Research Report

Efficacy of a Texas Technology Integration Project for 9th Grade Algebra I Students: The Basis for the Functions Approach to Algebra I in the *A+nyWhere Learning System*

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The San Antonio Area Technology in Education Council (SATEC) under a grant for the National Science Foundation and the United States Department of Education developed a hands-on approach to teaching algebra using technology. The research paper that follows is the evaluation of the efficacy of this program.

The American Education Corporation is working collaboratively with the directors of the SATEC project to incorporate the principles of instruction derived from the grant into a new instructional title in the *A+nyWhere Learning System.* The research paper is presented here to establish the scientific-research base for the Algebra I: A Functions Approach to be released in 2008.

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With the widespread introduction of computers into the modern classroom, increasing interest has developed in how to best employ computers within the broader educational curriculum. While this trend is not limited to the United States (e.g. Mamoukaris, Bakatselos, & Economides, 2000; Webster, 2003), it has been brought into sharp focus due to the passage of the NCLB act of 2002. This legislative act requires educators to determine the efficacy of any instructional method and specifically of the newer technology based instruction. While it has been generally demonstrated that the use of various types of multimedia enhances student learning for a variety of diverse topics (e.g., Bagui, 1998), the effectiveness of specific technological interventions that utilize computer software has been haphazardly investigated. Although computers are used in all areas of instruction, this paper is restricted to mathematics instruction, specifically Algebra I, and examines the results of students involved in a computer assisted instruction program utilizing a non-randomized comparison group design.

Interest in computer-based mathematics education has accelerated over the last twenty years. McCoy (1996), within the context of the underlying philosophy of constructivism, presents a conceptual framework for viewing computer-based mathematics education that splits the content area into two pieces: a programming mode and a computer assisted instruction mode. The programming mode covers those activities where the individual utilizes logical reasoning to “teach” the computer via the writing of computer programs. Through the use of various programming languages, these students experience how mathematical logic works and receive direct and immediate feedback that enhances their learning of mathematical principles. Computer-assisted instruction is when the computer is used to teach mathematical principles from very simple rote practice to more complex computer simulations that let the students direct the events within that simulation. These computer simulations are also known as “microworlds” (see Papert, 1980 or Hoyles, 1994).

Many different populations are served by computer assisted instruction. While the normal student population is increasingly being exposed to some form of computer-assisted instruction (Becker, 1991), some less obvious examples include the adult population (see Safford-Ramus, 2001 for a review of relevant dissertations), the adult prison population (e.g., Batchelder & Rachel, 2000), and the learning disabled (see meta-analysis by Kroesbergen & Van Luit, 2003). While these unique populations are interesting in their own right, the use of computers in everyday instruction is becoming more and more prevalent. For example, in the Miami-Dade public school system for middle school students (Valdez, 2000), specific recommendations were made indicating that they needed to employ only technology and software that has the greatest possible chance for maximum results. The quandary facing Miami-Dade and other school systems is there exists a dearth of scientific studies that investigate specific technologies and software programs. This problem has been brought into sharp focus due to the passage of the No Child Left Behind act in 2002 that mandated skill and competency testing in the elementary school with increasing negative consequences for schools whose students failed to make adequate yearly progress.

Problems immediately developed due both to the lack of existing research and procedural obstacles facing new research. Zvoch and Stevens (2003) found additional problems occurred when one tried to compare the effects of computer-assisted instruction across schools noting that outcomes based on the assessment of school performance are dependent on the specific choices of data modeling and statistical testing techniques to use. Such results could be misleading, for example concluding that a school’s poor mean standardized test scores indicates poor performance when an analysis of other variables, say the amount of improvement or change in those scores, could very well indicate a robust positive effect of a particular computer-assisted instruction program.

A serious gap in the mathematics education literature exists today due to the very small number of studies, observational or experimental; available today that examines specific interventions available to schools. This research investigates selected results from the San Antonio Technology in Education Coalition (SATEC) project. This project was a five year effort that began in 1998 and this paper describes results from the school year of 2001-2002.

The San Antonio Technology in Education Coalition (SATEC).

SATEC accepts the premise that sound teaching begins with questions about real world events that are interesting and familiar, not with abstract concepts. Students cannot learn to think critically, analyze information, make logical arguments, explain natural phenomena, or work as part of a team unless they are permitted and encouraged to do so over and over in many different ways. These principles were enumerated by Phillip Schechty in his book Inventing Better Schools: An Action Plan for Educational Reforms (1997).

When students connect their basic learning to concrete experiences, they develop a foundation for understanding more complex ideas. Because the computer helps to rapidly collect, organize, and analyze data, technology enables students to quickly and easily replicate previously laborious experiments that used to be too time consuming to complete. Once data has been collected, students can grow in their ability to make observations and generalizations, reason logically, manipulate symbols, and derive "formulas."

At the time the SATEC project was created The Curriculum and Evaluation Standards for School Mathematics published by the National Council of Teachers of Mathematics (NCTM) in 1989 established new social goals for education and emphasized a mathematically literate populace, lifelong learning, opportunity for all, and an informed electorate. These goals imply that a school system be organized to serve as an important resource for all citizens throughout their lives. The NCTM Standards for K-12 further articulated five mathematics goals for all students: learning to value mathematics, becoming confident in the ability to do mathematics, becoming mathematical problem solvers, learning to communicate mathematically, and learning to reason mathematically. These goals imply students should be exposed to many experiences that provide opportunities to develop mathematical habits of mind and to understand and appreciate the role of mathematics in human affairs.

The SATEC project also incorporated The Conference Board of the Mathematical Sciences views that changes in the teaching of mathematics are a natural outgrowth of the advance of technology. The Board's recommendations, published in “Educating the Americans for the 21st Century,” state that the development of computer science as well as computer technology suggests new approaches to the teaching of all mathematics in which emphasis should be on the following ideas:

- Algorithmic thinking is an essential part of problem-solving.
- Student data gathering and the investigation of mathematical ideas are essential activities for facilitating learning mathematics by discovery.
- Calculators and computers must be introduced into the mathematics classroom at the earliest grade practical and should be utilized to enhance the understanding of arithmetic and geometry as well as the learning of problem-solving.
- Substantially more emphasis must be placed on the development of skills in mental arithmetic, estimation and approximation, and substantially less on paper and pencil execution of the arithmetic operation.

- Direct experience with the collection and analysis of data must be provided for in the curriculum to insure that every student becomes familiar with these important processes.
- The traditional component of the secondary school curriculum must be streamlined to make room for important new topics; and the content emphases and approaches of courses in algebra, geometry, precalculus, and calculus need to be reexamined in light of new computer technologies.
- Discrete mathematics, statistics and probability, and computer science should now be regarded as "fundamental," and appropriate topics and techniques from these subjects should be introduced into the curriculum.

Thus, recommendations from these major mathematics instruction groups formed the backdrop for changes in instruction in SATEC classrooms.

Students in SATEC classrooms were exposed to a variety of teaching methods relating instruction to real-world situations incorporating the latest state-of-the-art technology. Enrichment and enhancement of standards-based curriculum from the National Council of Teachers of Mathematics (NCTM) with San Antonio Urban Systemic Initiative and Brooks AFB programs was predicted to result in an increase of mathematics achievement. The purpose of this program was for students to develop higher level thinking skills by using modern technology.

In such a classroom, at the end of a concept-unit (i.e., ratio and proportion) teachers were able to follow the National Science Educational Standards by having students create a project to demonstrate their understanding of the concept and relate it to previous knowledge. Students employed available technology to gather, sort, analyze, synthesize and illustrate their understanding of the information in both formal and informal presentations. From such methods, the students gained not only the knowledge of a specific mathematical concept, but also the development of higher order thinking skills. This ability to relate information from one source to concepts learned in the classroom results in students who were able to transfer this knowledge to other disciplines.

Each student had access to a graphing calculator, a pod of six computers loaded with graphical analysis, image processing and analysis software, and probeware to connect to either the computers or calculators. Software was available for spreadsheet-based simulations and analysis. In addition, computer-interfaced probes were available to explore mathematical concepts. Other appropriate equipment was available to print in color and project from the computer monitor to a large screen via an LCD projector.

Hypotheses

This paper presents results for 9th grade students from the year 2001-2002 covering the SATEC effects on student's knowledge of Algebra I and on student attendance rates, effect of teacher's level of SATEC implementation and effect of each schools general level of use of technology-based instruction.

The following hypotheses of SATEC project were tested:

Hypothesis 1: The percent of SATEC curriculum students who pass the Algebra I End-Of-Course Exam will be higher than non-SATEC students.

Hypothesis 2: The average scores of the End-Of-Course (EOC) Algebra I Exam will be higher in SATEC curriculum students than non-SATEC students.

Hypothesis 3: The average course grade in Algebra I course for SATEC curriculum students will be higher than non-SATEC students.

Hypothesis 4: The school attendance rate will be higher for SATEC students when compared to non-SATEC students.

Hypothesis 5: Students enrolled in high SATEC implementation classrooms will have a greater frequency of passing EOC Algebra I exams than those students EOC pass rates who are enrolled in moderate SATEC implementation classrooms.

Hypothesis 6: Students in schools with high levels of technology-based instruction utilization will have greater frequency of passing EOC Algebra I exams than students enrolled at schools with lower levels of technology-based instruction utilizations.

METHODOLOGY

Study Design

A non-randomized comparison group design was used to evaluate the impact of SATEC on student-related outcomes.

Study schools. Six high schools from two different independent school districts (three from District A and three from District B) participated in the SATEC curriculum and were considered SATEC schools. The rest of the high schools in the two school districts were used as comparison schools. This was a convenience sample.

SATEC curriculum instruction. A total of thirty-four (34) 9^{th} grade teachers in SATEC schools volunteered to implement the SATEC curriculum for two semesters in the 2001-2002 school-year. Their classrooms were considered to have SATEC curriculum instruction and designated as SATEC curriculum students. Students who did receive SATEC were designated on Non-SATEC students, including those in a SATEC school but did not receive SATEC curriculum in their classrooms.

<u>Description of Study Sample Selection</u>

Data for this evaluation was provided by the two large school districts in South Texas. The inclusion criteria for data analysis were that students must have records available on their end of course Algebra I Exam, final grade for Algebra I and available attendance records. In addition, students who had missing information that included their gender and their ethnicity, as well as at-risk status for academic failure were excluded from the study. Since students with Asian (1.6%) and Native American (0.1%) ethnic backgrounds were too small, they were not included in data analysis.

Following these criteria, a total of 3,920 9th grade students (2,467 in district A and 1,453 in district B; 2,120 males and 1910 females) were selected for inclusion in evaluation analysis of student performance. Ethnic composition was 9% African American, 61% Hispanics and 30% Anglo. Sixty-three percent were at risk for academic failure. Furthermore, more students in District A were ethnic minority, at-risk for academic failure and scored below the median of 8th grade TAAS math test. Tables 1 and 2 display the details of the study samples.

<u>Study Measures</u>

End of Course (EOC) Exam for Algebra I: The EOC exam was a test developed by Texas Education Agency (TEA) that is administered to all students enrolled in Algebra I classes in the State of Texas. Standardized score is used in this evaluation. A passing score was given to students who answered 70% or more of the questions correctly.

Final grade for Algebra I course: A final grade was given to students who completed two semesters of the Algebra I course. Normally it was the grade average of two semesters. However, this grade was based scores from exams that were developed by teachers from each participating school.

School attendance rate in Algebra I class: This was calculated by number of days attended class divided by the sum of number of days attended class and number of days absent.

TAAS math test score: This was part of the standardized academic skill test developed and administered by Texas Education Agency at 5th, 8th, and 10th grade. It is used to control for difference in student's math ability prior to SATEC curriculum implementation.

At risk index for academic failure: An index created by TEA indicating a student is at increased risk for failing in school due to previous underperformance in school, as well as personal and social obstacles that negatively impact students learning (TEA, 1995).

Quality of SATEC curriculum implementation by each SATEC classroom teacher: Based on classroom observation, SATEC research staff rated teachers who used SATEC curriculum were rated and divided them into three levels:

- none to low: less than 25% of class time involved use of SATEC curriculum and use of technology
- moderate: 26-50% of class time involved use of SATEC curriculum and use of technology
- high: greater than 50% of class time involved use of SATEC curriculum and use of technology

Level of use of technology-based instruction in Algebra I course at each participating school: Based on reported use of technology-based instructional tools, media and curriculum, all schools in the two participating school districts were classified into three categories:

- Unaccepting: Teachers in the math department do not generally use technology in instruction.
- Struggling: Between 40 and 60 percent of the math teachers use technology some of the time in instruction.
- Accepting: A majority of the mathematics teachers regularly use technology in instruction.

<u>Statistical Analysis</u>

Since the study did not use an experimental design, the analyses were devised to test the effects of SATEC curriculum on on student's performance, controlling for student background variables, such as student's gender, ethnicity, and risk for academic failure. Students' scores of TAAS math at 8^{th} grade in all analyses as a way to control for the variations of math ability in students prior to the beginning of the SATEC curriculum implementation were also included.

The outcome variables for this evaluation study were end of course Algebra I Exam, final grade for Algebra I and school attendance rate. Students whose scores were outside of plus and minus 3 standard deviation of end of these outcome variables were excluded from the data analysis. Normality of distribution and homogeneity of variance were checked prior to any proposed analysis. *Listwise* deletion is applied when missing data is encountered in all statistical analyses. Confidence level of statistical significance is set up at 95%. All statistical analyses will be performed with SPSS Release 10 for Windows (SPSS Inc., 2000).

Chi-square test was used to examine the associations between categorical outcome variable (passing vs. not passing EOC exam). In a 2x2 table, continuity corrected Chi-square statistic was used for significance test. Chi-square tests were stratified to examine the effect of potential confounders. The tests were also stratified by student's background variables and TAAS math score to test if they moderate the relationship between SATEC curriculum and student performance.

For continuous outcome variables, a one-way analysis of covariance (ANCOVA) was performed to assess if the SATEC curriculum or level of SATEC implementation had significant influence on outcome variables after adjusting for TAAS math score, gender, ethnicity and at-risk status for academic failure. An estimated marginal means with adjustment for covariates was also provided. Examination of homogeneity of variance indicated that there were significant differences in the variance of EOC Algebra I exam score and final grade for Algebra I between students in school districts A and B. It was then decided to test hypotheses 2, 3 and 4, separately for the two school districts since they had very different composition of student populations as well as resident socio-economic make-up.

RESULTS

Hypothesis 1: The percent of SATEC curriculum students who pass the Algebra I End-Of-Course Exam will be higher than non-SATEC students.

Result of Chi-square test indicated that there was a significantly higher percentage of students passed the EOC test who attended Algebra I class with a SATEC classroom teachers (64%) compared to students not in SATEC classrooms (50%; chi-square(1)= 49.07, $p < .001$). It thus provided support to Hypothesis 1 (see Table 3 in Appendix A).

Stratified analysis by gender (see Table 4 in Appendix A), ethnicity (see Table 5 in Appendix A), at risk status for academic failure (see Table 6 in Appendix A) and TAAS math score (see Table 7 in Appendix A) showed that the relationship between EOC test passing rate and SATEC curriculum remained stable and significant. In general, passing of EOC test was 10-16% higher in students in SATEC classroom.

Hypothesis 2: The average score of the state Algebra I End-Of-Course Exam (EOC) will be higher in SATEC curriculum students than non-SATEC curriculum students.

Table 8 (in Appendix A) displays the mean (M), standard deviation (SD), marginal mean (MM) and standard error (SE) of EOC standardized score, final course grade, and school attendance rate. Results of ANCOVA indicated that SATEC students outperformed non-SATEC students in both school district A ($F(1,1309)= 4.68$, $p<.03$) and school district B ($F(1,2463)= 11.6$, $p<.001$) after adjusting to gender, ethnicity, at-risk status, TAAS math score and school attendance rate (see Table 9 in Appendix A). Estimated marginal means for SATEC students were 38 point higher in district A and 21 points higher in district B than non-SATEC students. Overall, hypothesis 2 was supported by study data.

Hypothesis 3: The average course grade in Algebra I course for SATEC curriculum students will be higher than non-SATEC students.

Students in SATEC teacher classrooms received higher final grades than their counterparts in both school district A ($F(1,1309)= 6.9$, $p<.009$) and school district B ($F(1,2467)=$

11.54, $p<.001$). The results of ANCOVA are displayed in Table 10 in Appendix A. Estimated marginal means of final grades for SATEC students were 3 point higher in district A and 1 point higher in district B than non-SATEC students. Overall, hypothesis 3 was supported by study data.

Hypothesis 4: The school attendance rate will be higher for SATEC curriculum students when compared to non-SATEC students.

No systematic variations were observed in school attendance rate between SATEC and non-SATEC students (see Tables 9 and 11 in Appendix A).

Hypothesis 5: Impact of the quality of SATEC curriculum implementation by SATEC Algebra I teachers on students' passing rates on EOC test.

We also examined the impact of teacher's level of SATEC implementation on passing rates on EOC algebra I course in all SATEC curriculum students. Since there were only 15 students in the low quality level of SATEC implementation, they were excluded from the analysis. Results of chi-square test revealed that high SATEC implementation classrooms (68%) was significantly more likely (chi-square(1)= 25.69, $p<.0001$) than students in moderate level of SATEC implementation classrooms (55%) to passing EOC Algebra I test (see Table 12 in Appendix A).

Hypothesis 6: Impact of the level of technology-based Algebra I instruction in all schools on students' passing rates on EOC Algebra I test.

We finally examined how the school's level of technology-based Algebra I instruction can influence the percentage of students passing EOC Algebra I test. Results of chi-square test found that percent of students passing EOC test was significantly higher (chi-square(2)= 186.35, $p<.0001$) in schools with highest level of use of technology-based instruction (67.8%) than schools with unaccepting (47.4%) or struggling (45%) level. The results are displayed in Table 13 in Appendix A.

SUMMARY

Due to changes in the procedure of student assignments to SATEC curriculum, students were no longer randomly assigned to SATEC classrooms, it was decided to include both demographic variables (i.e., gender, ethnicity, at risk status for academic failure) and school attendance rate as covariates to control for their potential confounding or moderating effects on the project's primary outcome variables. Student scores from 8th grade TAAS, a standardized academic skill test, were collected as a control device to adjust difference in math ability at the beginning of SATEC curriculum since the evaluation design did not include a pre-intervention assessment. It was worthy of noticing that the use of TAAS math score as a covariate to adjust for difference in math ability proved to be very informative and effective since it consistently reached statistical significance and served as a powerful adjustment (see adjusted marginal means in Tables 9, 10 and 11 in Appendix A).

Overall, 5 of the 6 study hypotheses were supported by the data. SATEC students, when compared to non-SATEC students, were more likely to pass EOC Algebra I test, scored significantly higher on EOC Algebra I test, and had higher average Algebra I course grades. Additionally students enrolled in high SATEC implementation classrooms or in schools that had high levels of technology-based instruction had significantly greater frequencies of passing EOC Algebra I exams as compared to students in enrolled in low SATEC implementation classrooms or in schools with low levels of technology-based instruction. School attendance rates were not statistically different between SATEC and non-SATEC students.

Furthermore, two new comparison variables – teacher's level of SATEC implementation and school's level of technology-based Algebra I instruction – showed to be extremely informative in scrutinizing the relationship between SATEC outcome variables and SATEC curriculum and/or technology use in Algebra I instruction.

There was a clear trend in which with highest level of SATEC implementation by teachers or use of technology-based instruction at each school was predictive of better students' performance on EOC Algebra I test. As previously observed, simply placing students in a technology based instructional environment, that did not effectively integrated technology and course content and promote active student participation, would not be sufficient enough to produce enhanced learning. It is believed this information about the levels of implementation and technology use adds to our understanding of the impact of SATEC curriculum and facilitates our effort to develop future technology-rich and technology-intense curriculum.

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Appendix A:

Tables for 2001-2002 SATEC evaluation

Table 1. Demographic information of student population in the evaluation study

School Distric				Student ethnic background			Total
				African American	Hispanics	White	
District A	Student gender	male	Count	58	694	18	770
			% within Student gend	7.5%	90.1%	2.3%	100.0%
		female	Count	52	608	23	683
			% within Student gend	7.6%	89.0%	3.4%	100.0%
	Total		Count	110	1302	41	1453
			% within Student gend	7.6%	89.6%	2.8%	100.0%
District B	Student gender	male	Count	109	529	602	1240
			% within Student gend	8.8%	42.7%	48.5%	100.0%
		female	Count	134	543	550	1227
			% within Student gend	10.9%	44.3%	44.8%	100.0%
	Total		Count	243	1072	1152	2467
			% within Student gend	9.9%	43.5%	46.7%	100.0%

Table 2. At-risk status for academic failure and TAAS math score of students in the evaluation study

School Distric				At-risk for academic failure		Total
				no risk	at risk	
District A	TAAS math scor by median split	below median	Count	93	731	824
			% within TAAS math score by median spl	11.3%	88.7%	100.0%
		above mediar	Count	202	271	473
			% within TAAS math score by median spl	42.7%	57.3%	100.0%
	Total		Count	295	1002	1297
			% within TAAS math score by median spl	22.7%	77.3%	100.0%
District B	TAAS math scor by median split	below median	Count	407	592	999
			% within TAAS math score by median spl	40.7%	59.3%	100.0%
		above mediar	Count	726	742	1468
			% within TAAS math score by median spl	49.5%	50.5%	100.0%
	Total		Count	1133	1334	2467
			% within TAAS math score by median spl	45.9%	54.1%	100.0%

Table 3. Result of Hypothesis 1 test: Percentages of students passing EOC Algebra I exam and SATEC curriculum status

			Passed EOC Algebra I test		Total
			no	yes	
SATEC classroom teacher	non-SATEC teacher	Count	1560	1556	3116
		% within SATEC classroom teacher	50.1%	49.9%	100.0%
	SATEC teacher	Count	289	511	800
		% within SATEC classroom teacher	36.1%	63.9%	100.0%
Total		Count	1849	2067	3916
		% within SATEC classroom teacher	47.2%	52.8%	100.0%

- Chi-square (1) = 49.07, p <.0001

Table 4. Result of Hypothesis 1 test stratified by student's gender: Percentages of students passing EOC Algebra I exam and SATEC curriculum status

				Passed EOC Algebra test		Total
Student gende				no	yes	
male	SATEC classroor teacher	non-SATEC teach	Count	801	774	1575
			% within SATEC classroom teache	50.9%	49.1%	100.0%
		SATEC teacher	Count	159	273	432
			% within SATEC classroom teache	36.8%	63.2%	100.0%
	Total		Count	960	1047	2007
			% within SATEC classroom teache	47.8%	52.2%	100.0%
female	SATEC classroor teacher	non-SATEC teach	Count	759	782	1541
			% within SATEC classroom teache	49.3%	50.7%	100.0%
		SATEC teacher	Count	130	238	368
			% within SATEC classroom teache	35.3%	64.7%	100.0%
	Total		Count	889	1020	1909
			% within SATEC classroom teache	46.6%	53.4%	100.0%

- Chi-square (1) = 26.26, p <.0001 for males
- Chi-square (1) = 22.60, p <.0001 for females

Table 5. Result of Hypothesis 1 test stratified by student's ethnicity: Percentages of students passing EOC Algebra I exam and SATEC curriculum status

Student ethnic background				assed EOC Algebra test		Total
				no	yes	
African Americ	SATEC classroo teacher	non-SATEC teacl	Count	178	101	279
			% within SATEC classroom teache	63.8%	36.2%	100.0%
		SATEC teacher	Count	30	44	74
			% within SATEC classroom teache	40.5%	59.5%	100.0%
	Total		Count	208	145	353
			% within SATEC classroom teache	58.9%	41.1%	100.0%
Hispanics	SATEC classroo teacher	non-SATEC teacl	Count	1120	826	1946
			% within SATEC classroom teache	57.6%	42.4%	100.0%
		SATEC teacher	Count	196	229	425
			% within SATEC classroom teache	46.1%	53.9%	100.0%
	Total		Count	1316	1055	2371
			% within SATEC classroom teache	55.5%	44.5%	100.0%
White	SATEC classroo teacher	non-SATEC teacl	Count	262	629	891
			% within SATEC classroom teache	29.4%	70.6%	100.0%
		SATEC teacher	Count	63	238	301
			% within SATEC classroom teache	20.9%	79.1%	100.0%
	Total		Count	325	867	1192
			% within SATEC classroom teache	27.3%	72.7%	100.0%

- Chi-square (1) = 12.13, p <.0001 for African American students
- Chi-square (1) = 18.01, p <.0001 for Hispanic students
- Chi-square (1) = 7.72, p <.0005 for white students

Table 6. Result of Hypothesis 1 test stratified by student's at risk status for academic failure: Percentages of students passing EOC Algebra I exam and SATEC curriculum status

At-risk for academic failure				Passed EOC Algebra I test: no	Passed EOC Algebra I test: yes	Total
no risk	SATEC classroom teacher	non-SATEC teacher	Count	384	740	1124
			% within SATEC classroom teacher	34.2%	65.8%	100.0%
		SATEC teacher	Count	64	267	331
			% within SATEC classroom teacher	19.3%	80.7%	100.0%
	Total		Count	448	1007	1455
			% within SATEC classroom teacher	30.8%	69.2%	100.0%
at risk	SATEC classroom teacher	non-SATEC teacher	Count	1176	816	1992
			% within SATEC classroom teacher	59.0%	41.0%	100.0%
		SATEC teacher	Count	225	244	469
			% within SATEC classroom teacher	48.0%	52.0%	100.0%
	Total		Count	1401	1060	2461
			% within SATEC classroom teacher	56.9%	43.1%	100.0%

- Chi-square (1) = 25.69, p <.0001 for no at risk students
- Chi-square (1) = 18.50, p <.0001 for at risk students

Table 7. Result of Hypothesis 1 test stratified by student's median level of TAAS math score: Percentages of students passing EOC Algebra I exam and SATEC curriculum status

TAAS math score by median split				Passed EOC Algebra I test: no	Passed EOC Algebra I test: yes	Total
below median	SATEC classroom teacher	non-SATEC teacher	Count	999	456	1455
			% within SATEC classroom teacher	68.7%	31.3%	100.0%
		SATEC teacher	Count	197	167	364
			% within SATEC classroom teacher	54.1%	45.9%	100.0%
	Total		Count	1196	623	1819
			% within SATEC classroom teacher	65.8%	34.2%	100.0%
above median	SATEC classroom teacher	non-SATEC teacher	Count	434	1088	1522
			% within SATEC classroom teacher	28.5%	71.5%	100.0%
		SATEC teacher	Count	76	343	419
			% within SATEC classroom teacher	18.1%	81.9%	100.0%
	Total		Count	510	1431	1941
			% within SATEC classroom teacher	26.3%	73.7%	100.0%

- Chi-square (1) = 26.68, p <.0001 for below TAAS median score students
- Chi-square (1) = 17,73, p <.0001 for above TAAS median score students

Table 8. Mean (M), standard deviation (SD), marginal mean (MM) and standard error (SE) of EOC standardized score, Final course grade, School attendance rate, and group comparisons# in two school districts.

District A		EOC standardized score				Final course grade				School attendance rate (%)			
SATEC curriculum	N	M	SD	MM*	SE	M	SD	MM*	SE	M	SD	MM**	SE
Non-SATEC students	1199	1,408	193.41	1,402	11.55	78	11.89	79	0.66	96	3.81	96	0.25
SATEC-students	110	1,419	156.90	1,440	20.13	78	9.15	82	1.15	95	4.12	95	0.44
Total	1309	1,409	190.59	1,421	13.88	78	11.68	81	0.79	96	3.84	95	0.30
District B													
Non-SATEC students	1779	1,501	151.61	1,494	4.02	75	11.86	75	0.30	96	4.04	96	0.11
SATEC-students	688	1,519	151.07	1,515	5.75	76	11.46	76	0.43	95	3.80	96	0.16
Total	2467	1,506	151.64	1,504	3.84	75	11.76	75	0.28	96	3.97	96	0.11

* Estimated marginal mean adjusted to TAAS math score (Mean=76.6 for District A and Mean=70.4 for District B) and school attendance (Mean=95.6% for District A and Mean=95.5% for District B); ** Estimated marginal mean adjusted to TAAS math score (Mean=76.6 for District A and Mean=70.4 for District B)

Table 9. Statistics for analysis of covariance for Hypothesis 2

Dependent Variable: End of course Algebra I test standaridized score

School Distric	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
District A	Corrected Model	889480.371[a]	7	127068.624	37.007	.000
	Intercept	143843.478	1	143843.478	4.723	.030
	Gender	171973.673	1	171973.673	5.647	.018
	Ethnicity	37972.585	2	18986.293	.623	.536
	At risk status	35597.657	1	35597.657	1.169	.280
	SATEC classroom	142645.647	1	142645.647	4.684	.031
	School attendance rate	380208.075	1	3380208.075	110.989	.000
	TAAS math score	686757.131	1	2686757.131	88.219	.000
	Error	39622523.6	1301	30455.437		
	Total	2645734800	1309			
	Corrected Total	47512004.0	1308			
District B	Corrected Model	990522.960[b]	7	1284360.423	66.213	.000
	Intercept	936086.435	1	936086.435	48.259	.000
	Gender	17881.294	1	17881.294	.922	.337
	Ethnicity	477004.642	2	238502.321	12.296	.000
	At risk status	997203.898	1	1997203.898	102.963	.000
	SATEC classroom	225039.372	1	225039.372	11.602	.001
	School attendance rate	847030.993	1	3847030.993	198.328	.000
	TAAS math score	612204.114	1	1612204.114	83.115	.000
	Error	47620444.0	2455	19397.330		
	Total	5645289900	2463			
	Corrected Total	56610967.0	2462			

a. R Squared = .166 (Adjusted R Squared = .162)

b. R Squared = .159 (Adjusted R Squared = .156)

Table 10. Statistics for analysis of covariance for Hypothesis 3

Dependent Variable: Algebra I final grade

School Distric	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
District A	Corrected Model	49515.114[a]	7	7073.588	71.311	.000
	Intercept	4648.152	1	4648.152	46.859	.000
	Gender	511.923	1	511.923	5.161	.023
	Ethnicity	3505.203	2	1752.601	17.668	.000
	At risk status	551.265	1	551.265	5.557	.019
	SATEC classroom	684.082	1	684.082	6.896	.009
	School attendance rate	18501.967	1	18501.967	186.523	.000
	TAAS math score	19485.069	1	19485.069	196.434	.000
	Error	129051.642	1301	99.194		
	Total	101392.000	1309			
	Corrected Total	178566.756	1308			
District B	Corrected Model	78528.415[b]	7	11218.345	105.063	.000
	Intercept	611.024	1	611.024	5.722	.017
	Gender	2304.742	1	2304.742	21.585	.000
	Ethnicity	3027.989	2	1513.994	14.179	.000
	At risk status	23327.074	1	23327.074	218.466	.000
	SATEC classroom	1231.845	1	1231.845	11.537	.001
	School attendance rate	27538.346	1	27538.346	257.906	.000
	TAAS math score	14373.275	1	14373.275	134.610	.000
	Error	262564.325	2459	106.777		
	Total	14319628.3	2467			
	Corrected Total	341092.740	2466			

a. R Squared = .277 (Adjusted R Squared = .273)

b. R Squared = .230 (Adjusted R Squared = .228)

Table 11. Statistics for analysis of covariance for Hypothesis 4

Dependent Variable: ATTNRATE Attendance rate

DISTRICT School Dis	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
1.00 District A	Corrected Model	614.944[a]	6	102.491	7.146	.000
	Intercept	123579.769	1	123579.769	3616.220	.000
	Gender	271.585	1	271.585	18.935	.000
	Ethnicity	15.934	2	7.967	.555	.574
	At risk status	21.050	1	21.050	1.468	.226
	SATEC classroom	34.527	1	34.527	2.407	.121
	TAAS math score	154.528	1	154.528	10.774	.001
	Error	18674.181	1302	14.343		
	Total	11974720.5	1309			
	Corrected Total	19289.125	1308			
2.00 District B	Corrected Model	1280.735[b]	6	213.456	13.952	.000
	Intercept	052867.583	1	052867.583	199547.0	.000
	Gender	313.894	1	313.894	20.517	.000
	Ethnicity	378.213	2	189.106	12.361	.000
	At risk status	221.440	1	221.440	14.474	.000
	SATEC classroom	2.121	1	2.121	.139	.710
	TAAS math score	374.798	1	374.798	24.498	.000
	Error	37635.514	2460	15.299		
	Total	22558621.0	2467			
	Corrected Total	38916.249	2466			

a. R Squared = .032 (Adjusted R Squared = .027)

b. R Squared = .033 (Adjusted R Squared = .031)

Table 12. Quality of SATEC curriculum implementation by SATEC Algebra I teachers and its impacted EOC Algebra I test

			Passed EOC Algebra I test		
			no	yes	Total
Teacher's level of SATEC implementation	moderate	Count	113	136	249
		% within Teacher's level of SATEC implementation	45.4%	54.6%	100.0%
	high	Count	176	375	551
		% within Teacher's level of SATEC implementation	31.9%	68.1%	100.0%
Total		Count	289	511	800
		% within Teacher's level of SATEC implementation	36.1%	63.9%	100.0%

- **Chi-square (1) = 25.69, p <.0001**

Table 13. Level of technology-based Algebra instruction at each school and its impact on EOC Algebra I test

			Passed EOC Algebra I test		
			no	yes	Total
School's level of technology implmenetation	unaccepting	Count	345	311	656
		% within School's level of technology implmenetation	52.6%	47.4%	100.0%
	struggling	Count	1119	914	2033
		% within School's level of technology implmenetation	55.0%	45.0%	100.0%
	accepting	Count	383	842	1225
		% within School's level of technology implmenetation	31.3%	68.7%	100.0%
Total		Count	1847	2067	3914
		% within School's level of technology implmenetation	47.2%	52.8%	100.0%

- **Chi-square (2) = 186.35, p <.0001**