E

Carnegie Algebra Tutor and Virginia Standard of Learning Assessment Algebra I Alignment Matrix

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VIRGINIA BEACH CITY PUBLIC SCHOOLS
AHEAD OF THE CURVE

VIRGINIA STANDARDS OF LEARNING (SOL)		CARNEIE LEARNING'S Cognitive Tutor™ Algebra I	
ALGEBRA I CONTENT STANDARD		COGNITIVE TUTOR COMPUTER LESSONS	COGNITIVE TUTOR CLASSROOM LESSONS
A.1	The student will solve linear equations and inequalities in one variable, solve literal equations (formulas) for a given variable and apply these skills to solve practical problems. Graphing calculators will be used to confirm algebraic solutions.	Lesson 3, sections 4-6 Lesson 4, sections 1-4 Lesson 5, sections 3-5 Lesson 7, sections 1-3 Lesson 9, sections 1-6 Lesson 11, sections 1-5 Lesson 23, section 1	Inequalities Graphing Inequalities Engineer a Highway Move a Sand Pile Rent a Car from Go-Go Rent a Car from Wreckem Rent a Car from Good Rents Shopping for Widgets and Dumbbells Paying Tolls and Renting Computers Plumbing and Dumping Hang a Mathematician on Your Wall Sell Balloons for Fun and Profit Videos and Sand Piles Cliffs, Bikes, and Loans Widgets and Discs Literal Equations

VIRGINIA STANDARDS OF LEARNING (SOL)		CARNEIE LEARNING'S Cognitive Tutor™ Algebra I	
ALGEBRA I CONTENT STANDARD		COGNITIVE TUTOR COMPUTER LESSONS	COGNITIVE TUTOR CLASSROOM LESSONS
A.2	The student will represent verbal quantitative situations algebraically and evaluate these expressions fro given replacement values of the variables. Students will choose an appropriate computational technique, such as mental mathematics, calculator, or paper and pencil.	Lesson 1, sections 1-4 Lesson 4, sections 1-4 Lesson 6, sections 1-5 Lesson 8, sections 1-3 Lesson 10, sections 1-6 Lesson 13, section 1 Lesson 14, sections 1-4 Lesson 20, sections 1-2 Lesson 21, sections 1-3	U.S. Shirts Hot Shirts TV News Ratings Truck Life Women at a University Taxes Deducted from Your Paycheck Tipping in a Restaurant Earning Sales Commission Comp-U-US Mowing Lawns Making Rectangles: Parts 1, 2, 3 Engineer a Highway Move a Sand Pile Rent a Car from Go-Go
A.2			Rent a Car from Wreckem Rent a Car from Good Rents Shopping for Widgets and Dumbbells Paying Tolls and Renting Computers Plumbing and Dumping Hang a Mathematician on Your Wall Sell Balloons for Fun and Profit Videos and Sand Piles Cliffs, Bikes and Loans Widgets and Discs
A.3	The student will justify steps used in simplifying expressions and solving equations and inequalities. Justifications will include the use of concrete objects, pictorial representations and the properties of real numbers.	Lesson 3, sections 1-3 Lesson 5, sections 1-2 Lesson 10, sections 1-6	Comp-U-Us Mowing Lawns Distributive Property
A.4	The student will use matrices to organize and manipulate data, including matrix addition, subtraction, and scalar multiplication. Data will arise from business, industrial, and consumer situations.		Matrices
A.5	The student will analyze a given set of data for the existence of a pattern, represent the pattern		Number Patterns Finding the Nth Term

VIRGINIA STANDARDS OF LEARNING (SOL)		CARNEIE LEARNING'S Cognitive Tutor™ Algebra I	
ALGEBRA I CONTENT STANDARD		COGNITIVE TUTOR COMPUTER LESSONS	COGNITIVE TUTOR CLASSROOM LESSONS
	algebraically and graphically, if possible, and determine if the relation is a function.		Handshake Problems Points and Lines Problem Gauss' Solution $4 an Hour Problem Consultant's Problem
A.6	The student will select, justify, and apply an appropriate technique to graph a linear function in two variables. Techniques will include slope-intercept, x- and y- intercepts, graphing by transformation, and the use of the graphing calculator.	Lesson 6, sections 1-5 Lesson 8, sections 1-3 Lesson 9, sections 1-6	Equations, Rates, and Intercepts Graphs and Linear Equations: Parts 1,2 Videos and Sand Piles Cliffs, Bikes, and Loans Widgets and Discs Graphing Lines: Parts 1,2,3,4 Finding the Formula from x and y Values: Parts 1,2 Spending Money Avoiding the Bends Losing Helium
A.7	The student will determine the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined. The graphic calculator will be used to investigate the effect of changes in the slope of the graph of the line.	Lesson 6, sections 1-5 Lesson 8, sections 1-3 Lesson 9, sections 1-6 Lesson 14, sections 1-4	Equations, Rates, and Intercepts Graphs and Linear Equations: Parts 2 Videos and Sand Piles Cliffs, Bikes, and Loans Widgets and Discs Graphing Lines: Parts 4 Finding an Equation from Points on Its Graph: Parts 1, 2, 3 Finding an equation from Its Graph: Parts 1, 2 Finding the Formula from x and y Values: Parts 1, 2 Sending Money Avoiding the Bend Losing Helium
A.8	The student will write an equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.	Lesson 14, sections 1-4 Lesson 20, sections 1-4	Finding an Equation from Points on Its Graph: Parts 1, 2, 3 Finding an Equation from Its Graph: Parts 1, 2 Finding the Formula from x and y Values: Parts 1, 2
A.9	The student will solve systems of two linear equations in two variables, both algebraically and graphically, and apply these techniques to solve practical problems. Graphing calculators will be used as both a primary tool of solution and to confirm algebraic solution.	Lesson 12, sections 1-6 Lesson 15, sections 1-3 Lesson 22, section 1	Producing and Selling Pens Making and Selling Shirts Solve Systems Using Slope and Y-Intercept: Parts 1, 2 Solve Systems of Equation Algebraically: Parts 1, 2 Connect Algebraic and Graphical Solutions: Parts 1, 2 Using up Oil Reserves

VIRGINIA STANDARDS OF LEARNING (SOL)		CARNEIE LEARNING'S Cognitive Tutor™ Algebra I	
ALGEBRA I CONTENT STANDARD		COGNITIVE TUTOR COMPUTER LESSONS	COGNITIVE TUTOR CLASSROOM LESSONS
			Finding the Best-Paying Job
A.10	The student will apply the laws of exponents to perform operations on expressions with integral exponents, using scientific notation when appropriate.		The Laws of Powers
A.11	The student will add, subtract, and multiply polynomials and divide polynomials with monomial divisors using concrete objects, pictorial representations, and algebraic manipulations.		Distributive Property
A.12	The student will factor completely first- and second degree binomials and trinomials in one or two variables. The graphing calculator will be used as both primary tool for factoring and for confirming an algebraic factorization.	Lesson 18, sections 1-5	Symmetry in Equations with Squares Factoring Equations with Squares: Parts 1, 2
A.13	The student will estimate square roots to the nearest tenth and use a calculator to compute decimal approximations of radicals.	Lesson 18, sections 1-5 Lesson 19, section 1	Quadratics Foul Ball Cannonball Flight
A.14	The student will solve quadratic equations in one variable both algebraically and graphically. Graphing calculators will be used both as a primary tool in solving problems and to verify algebraic solutions.	Lesson 16,section 1 Lesson 17, section 1 Lesson 18, sections 1-5 Lesson 19, section 1	Equations with Squares: Parts 1, 2 Symmetry in Equations with Square Factoring Equations with Squares: Parts 1, 2 Foul Ball Foul Ball from the Third Deck: Parts 1, 2 Quadratic Formula: Parts 1, 2, 3 Cannonball Flight Cannonball Flight from a Mountainside
A.16	The student will, given a rule, find the values of a function for elements in its domain and locate the zeros of the function both algebraically and with a graphing calculator. The value of f(x) will be related to the ordinate on the graph.	Lesson 6, sections 1-5 Lesson 8, sections 1-3 Lesson 9, section 1 Lesson 14, sections 1-4 Lesson 17, section1 Lesson 19, section 1 Lesson 20, sections 1-2	Equations, Rates and Intercepts Graphs and Linear Equations: Part 1 Widgets and Discs
A.17	The student will, given a set of data points, write an equation for a line using the median fit method, and use the equations to make		Predicting study time and test scores Predicting hard drive prices and retail sales Hanford Power Plant

VIRGINIA STANDARDS OF LEARNING (SOL)		CARNEIE LEARNING'S Cognitive Tutor™ Algebra I	
ALGEBRA I CONTENT STANDARD		COGNITIVE TUTOR COMPUTER LESSONS	COGNITIVE TUTOR CLASSROOM LESSONS
	predictions.		Stroup Test: Collect Data, Line of Best Fit Human Chain Wrist Experiment Human Chain Shoulder Experiment
A.18	The student will compare multiple one variable data sets, using statistical techniques that include measures of central tendency, range, and stem-and-leaf plots, and box-and whisker graphs.		Statistics
A.19	The student will analyze a relation to determine whether a direct or inverse variation exists and represent it algebraically and graphically, if possible.		Inverse variation

Appendix F

The Algebra I Standard of Learning Blueprint

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Reporting Categories	**No. of Items**	**SOLs**
Expressions and Operations	12	A.2 A.10 A.11 A.12 A.13
Relations and Functions	12	A.5 a.15 A.16 A.19
Equations and Inequalities	18	A.1 A.3 A.6 a.7 A.8 A.9 A.14
Statistics	8	A.4 A.17 a.18
SOLs Excluded from This Test: No SOLs are excluded.		
Total Number of Operational Items		**50**
Field-Test Items*		**10**
Total Number of Items		**60**

Appendix G
The Attitude Survey Instrument:

The Fennema-Sherman Mathematics Attitude Scales

Virginia Polytechnic Institute and State University
College Of Human Resources and Education
Educational Leadership and Policy Studies
East Eggleston Hall, Blacksburg, Virginia 24061
(540) 21-5111

The Fennema-Sherman Mathematics Attitude Scale

		SD				SA
1	It would make me happy to be recognized as an excellent student in mathematics.	1	2	3	4	5
2	I'd be proud to be the outstanding student in mathematics.	1	2	3	4	5
3	I am happy to get top grades in mathematics.	1	2	3	4	5
4	It would be really great to win a prize in mathematics.	1	2	3	4	5
5	Being first in a mathematics competition would make me pleased.	1	2	3	4	5
6	Being regarded as smart in mathematics would be a great thing.	1	2	3	4	5
7	Winning a prize in mathematics would make me feel unpleasantly conspicuous.	1	2	3	4	5
8	People would think I was strange if I got high grades in mathematics.	1	2	3	4	5
9	If I got good grades in mathematics, I would try to hide it.	1	2	3	4	5
10	If I got the highest grade in mathematics, I'd prefer no one knew.	1	2	3	4	5
11	It would make people like me less if I were a really good mathematics student.	1	2	3	4	5
12	I don't like people to think I'm smart in mathematics.	1	2	3	4	5
13	Generally I have felt secure about attempting mathematics.	1	2	3	4	5
14	I am sure I could do advanced work in mathematics.	1	2	3	4	5
15	I am sure that I can learn mathematics.	1	2	3	4	5
16	I think I could handle more difficult mathematics.	1	2	3	4	5
17	I can get good grades in mathematics.	1	2	3	4	5
18	I have a lot of self-confidence when it comes to mathematics.	1	2	3	4	5

19	I'm no good at mathematics.	1	2	3	4	5
20	I don't think I could do advanced mathematics.	1	2	3	4	5
21	I'm not the type to do well in mathematics.	1	2	3	4	5
22	For some reason even though I study, mathematics seems unusually hard for me.	1	2	3	4	5
23	Most subjects I can handle OK, but I have a knack of messing up in mathematics.	1	2	3	4	5
24	Mathematics has been my worst subject.	1	2	3	4	5
25	I'll need mathematics for my future work.	1	2	3	4	5
26	I study mathematics because I know how useful it is.	1	2	3	4	5
27	Knowing mathematics will help me earn a living	1	2	3	4	5
28	Mathematics is a worthwhile and necessary subject.	1	2	3	4	5
29	I'll need a firm mastery of mathematics for my future work.	1	2	3	4	5
30	I will use mathematics in many ways as an adult,	1	2	3	4	5
31	Mathematics is of no relevance to my life.	1	2	3	4	5
32	Mathematics will not be important to me in my life's work.	1	2	3	4	5
33	I see mathematics as a subject I will rarely use in daily life as an adult.	1	2	3	4	5
34	Taking mathematics is a waste of time.	1	2	3	4	5
35	In terms of my adult life, it is not important for me to do well in mathematics	1	2	3	4	5
36	I expect to have little use for mathematics when I get out of school.	1	2	3	4	5
37	I like mathematics puzzles.	1	2	3	4	5
38	Mathematics is enjoyable and stimulating to me.	1	2	3	4	5
39	When a mathematics problem arises that I can't immediately solve, I stick with it until I have the solution.	1	2	3	4	5
40	Once I start trying to work on a mathematics puzzle I find it hard to stop.	1	2	3	4	5
41	When a question is left unanswered in mathematics class, I continue to think about it afterwards.	1	2	3	4	5
42	I am challenged by mathematics problems I can't understand immediately.	1	2	3	4	5
43	Figuring out mathematics problems does not appeal to me.	1	2	3	4	5
44	The challenge of mathematics problems does not appeal to me.	1	2	3	4	5
45	Mathematics puzzles are boring.	1	2	3	4	5

46	I don’t understand how some people can spend so much time on mathematics and seem to enjoy it.	1	2	3	4	5
47	I would rather have someone give me a solution to a difficult mathematics problem than to have it work it out for myself.	1	2	3	4	5
48	I do as little work in mathematics as possible.	1	2	3	4	5

Appendix H
Teacher Focus Group Transcript

Question:

How do you describe a typical week in your class, the typical activities that make up your week?

Tch1: Being on the computer --- it depends on the week but since its block if it's a Monday, Wednesday, or Friday, then you would have first half of the block when you want to work on the computers for 45 minutes.

John: Does everyone think they hit pretty much the 40% over the course of the semester, not every week, but over the three semesters that you were fairly consistent as to how often you got in there?

Tch1: I was consistent with how often, but it wasn't 40.

Tch2: I gave 40% of time to get in there, but the kids did not get 40% time on the computer. Our computers are really messed up and the computer itself is just down or broken. We've had monitors go out and all kinds of crazy things have happened.

John: If you had to ballpark what percentage would you put to how much computer time you had?

Tch4: I'd say they had maybe 20 to 30% that they actually worked on computers.

Tch5:I would say mine pretty much got 40%. Two days a week. We're not on block.

John: You're on a bell and you're on a bell.

Tch2: 40% two days a week and even when the computers went down I tried to make-up the time some other time so I pretty much think we got our 40%.

Tch3: Mine definitely got 40% last year. This year it kind of averages out to 40% because I'm actually lucky enough to be teaching in the computer lab this year so that makes a world of difference.

John: I take it everyone else is pretty much classroom and then go sign up?

Tch4: Signed up for the year every Tuesday and Thursday. Well I think it's pretty much for the semester but she's going to sign me up for the last three.

Tch2: We actually have a Carnegie lab. We have two computer labs, one is um, there are three of us who teach Carnegie and we share that one lab with three teachers. Our classes are not at the same time so we share that lab. We don't go to the main computer lab that's used by the entire school

John: Let's get to the first question that is strengths of the Carnegie Program. What would you say are the strong points of it that you liked. Who wants to start?

Tch5: The students get to problem solve. They just pick it up so much easier. Now if I throw a word problem at them now they don't go "oow".

Tch1: They're not afraid, whereas before in a traditional classroom if you had a word problem like you don't have that as often. I mean in the beginning they didn't like it because it was writing, but now okay – no big deal because of the fact that they are used to it. I did give a quiz in which the kids did better on the word problem section than the just basic computation.

John: Tch3 anything?

Tch3: Well, I concur with the word problem part and I think really major strength is the total integration because you're not doing just things in isolation and then you say remember back in September when we did everything is so integrated that it kind of – they just kind of sneak in a little bit more here and there and nothing is really terribly scary because it's all in small doses at first and all of a sudden they're doing these huge quadratic equations and going WOW.

Tch5: You also build a bond with a kid especially if you have him the second year.

Tch1: Yeah, that's a good and bad thing.

Tch5: It can be both. I have one, but for the most part.

Tch1: We really enjoy each other. It's funny because they're going on and they don't want to. They don't want to end a chapter. It's only fair.

Tch5: And they ask, do we have to get new kids in my class. We don't want anybody new, we just want you.

John: Tch6, how about you?

Tch6: I like the problem solving and I also like the fact, I'm on block, so every class period, the last half I go to the computer lab and it give the kids time to break. I know I was on traditional last year and they just did not have the attention span to sit there during the whole block. That level of kids just did not have the attention span to sit there and do book work during the entire block, but you just take half of the time and then you go to the computer lab an it kind of gives somewhat of a change of pace and something new to focus on

Tch2: It definitely give them a lot of problem solving and I'm just finding that they can problem solve on the computer but they still can't do it in the classroom. I like the concept of Carnegie personally, but I don't know and I think my problem is that I took over this class from somebody else so I took all the problems that she had and all the attitudes that the kids had for her and the whole thing so I haven't had a very good experience this year so I'm still working on some strengths.

John: Okay, you came in to it new this year. Tch1 had the same cohort from last year. Tch5 you had the same cohort?

Tch5: New.

Tch2:: She's new.

Tch6: New, different co-teacher.

John: You just started in on it so yours is new. What about those of you that had the same cohort? Do you have something to describe?

Tch4: I feel the same way. I have yet to be able to say I'm fully for this. I even brought up the fact that it would be great if it were a class offered not with SOLs attached to it. That's my biggest problem because that's why this last semester even though we're in the computer lab we still do not get the 40%. I had to really re-teach last year. That may not be a Carnegie, that may be the fact that we're doing Algebra I during the first two thirds one year and coming back and doing the last third and you know that summer you can't even give them the four day weekend so you give them the whole summer I really do re-teach and I used Carnegie and I used all of it so I was doing everything and it's so much that I'm not sure. I'm with you to this day. It's a great concept it really gives them the hands on understanding of Algebra use everyday with real life application.

Tch2: I just don't think they like the computer. The one's that like it, some of the don't. Some of them tell you I didn't ask to be in this class and I don't like this computer. I'd rather be using a book everyday, so, but the one's that like the computer like the computer but they don't want to go back to the classroom. They want to stay in the computer lab all the time. So, I'm not sure.

Tch1: Are we still on strengths?

John: You were piggybacking on what Tch2 said and I just wanted to see what you were adding to it.

Tch3: The Algebra over three semesters, I think that has to do. I mean that's my own personal opinion of that.

Tch1: Well it's the way. Now Geometry thinks it will work out great.

Tch3: Because they get a semester and then you get a third semester and that makes a difference. We've been having this discussion in our department meetings and everything and I think there's going to have to be some change made but I don't think that's a weakness of Carnegie I think that it really is a weakness of how Virginia Beach has this set up. Algebra X is like re-teaching Alg. I so they can work on SOL'S.

Tch1: Right, and that's all I've been doing.

Tch3: And you spend so much time doing that re-teaching and that just really plug and chug and try to get ready for this SOL test and it makes it difficult to carry on with the business of the day.

Tch1: You also have to do a lot of it a lot more for the Carnegie because they haven't had a sack of questions.

Tch3: Right, because it's not a traditional presentation.

Tch1: Because someone important. a math person, said when she called the house so see how things are going and I said we're are getting ready for SOL's. She said hopefully you're getting them SOL style questions so even she knows that we have to do that so in turn again, I'm doing everything, a little Carnegie here, a little traditional here, SOL, It's like a big pot.

Tch2: Yeah, Me too?

Tch1: You have too.

Tch2: We had all these review sheets. The other traditional classes they gave them to their kids to work on and they understood them. I gave them to my kids and they looked at me and like ten minutes they go I did all the problem I know how to do I don't know how to do anymore.

Tch1: Because they hadn't bee exposed to that style.

Tch2: So I said fine and I just took all the packets and I sat at the overhead and I worked through and taught every single problem.

Tch3: Mine did get the work problems.

John: Okay, let me ask you this. I've seen the supposed SOL and Carnegie alignment matrix. With the emphasis I'm hearing I'm going away from Carnegie to focus on SOL alignment. Was it accurate?

Tch1: It is, it's there.

Tch3: I think it's misleading. Where you look for a topic it says it covers SOL whatever functions and you go okay we're going to get something on functions here and then it's another word problem and they mention the word function in it once and they say now we've covered functions. For example, I'm not sure that one is exactly accurate, but in general that's what I found. They say it's there and it's mentioned once but it's not really covered in a way that I would say it's covered, so I'd say it's misleading.

Tch1: There's some that's not in here. That's the whole thing so it's not there and it has a big space that says it's not in there.

Tch5: They gave us a huge appendices or appendix this year and there's like this much in there and a lot of what wasn't covered is now covered in that appendix, but you didn't work it in along the way.

Tch1: See, it may work out for those who are doing it now, but it's still not in the core of the program.

Tch4: Then you've got the time constraints, with only 60% of time you're supposed to teach a book this thick in a year and half and than you're supposed to add an appendix this thick, thicker than the book, I don't know where.

Tch3: It's big time constraints.

Tch3: If you think about any traditional textbook you've ever used, you have to teach it a year, you have to teach it a second year, the third year you feel comfortable. You know what you can skip over. You know what you need to get in there and that's what concerns me with this being a pilot program that's not a pilot program that they're either going to chuck it or keep it on the basis of our first SOL scores and I don't know it that cut and dry true, but because you have time, you know over time you get better at what you are doing no matter what resources you're using and we discovered as we went through it, yes a lot of these problems are so repetitive like the foul ball from the third deck part I and part II, part III, you know you don't need all that so you pick out what you need and throw out and I'm doing the Alg. X and I've had my kids, this is my third semester, and I'm at the end of the book and I still have two weeks to go.

Tch1: Did you do the appendix?

Tch3: I did a lot of the appendix. I did not do all of the appendix because there's some of the stuff in the appendix I'm like what the heck is this in here for. I don't have a clue why it's in there, but I didn't have that last year to work in and we started at a disadvantage by starting in October last year. See that girl that starting that's my roommate in the intro she is about the same place I was in that time frame so she should come out in really good shape as far as her pacing and she's been putting some things from the appendix in like the law power. She threw in like just before Christmas because that was like an easy thing or maybe she did it right after Christmas because it was an easy thing to pull them back in with.

Tch3: Changing tacks a little bit, the other strength that I think is good is for this level of kid is that the homework is short. It's short amounts of homework and most it's short. There's not so much on one page that they feel like this is forty problems and you're expecting me to chug through all these and I'm never going to get past No. 5 because that's what I got done in class and I'm not going to work at it again.

John: Any other strengths that we want to put on the table?

John: No? Why don't we go to the flip side of that one which are the things that we don't like or the weaknesses of the program.

Tch1: Software or any part of the curriculum?

John: The software or the curriculum

Tch1: The software drives me crazy. I don't know about you guys, but the problems, there's one where the help is wrong so you work with the first kid and it drives you crazy and they're upset because you told them the story about the time and it monitors how long you're doing the problem, whatever, whatever, so then you finally get through and by that time you know what's going on so the others you just tell them, but it's so many that are like that here and there and then you're used to something being wrong so you immediately go to something's wrong with the program you realize the kid is doing the problem wrong. So, I have a major problem with that.

John: Can you give me an example of that?

Tch5: Okay. Like for example it should have been like you are you're digging the hole or there's the unproblem. With the money you type in 1X and you type in 1X and it's not 1X.

Tch3: It's X minus 100.

Tch5: And they say in the help thing put 1X.

Tch2: This is what drives me crazy and I think again this come from me not teaching Carnegie last year and coming in this year starting in Level 15 so the whole first 14 levels I never saw any of those problems except the few that I did during the training. So I come in Level 15 at the beginning of the year not really knowing what I'm doing in the first place. You're just kind of here. So, we get to this problem where we have to graph the smoke of a line and the smoke is 2.5. Now if I were going to graph 2.5 on a piece of paper I would graph 5 over 2. So here I am on this computer trying to go up 5 and over 2 and it won't take the point, so I don't have a clue that I'm supposed to go up 2.5 and over 1, that's what he wants me to do. So stuff like that really bugs me and then I get the kids going “well, if the teacher don’t know what to do, how are we supposed to know what to do?” You know, and this is the kind of comment, this is what I’ve been going through all year with this Carnegie thing. So, I have just NOW, when I’m just about through with Carnegie feeling pretty comfortable that I can go to the computer and a kid asks me a question, I can work the problem out. You know, within a reasonable amount of time and feel good about it, because up until that I don’t like that software. I’m not that good with computers first of all. I’m one of those people who, I was afraid of a computer until a couple of years ago, so um it’s just been a real challenge for me.

Tch4: I think when they rewrote the software, because they changed it mid-year, I’m sure which one, that they rewrote all the software so that they could put more into it or make it a larger data, I don'’ know what the reasoning was. But they had to rewrite the language it was in and when they did that I think they screwed up a lot. There were bugs last year, but this new version has a whole lot more bugs.

Tch5: What about the new? Whereas before, when you did the equation software, there’s a step that all the new kids could do, but the old kids were doing the old stuff. It’s something about where you have to put where every step in. You cannot skip a step. Or when you subtract four from both sides you have to show four from both sides of the equation.

Tch1: And I was telling the kids that the computer was wrong so I was advancing them.

Tch2: Me too.

Tch3: That’s what happened to us because my co-teacher left me this year so I have a new co-teacher. She came at Christmas just popped in for five seconds just to say hi and I had been advancing kids all over the place and the stupid part of this, I can’t get it, and Pat looks at it and she says well they probably want you to do this and this. I was like oh my god, no wonder I miss her so much. She just came in with a fresh view and said step back

Tch2: I got so mad I said I know this has to work so I put myself in as a student and started working through those problems on that computer in the time that I had because it was really frustrating to me. And then I started teaching Carnegie at night at Open Campus and I started an interim so that helped me to start from the beginning to help my kids during the day so that helped me a lot. But, I’m telling you, I was ready to leave. At the beginning of the year I was really frustrated and my kids were frustrated, too.

Tch3: The upper levels in the quadratics we’re at a point now I can’t even figure out the answer and they’re not in the solution books.

Tch1: right, right—C factor?

Tch4: The C factor.

Tch5: And it says fill in the worksheet, I'm like okay it's a quadratic equation, what do you mean fill in the worksheet?
It won't let you get out.

Tch5: Does your teacher tool kit freeze? My teacher took kit freezes. My teacher took kit loses names into cyber space I put them in and….

Tch4: They can do the work forever and ever and then I can't find them and they tell me they're up to Level 6 and I say you haven't even started and they just don't exist and they get really mad.

Tch1: Yeah, they're in there and our CST, she found a way so I call her up and say such and such has disappeared again. That hasn't happened in a while, but

Tch5: It hasn't changed the students. She made a comment earlier that about homework and then you said that if they do it. I found out something. This year I have X and I have Carnegie X. They don't do work. They don't do homework so whether you have a computer if you have whatever, it's not the computer it is these kids, we need to motivate them in some other way. The computer's not working because I think on the evaluation it says has it worn off, the novelty of it? Yes! I wore off in September. When did we start? In October, so it wore off in November, and it's not changing the students. It's great that you have this level doing some problems that some algebra student's couldn't do, but it's not changed the student. I'm finding that I believe these kids would get the same grades if they were in Carnegie or in regular.

Tch2: I feel the same way.

Tch1: I have a bunch of failures because they won't do the work. I grade everything they do because if you don't it they won't do it. If you grade it they won't do it.

Tch2: And I also think that what I have a lot of students that they go into the you know. At first they really enjoy it. You keep hearing the "this is something new" we don't to sit here and do pencil and paper work all the time, but that got old because it's the same type of problem over and over and over.

Tch3: And I watch them sometimes and see how they progress and I have them they'll give them the problem and they'll hit help and it will give them that answer and they'll put it in and they'll go help—help—it will give them the next answer and they'll put it in and look at it and they get help 84 times in one problem because all they do is go in and hit the help button until it gives them all the answers and they put it in and they go on. They have no clue what they did.

Tch5: But at some point they do have to. I don't know what level you're on now, but at some point you have to do work.

Tch3: When you get to the graphs.

Tch4: I have one kid, I looked at his progress. He pressed the help button 284 times on one problem.

Tch3: That's an average too.

Tch1: Well, I heard that that might happen so I started the semester by telling them that if you press help your gold bars are going to start to disappear. And that was good and they didn't press help, but I was going insane. Because you have 30 kids and they're yelling at me you don't—you're not helping me. It's really hard to find that happy medium between help—help—help…or you know, yelling it.

Tch2: And then you have those who don't want to press help. They don't want t use it so if they can't get it they'll just sit there until you come around because they will not press the help button because they don't want that gold bar to move.

Tch1: And the problem is just can't look at it and the find the mistake like in the traditional classroom. You have to read through the whole question, and I'll tell them I'm sorry but it's going to take me a while because I have to read it all. I was reading about t-shirts over here now I have bullets, now I'm looking at something else. So it's time consuming to help one student. That's why when you find a mistake you just tell them that the answer's five, okay keep going. Don't have time.

Tch4: I had a problem with the solver. Two things with the solver that I wrote down because I wanted to mention it at some point. One of them was I think it lets them solve equations in such a way that they would never be able to do it by hand. Like it might be an equation 1.735X plus 2.897 equals 3.67. Well, what they'll do first is divide the 1.73 so it'll divide the X, it'll divide number along with the X and it'll divide the number on the other side. And, since it divides it for them it looks okay and it works out. The X is alone and they can move it to the other side. And they'll do it. The whole section that way. They'll do every section that way, but then when they try to do it by hand, even it they did it correctly, there's no they're ever going to figure out what it is. So the solver lets them do things that are totally inappropriate to do. Not illegal, but inappropriate.

Tch4: That is the first thing. The second thing is the solvers supposed to be really helpful to them when they're doing the worksheet, but, on the other hand, if it doesn't like the equation you putting in, even if it's correct, it doesn't let you put it in. It says it's not appropriate or it's inefficient. It's not inefficient for that kid. The answer might be zero, it might be true, but to that kid if they can't see it, but they can do it by solving the equation, that efficient.

John: That would probably be a case of their data base….

Tch4: No, I don't think that's what it is. I think they think the student should have the insight into the problem to know that when the time is zero such and such is going to happen. They want the students to have that insight into the problem. Like where would it be when you first start digging? They expect them to know that the level is zero even though you can still get the answer by solving the equation. They want the students to have that insight. So, I don't think it's the data base, I think it's that they expecting the students to have a certain level of insight and won't let them proceed without that level of insight.

Tch2: I think it's one of the early sections, but there's one problem where it tells you how much will you have tomorrow at this same time? And the kids do not know that that's twenty-four hours away. They go, they didn't tell me how many hours this was.

Tch5: That's a problem with the kid, not the software.

Tch3: But it does force them to think about you know like it says 13 months from now or whatever, yes it is frustrating for you at the very beginning, but after, like Tch1: said, sometimes you just get to that point where you start telling the answers. You also get to that point where you have a pat answer of okay are they asking you for months here and they gave it to you in years? Now look at your units measure and it really forces the kids to use a little bit higher level thinking. If it gave me three years and my unit says a month in months, then they have to make that conversion and most of them know there are twelve months in a year. MOST!

Tch5: Are you still doing Carnegie now?

Tch1: Yes!

Tch3: I'm not. All I'm doing is the computer. I have to be honest.

Tch4: How about their worksheets?

Tch1: Oh, I'm finished the worksheets.

Tch2: I didn't have a book.

Tch3: I finished the worksheets. I never got a book

Tch1: I have the worksheets as a project.

Tch2: That's a good idea.

Tch1: There're in groups of three. I have what you call a no show group that come when they feel like it and the others are in three, groups of three and I have a hard time so I couldn't imagine if I'd actually given this as an exam. You know, I have zero, ten 20, but I'm doing the cell phone work and they have to actually type a report and present it and stuff. And they didn't get it in the beginning. We talked about how people are actually paid to do this. Go out and investigate what would be the best service. So, I didn't do

anything last year. So, that’s the only thing I don’t like about it. And then too, because I’m the one who’s known as Miss mean Tch1, but they’ve known me long enough that they kind of like she not, she’s just like---right! So that’s the only thing. So that’s what I was going to ask you. Can they not be in my class next year.
(laughter)

John: We’re going to get to a question in a little bit that asks what would you do different.

Tch1: Okay, what is the next question?

John: Any other weaknesses or dislikes?

Tch3: Intro.

Tch5: I have trouble with group work.

Tch2: Yeah, I do too.

Tch4: So do I.

Tch5: Maybe it’s the students that I’m dealing with? But at my school we have different students and its very difficult. I jumped right into group work the first day like we were told to, unfortunately. Why didn’t you tell me no?

Tch3: I ended up not doing it.

Tch4: I left school crying for a long time and I, in a way I felt, I felt it was unfair. You’re thrown into a situation and say do group work with your kids the first day and I think group work is a very large part.

John: Why is that a Carnegie weakness?

Tch4: Because with Carnegie you’re not supposed to let them work on their own.

John: You do when you leave the computer and go back to the class work.

Tch4: It’s all group work.

Tch5: Supposed to be. I stopped.

Tch4: I followed the rules to the letter. No one told me that you weren’t supposed to.

Tch5: Pairs work.

Tch1: I don't even do pairs because you have some you're just like the help button. They know how to play the game.

Tch3: Oh yeah.

Tch1: They're looking like they're doing something. They'll just keep everyone on task but they have no clue what's going on and they have all the right answers. So I stopped that and we'll do once in the blue moon.

Tch3: That's why I give a traditional quiz. Then they can't share. Then if they fail, well, it is on them.

Tch3: And the other thing that kind of goes back to is that every textbook has a way or every professor has a way that tells you how to teach a class, but then you still have to make it your own. You try their way or whatever you were told to do but you still have to make it your own and we learned last year we had to teach our kids how to work in groups. You know, we did try the jump into group work from day one and we had to back off of it and not do group work for a while and come back to it and I think that, you know like one of the teachers I know goes around and they all have a sheet on their desk and she marks off either the top one or the bottom score so that if they're doing really well then they get more points, and for her it works, you know, and honestly I probably have had a better experience than some people because I had a fantastic co-teacher last year we were able between the two of to do the crowd control. Because group work is hard to do. There's no easy way.

John: So you have two teachers in your class.

Tch3: Yeah.

Tch6: I think it needs two teachers. I don't have two teachers.

Tch1: Carnegie needs two teachers.

Tch5: It does.

Tch3: The other thing that I think is a big thing, and I don't say this to be offensive in any way, but I think it takes a very strong teacher who has a good sense of their teaching self to teach Carnegie, because you have to adjust and modify so much than when you're in a traditional curriculum. You know, it's like in a traditional curriculum, at least in our school, we all kind of get together, we have a syllabus we follow, we know that to get to the division's curriculum we have to be here, here, and here. On Wednesday we better all be about right here or we're not getting through it. But with Carnegie there's so much latitude, even though you feel like you want to follow all the rules and do every page, because that's how I was in the beginning. Like, okay, turn the page, turn the page, Do the next page. And all of a sudden I realized that good grief, this is to much, you know, to really feel I had to get through every single page, but it really does kind of force you to think about how you teach and it's had to step back from that traditional model when that's what you've been practicing for years.

John: Let's jump to this next question because it's flowing with where you guys are taking it.

John: What would you do different to make this a better math experience for the kids?

Tch5: What I feel like is almost what Karen said. It shouldn't be thrown on the new teachers. I mean, new teachers work hard enough. I mean they work their tails off to be new. Then to be thrown in with this Carnegie, which is not anything you've see before, you've never worked with it. You don't know your own style yet. You know, it should be someone who has a little more experience that even gets to know the kids. Know the kind of group you're working with, you know. And that would help some people.

Tch2: One thing I think that we should do, and I don't know if its possible, maybe it's not. But I think we should explain to the kids what they're going to be doing. And say, do you think you would like to do something like this?

John: When they're going through this registration process?

Tch2: When they're signing up for regular Introduction to Algebra or Carnegie because I don't know how they chose the kids in our school for the pilot, but a lot of them, I mean this year.

John: Whatever teacher volunteers.

Tch5: Just the luck of the draw.

Tch2: But this year because our guidance people didn't schedule the class's right, along of the Carnegie kids were misplaced. And some of those kids pitched a screaming fit because they had to go back to Carnegie. They did not want to go. I mean, it took me three weeks, three or four weeks to get all the kids in the class that were supposed to be in there and to this day, some of the kids who took Carnegie last year did not end up in my class because they got their parents to go to the School Board and everything because they didn't want to be in there. I'm serious. So first of all if the kids don't want to do it.

Tch3: I don't think we should make them.

Tch2: We shouldn't make them.

John: We let a couple of them opt out because they didn't want to be in the class.

Tch1: Yes, the parents, none of them were very upset. Most of them, I think its like a total of five throughout the whole year, concerned about the SOL geometry. That was the question. One parent came up and she said and I told her I would work with her son because she said if it's not a geometry Carnegie then my son needs to get out of this class. He had a 20 so she knew what they were doing, and she could compare. Like this doesn't look like what he's doing and you're in the same subject, so then she said he needs to get out because I want him to be able to take geometry. Um, and then there were some others because they didn't have a textbook and such and such does better in having a textbook and that was an excuse, to tell you the truth, because that person wasn't doing any homework at all, But um, so you have your problems with that.

John: We would, what I would do in the summer, I would take TCH1's grade book, and you know it's got the list of kids that were intro to algebra. Those were all Carnegies and then I'd just pre-schedule and I'd use section 98 and 99 and I just put all those kids. I just pre-scheduled them all and then when you run your master scheduler off you have the kids.

Tch1: That's what I thought.

Tch4: That didn't work out.

Tch1: They didn't want to come back. One did come back and then she was failing and she's still failing now, so it doesn't matter. There was one the Mom did not want him in the class.

Tch3: Well some of ours got moved out to the traditional

John: We were going through what would you change? What would you do differently? What if you did let the kids know in advance so they could enroll and have the option? What else would you do differently?

Tch5: There needs to be two teachers. There needs to be Special Education help or something because the level of kids you get in Intro and Algebra X, you've got a special education class, whether you want it or not.

Tch1: Yeah, because I've seen. It depends on the number, um, I don't know, because I can handle the class and that goes back to the type of teaching style, um, because I don't know if you have two in there sometimes.

Tch3: Well there you have to because the co-teaching thing is a totally different animal too. Because if you have a co-teacher that you don't function well with, that can be more of a detriment and a help. It's not just having another adult in the room, it's that you work well together and the kids respect both of you and think of you both as a teacher.

John: Why did you have a co-teacher?

Tch3: Because I have been doing inclusion.

John: Okay so it was a special education class.

Tch3: Just like second or third year and I have a major population of special education kids because I'll take them.

John: Okay. Would you say that you had a lot of special ed kids in all your sections or did you find you had some in a section, or how did that?

Tch6: I have one class that has a ton of them and they ask me questions that they don't know math. They don't have a background in math at all. And I can't be there. I can't answer every single question at one time. I tried and they all have the same questions at the same time.

Tch3: That's kind of a building problem too because it depends on how your special ed. department is set up in your building; whether they have like a basic math or pre-algebra that's self-contained because at PA we do have that and so if I have kids that just aren't cutting it no matter what my math class is I can go back to their case worker and say look, this person has major gaps in their basic skills, I think they need to come back to a pre-algebra or self contained and if they can get the parents to, you know, buy into the whole idea that if they get the basic skills, then they're going to do better later on, that makes a big difference, but we have basically, I think, maybe I'm wrong, the strongest special ed department in the whole city because they all come to us.

John: Our inclusive classes are not the Carnegie sections.

Tch1: Even though I have some that have IEP's and stuff, but, um, how many kids do you have in intro that should be somewhere else?

Tch3: That should be special ed.?

Tch1: Yeah.

Tch3: 12.

Tch1: You know that's the whole thing.

Tch4: But they're too low to test for special ed.

Tch1: Exactly! So, you know, you're talking about this Carnegie and it should be for Algebra I kids. It's too hard for Intro.

Tch5:: It really is. It should be a separate class offered. I know you can't get any credit or something. It should not have SOL's attached to it. I don't know why, I don't, how can we improve it/change it?

John: If I'm reading between the lines a little bit, I think what you might like to see, or at least somebody try it, would be to do it with your regular Algebra I's and see what the outcome would be.

Tch1: They have, at another school.

John: Did they do an evaluation of it?

Tch1: I imagine.

Tch2: Test scores were a little bit higher than regular?

Tch1: I'm not sure, but they were pretty good.

John: That the one where they did it at?

Tch3: I tried to do it with my Algebra I and they wouldn't let me do it.

Tch1: Correction! It's done in a middle school, so you're talking about an advanced eighth grade.

Tch2: That makes a big difference.

Tch4: I like it with Intro, but I think it should be more of an average Intro. I know you can't do that. Not like the low, low intro kids who can't read.

Tch3: I had that problem. A couple of kids had to be taken out because they had third grade reading level. It's not fair.

John: Non-reader?

Tch5: Yeah!

Tch2: What I'd like to see added is more worksheet, not worksheet, it's all worksheets, but more problems, what is that called? You know, where you just do problem after problem after problem.

Tch1: More repetition.

Tch3: A little more drill.

Tch4: Without word problems.

Tch3: Right, a new distributive 3 section and things like that.

Tch1: But that's the whole idea of this program.

Tch4: You don't have to go completely away from that. Why can't you find a happy medium where it's more interesting for them, you include some of that, yet they still get some of the drilling.

John: Anything else you would change?

Tch1: Like I said, the category. Because after you take Carnegie I'm darn sick of having these kids in Geometry because of the fact that you still, being a Geometry teacher, you still have to be able to solve equations and if you do it the Carnegie way, you have to break out the graph and whatever. Whereas Geometry you need solve them alphabetically and keep on trucking. See, that's going to be a major hurdle when they get there. You can do Geometry without Algebra, but then again, whom will they have?

Tch3: That's the only thing. This is the only high school math experience they've ever had so they've never had a traditional high school math experience, and that is going to make a huge amount of difference. You know, taking notes and things like that.

Tch1: Oh, but even if it's high school, but still how many math teachers do the same style from middle school up, you know? You still have pre-algebra and that's the same thing.

Tch3: Yeah, but they've been away from it for a year and half. And now you're going to expect them to take notes and do 20 problems or 30 problems a night, and it's going to be a big culture shock for them.

Tch5: I still have mine take notes.

Tch1: Yeah, I still do all that stuff too. They have a vocabulary quiz and on their final exam um, because again, I brought in everything, the melting pot, so what I did, they have 25 percent of their final exam which is nothing but vocabulary, from September of last year up until now because, I know you had this.

Tch3: One other thing I was just thinking about that I would like to change, and this totally logistical nightmare, but I think that every teacher that teaches this ought to be allowed to teach it in the computer lab, so they can do like we're' doing this year; when I say "when you're finished get on the computer." So that's why I kind of hesitated a while ago with 40% because it like some of them are on the computer really fast and some of them get no computer time at all during class and I tell them well, I'm grading you on the computer so you have to make it up on your own time. If you work slow in class, then you either take that stuff to your resource classroom and work on it or you come back during the resource time and work on the computer lab. And we have enough, we have like a little teeny tiny 10 computer lab that a cap lab that's grant money, and blah, blah, blah. It still has computers that they might be able one or two get on. So they can make up their time for me.

John: Makes it hard to really integrate if they don't.

Tch3: Yeah, when you have to travel, like last year it took us five minutes at least to get from out in my portable to the computer lab. And they you really have to practice walking and not talking and stuff, like the snack machines and whatever.

John: The one thing I haven't heard so far is what you might change. I'm curious to get your impression on is when you start talking about SOL's. You never really say anything about whether or not you thought it prepared the kids for the SOL test.

Tch1: It didn't. I did. I did by putting in the time, the SOL style questions. Because even if you teach a traditional Alg. I, you still have to do SOL style questions.

Tch4: "true".

Tch1: So it's kind of like saying, but no.

Tch2: Because she said that? You see, I didn't know that was what I was supposed to do. I didn't know that, I mean I knew and I took two weeks and we went over SOL drill, but I thought that this course was going to prepare them for the SOL's. That's what I understood the coordinator to say last year when I had been trained. That this was what we were looking to see. That if this course prepared them for that. And if I had known that it wouldn't, I would have started in September reviewing everything that they did last year, but I didn't do that, I took the two weeks before the SOL test, broke out the worksheet, the same ones that I gave all the classes, and I don't think it prepared them. But my other class wasn't prepared either.

Tch3: I think that the Carnegie style doesn't prepare them to pass the SOL test. I think they know a whole lot of algebra and I think they know a lot of different ways to look at problems to do problem solving and I have no doubt in my mind that my kids know a lot of algebra. I really do feel that way, but can they pass the standardized test? I guess we'll know in a few weeks. You know. Standardized testing is a far cry from what we're doing.

Tch1: What did you do to prepare the kids for the SOL?

Tch3: I did a lot of two to three weeks of drill and we did warm up problems every single day. Every single day we did warm up problems SOL style.

Tch1: So, in essence, we're still at the point of the question? Does the program prepare the kids?

Tch3: I don't think so, but you even had to do some stuff. Yeah, it does not prepare them to pass our Virginia SOL test. No!

Tch1: That goes back to the whole purpose of why he set the program up, this teacher whatever, because they're tired of the traditional algebra and I think again, it a great program if it did not have SOL's. If we can bring back a free math credit class for those who just want to take it, and who have finished regular algebra I and geometry and you want one more math credit. Take it out because it does not fit. You have to do too much work and it, like she said, she didn't know, but you can go back and say you still have the SOL's. I use my SOL blueprints as a bible, you know, for Geometry A and Algebra, and I go back and I know that this is not in here or they haven't mentioned the word. Like this teacher last year, they didn't say the word function or domain and range, They were not used. You have to know that it's not in there. How do you know? You have to reference traditional Carnegie SOL across the board. And you have to do that and unfortunately, because of the fact that these kids are now being required to pass the SOL, it is not fair to them to be in a Carnegie class. They need to be out into a traditional classroom and then you have traditional SOL. Carnegie should be over here, an optional class. I don't have a problem teaching it; it's just the fact I think it's not fair to have the SOL's attached to this class, because we're doing everything and it's not enough time for this level.

John: Anybody else want to add anything. Is that how everyone feels for the most part?

Tch3: I think my kids were prepared, but I didn't do a lot of the Carnegie. I had to go back to the traditional. But they got the thing and when I got to things with them they caught on much quicker than Intros that I had in the past.

John: But if you had left it up entirely to the Carnegie software, the curriculum, you don't?

Tch3: No.

Tch1: No. Absolutely not!

Tch3: Because there's no traditional multiple choice format and solve the problem format, whatever. The equation solvers the only place they get it and I feel like it was a great course for my kids to take because I have so many special ed. kids and this is the first success a lot of them have ever had in math. Ever! And I'm not just talking low level whatever, you know, I mean everybody has the low level in this course. That's what it's designed for, but I think with the special ed. kids, it made a difference for the because they could see their successes along the way. Like on the computer they see the gold bars and whatever and at least now they're not afraid of math. Whereas before, a lot of them just went "can't do math." And I do have a lot more now, but you know, I went from three classes to two. I had a high failure rate, but I think I would have had a higher failure rate had I been teaching a traditional class and I would have lost a lot more students earlier, that would have just totally zoned out on me and just sat there the rest of the year.

Tch6: And it's great for the block.

Tch3: Yeah, it is good the block, but it's also better if you teach it in the lab. You know?

John: Anything else to add in related to the SOL's?

John: Let me ask you this. If you had to take the three semesters and combine it all together, would you give it a plus, a thumbs up or a thumbs down? What would you give it and why?

Tch1: I would give it .a thumbs down. I think the student's lessons were prepared to the best of their ability, but um, I would go back over two things. I would try and cram much more into the first two thirds than I did, so that I could have more time to review this semester. That was something. I did the Carnegie the way it should be and I just kind of put my own little, the necessary language in, vocabulary and terms. But, I would go back in. I'm not pleased totally with it. I did the best that I could do and I did everything, but the way it was done, it was choppy, because of the fact that I was, you know, pressed for time.

Tch6: I'm confused on whether it's thumbs up or thumbs down. I like it for block. I don't have as many problems with the kids as what I have in a traditional classroom than for block. They can't sit there that long and do the same old thing.

John: Do want to give one of these (so/so gesture).

Tch6: Kind of one of these (so/so gesture).

John: Okay.

Tch1: Well, that's what I should have done, too!

Tch6: I don't think it prepares them for the test like it should have done, and I didn't know I needed to put as much in as what I should have done, so I think they would have been more prepared if I would have known that I needed to put a whole lot in before I got into it. I did the two weeks after Thanksgiving just cram. I took 60 question multiple choice things on each reporting category with every SOL and just went over them. They saw the strategies for solving all these problems for two weeks straight. And a lot of them were just lost and they tuned me out completely and didn't want to hear anything. Some of them sat right up there and they'll probably do well on the test because they listened and really wanted to work hard. Still hard to say. The kids don't have the motivation for it.

Tch1: See I didn't get a chance to look at it.

Tch6: It's hard.

Tch5: Yeah, there was a lot of things on it that shouldn't have been, which is very unfair no matter who would take it. In fact, I thought the test was more viewed for Carnegie stuff with the word problems.

Tch6: I thought it was, too.

Tch5: It wasn't geared towards like my traditional algebra class. I looked at it and I thought, I don't even know if they'll even pass. I mean it's not going to be the same test, but there's no way the traditional teacher. And they looked at me like there's no way. And I looked and I go "oh my gosh, look at all these word problems."

Tch1: Well that's what it was like when?

Tch5: Like two years ago.

Tch1: Yeah, when I gave it in middle school.

Tch5: Exactly! Which was really hard. It was that same kind test.

Tch1: First ten.

Tch5: Yes, there was a lot of like the price and the cost and I asked my kids and they're like yeah, we think these are pretty good. I mean kids are always, yeah alright, it's easy. But it was more geared towards that. And I asked them, I said, "Did you see?"
And I said, "I told them I can't look at the test while you're taking it". And like why not?

Tch6: I was audited, thank you!

Tch1: I was, too. But I didn't look at any of them.

Tch6: I just stood there, like uh, hum.

Tch4: We had a fire alarm during mine. A real fire alarm!

Tch5: I like the program. I like it on the block. I taught it without the block last year, but I had a good computer teacher and you're right across the hall so that I lucked out. I also liked being able to weed out the kids that I knew would have failed them. But I didn't want to have some of them in there. There's a couple I wish I would have moved out, but I didn't. I has helped a lot of the kids succeed. Some of them are over the computer and that's their choice, I'm not going to argue with them because we're in the computer lab. I has helped them mathematically think more traditional stuff that is easy, but it's also boring, which is what you all were saying. I'm worried about them in Geometry, sitting the hour and a half, so it's, I mean I like it, I like how it helped them think, there's a lot of bugs they need to work out. There's too many and that really gets the kids angry and me angry.

Tch4: The frustration level gets high. It starts out fine.

Tch5: You know, some of those graphing now, they have to graph something with a slope of 5,208.

Tch1: Which is absolutely ridiculous.

Tch5: Now that is ridiculous. You know, it doesn't fit on the screen. It doesn't need to be that big. You know that's some things that the company needs to realize. If they know how 5X, you know they're probably going to know how to graph 5,208, which I don't like that one.

John: So you're giving this (so/so gesture).

Tch5: Yeah, just because the program has a lot of bugs. And group work, I don't do group work, I do pairs.

Tch4: Well, that's a group.

Tch5: Small group.

Tch3: I would probably do this to just, probably a little bit more to the thumbs up just simply because of my population. Um, really I kind of would parrot everything Tch5 just said. Um, I trying to think if there's anything else I wanted to add too. I don't really think there's anything else, other than you know just over all three semesters I think it is important that I have the same kids, that I was their teacher again. Not that I have the same kids, but they have me again. You know, and I, that's not part of, that's not Carnegie, that's within, that's a situational thing. A lot of people are jumping into Algebra X without having taught the Algebra Intro. but I think that's part of what helped make it a better experience for me is that my kids knew what to expect from me and they knew what to expect from the program when we started the Algebra X this year.

John: Tch6, do you want to throw one in there?

Tch4: I haven't taught three semesters yet so I can't vote up or down.

John: Well let's see, okay, last question: If you don't have anything to add to this then we are done. All the stuff that you've heard today that we've talked about, if there's anything you'd like to add into this? This is kind of a catch all question. Anything else you would want to put on the table about the Carnegie experience in the last three semesters that you haven't had a chance to say or you haven't said, this is it! So, it anything else that you want express that you haven't in any context of Carnegie.

Tch5: I don't think the Carnegie will work if they don't have the same teacher for three semesters.

Tch3: I concur with that, and I don't think just because you have them for the Algebra X you should have to teach them Geometry.

Tch5: Right! Exactly!

Tch1: I'm with you on that one. But I don't mind, some of them I don't mind.

Tch3: Same here!

John: You don't have to plan it that way. That's an administrative thing, because you know I took care of one of the boys for you.

Tch3: I did that too. I've done a little bit of that myself and I would go back and make a stronger point of it. I think it's wholly unfair to give this program to a new teacher. I think it's quite a bid unfair to give it to a teacher who's new to the building and not new to the system. You know, unless they're really, really asking to do it. But to give it to a new a new teacher, fresh out of college, there's just so much to do. You know, you have to be like dancing on, with your tap shoes on the whole day long and you know, the trainers told us that when we had our initial training that we would probably work harder in the computer lab than what you do in the classroom. And that's pretty true. And like Tch1 said, you have to read those problems and if you don't, then you're not aware of all the problems.

CHANGED TAPE

Tch1: You're, I mean I'm quicker. In the beginning, I'm like let me ready the problem, put my glasses on or whatever.

Tch3: And that goes back to what I said at the very beginning too. Anytime you get a new textbook or whatever, as you go through it a few more times, you know like this year I have to do a lot of the homework problems myself well, maybe not a whole lot of them! But I do some of them.

Tch1: You can't compare those problems on the computer to a test.

Tch3: Oh no, no. I know.

Tch1: Because it's just that each question depends on how they're asking the question whether you start, and that's the whole thing.

Tch3: What I'm saying though is once you get used to the style that they're asking, you said you look for key words now and you didn't know how to do that in the beginning, but nobody else would in any other setting either. You know, so!

Tch1: Well that's a suggestion because I'm thinking about how I've worked with this teacher since he's been here and he's not new, but he's new to the building and, you know, and I'm hearing a lot of things I didn't know, because I remember that that was something I kept bringing up in the initial training as well, that will this help the kids get the Carnegie and now, we believe so. So, if I'm hearing that, I'm thinking if I just do this I'm okay.

Tch3: Right.

Tch1: And that's not the case. And she even knows it, so what I'm saying?

Tch3: Uh Huh.

Tch1: Because she asked me when she called, how's it going and so are giving them some type of SOL questions? And I say, oh yes, Okay.

Tch6: I think if she was more straight-forward with the teachers at training it would have helped. Really, people have asked her over and over again at the training. You mean if we just do this it's going to be okay? If we just do this? Yes, definitely. And I didn't know because I have other classes, because I could have brought in tons of stuff from the beginning.

Tch1: I think it's a miscommunication.

Tch3: Can I ask? When were you trained? In the spring or the summer?

Tch4: Summer!

Tch1: She said the same thing though with us. She said the same thing with us. What I think what's she's saying is that what we're doing along with what you need to add to it It's miscommunication. She knows that this stuff, I mean when you send out the little thing, the sheet that compares the two, it has the big space for certain SOL'S because there's nothing there for Carnegie, at that time. Now they're putting in all the other stuff that matches up. So she knew. So I think what she was saying to you is that if you do your part, if you cover those missing sections.

Tch4: That's really because she made it seem, quite honestly.

Tch1: I know. I heard her.

Tch4: Because we asked her over and over, you mean if we just do this all we need to do is just follow the book.

Tch3: I have taught Algebra for two years and took her at her word.

Tch4: I heard that as well.

Tch1: Because they actually want me to endorse the product. I've got letters about let us know when you feel that they want to use my name. I tell them I'm not so sure.

Tch3: What my hope is, is that when those of us who went through that summer training you know, we had the trainers show and they're both very dynamic people and it was a had and fast three days training. They wanted to do it in four, first of all, and district wouldn't pay for it in four. And then, in the spring I think the same thing happened. Then you know, it was three days and then in the summer I wasn't there and though that's technically why I was sent to Pittsburgh and then, they, it was scheduled whenever I had vacation scheduled. So, Tch4 and another teacher kind of got to solo it, or not solo it, but duo it, or whatever, and I guess what my hope is that we get to keep the program. That more of us that are in the classroom here in the district, are trainers, that we can answer those questions using our experience.

Tch6: Then you can say what we want to say.

Tch3: Thank you!

Tch6: You're watched.

Tch3: Yeah. Then I can say yeah. I do both, I don't do exclusive Carnegie. I know the other teacher came up to me and said what are you doing? And I told him. This is what I'm doing. I'm doing both. I said I always have. I said yes, I'm pulling my hair out. Yes I'm getting gray hair from it, but I have to feel satisfied. I have to do both so I know my students are getting it.

Tch4: You have to feel like you're doing your best.

Tch3: Yes! What if one of my kids moves?

Tch1: It's not even that you feel satisfied. It's the fact that you have to do both. There's no way, again, because it's attached to the SOL exam. There's no way that you can just do Carnegie alone and even the little stuff they put in the back of the book without practicing because the back of the book does not have multiple choice in the way they're asking the questions. And that's just a fact. And it shouldn't be that because someone's in the room so there you know how I feel about it, no new surprise. And they'll say someone was talking about them, oh it must be me. And that the bottom line is that you have to remember why are we all here? For the students! And now, SOL's' are no joke. You have to pass these "bad boys" and go on. It is not fair, because you like a program. Is it helping the student? That's the first, and only reason.

Tch5: Now last year's kids didn't take the SOL. I mean it doesn't count. But now it does.

Tch1: Now it does.

Tch3: Most all of mine, I guess does.

Tch1: And the Intros now it matters!

Tch3: I think we were at a disadvantage last year by starting in October, because if I would have had that extra month then this year I would have had more time to play with it, too.

Tch5: We didn't know the program. We didn't and I didn't go through the whole thing. You know I didn't know what was on the whole thing.

Tch3: Well, you don't have time to go through the whole thing.

Tch5: Some people were much more organized that I was, but I just went through it day by day.

Tch3: So did I. And I didn't throw up a lot of traditional last year either.

Tch3: I did. This year is the only year I did. I mean we did our warm-up everyday and that was traditional and I did some multiple choice testing. Last year I did my final mostly traditional no, half and half of the multiple choice and you know, if I had it to do over again yeah, I would do a traditional SOL style question at the very beginning as a warm-up, every single day, even in Intro, but I truly threw my faith into the program and turned the pages and planned a couple of days ahead. If I was lucky maybe I knew what I was doing tomorrow and I had more sheets run off or whatever, but, you know, when Tch4 told me she was doing traditional and Carnegie you know, its like, I'm thinking that you must be busting your butt. You know you've got to be working way, way harder than I am to do all those things at the same time. And you know, this year, I got terrified when it got to be like a month from the SOL's and I'm going "oh, my God".

Tch1: I was there, too.

Tch3: Well, and I think that kind of across the board. All the other algebra teachers in the building were feeling the same way and I was, but you know, it's just like this big guillotine hanging over your head.

John: You've got the SOL guillotine hanging over your head and than you have the Carnegie on top of that?

Tch5: And then the other thing. Well you know, my building principal came into my classroom and says "Hey, this is the Carnegie group. We're all going to look at your scores." And they're like: What?

Tch1: What scores?

Everyone in unison: Their SOL scores!

Tch5: To see how you guys compare to everyone else. Okay, so first of all we have the stress of passing the SOL's, now all their scores are going to be compared.

Tch1: Well you knew that going into it.

Tch5: I know, but the kids were like—oh no. You know, so they're feeling enough stress already.

Tch3: I think my kids took it more seriously.

Tch1: My kids took it seriously because I told them that 75% was passing my class and if you pass the SOL I'll pass you. Uh huh, that's when they took it seriously. I had a couple that actually came up to me, and there so it's funny because I'm supposed to be Ms. Meanie and they'll see me in the hall and speak 50 million times. You know, and that's what cracks me up. They've really worked hard on the SOL and we had an auditor in the classroom which really added to the pressure so an assistant principal came in and made a statement about helping their scores stay up and that was kind of like a good thing. I don't know if it made any difference on paper, but at least they had the motivation and effort. We'll find out.

Tch4: I actually gave out a set of books for students to use at home for SOL practice and was told that I was not supposed to do that.

Tch3: I was using books ordered for the special education students as a resource and was told the same thing.

John: Well, is there anything else that you would like to add that hasn't come out? No? Then I appreciate all of your time and honesty. I will get a final draft to each of you as soon as I am finished. Thanks again, I couldn't have done this without you.

VITA

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1997-2001	Virginia Polytechnic Institute and State University, Blacksburg, VA. Graduate Student in Educational Administration
1990-1994	The George Washington University Washington, District of Columbia Master of Arts in Education and Human Development
1979-1984	James Madison University Harrisonburg, VA. Bachelor of Science, Geology

PROFESSIONAL EXPERIENCES

2/01- present	Principal, Great Neck Middle School Virginia Beach, VA.
6/95-2/01	Assistant Principal, Frank W. Cox High School Virginia Beach, VA.
8/94-6/95	Administrative Intern, Green Run High School Virginia Beach, VA.
8/91-8/94	Teacher—Earth Science, Bayside High School Virginia Beach, VA.
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John E. Smith