
Evaluation Report

**Scope, Sequence & Coordination:
10th Grade Science**

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ACKNOWLEDGMENTS

The evaluation of SS&C would not have been possible without the effort of many people. We'd like to thank the SS&C site directors and the classroom science teachers for all their support. We'd also like to thank the students at the University of Minnesota who helped conduct this evaluation including: Mark Minger, Dan Mugge, Jennifer Robey, and Charles Jensen. Finally, we'd like to thank Dr. Wayne Welch for his thoughtful advice on this evaluation.

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I. EXECUTIVE SUMMARY

The purpose of this evaluation was to ascertain the effectiveness of the SS&C project on tenth grade student achievement of the National Science Education Standards (NRC, 1996). To accomplish this task a time lag, post-test only design was utilized in which the perceptions and performance of students studying science using current approaches (the 10th grade students in the 1995-96 school year) were compared with those of the students studying SS&C (the 10th grade students in the 1996-97 school year). Ninth grade evaluation results are available in a separate report.

The psycho-social environment of the comparison and SS&C classes was described using student self reported perceptions from interviews and surveys, teacher interviews and surveys, principal interviews, and classroom observations. All of these data showed very strong and consistent evidence that the SS&C classes were more inquiry-oriented and more hands-on than the comparison classes. There were two significant differences on the six scale Learning Environment Inventory: 1) SS&C classes included more open-ended experiments than comparison classes, and 2) SS&C classes were more likely to use an inquiry-oriented sequence where they did hands-on activities before lectures. There were numerous significant differences favoring SS&C on the type of activities used in classes. For example, students in SS&C reported that they did more experimenting with other students, sharing results of experiments, and interpreting data. The differences indicated that the SS&C project helped create a learning environment that was aligned with the type of classroom learning environment recommended by the NRC standards.

Student attitude and motivation toward science was measured using student surveys. Students in SS&C classes were similar to students in comparison classes in their attitudes and beliefs about their science class and in their tendency to engage in science related activities outside of class. SS&C students reported that they were more likely to take a science class in 11th grade than were comparison students. This difference, however, appears to be primarily due to a change in school policy at one of the schools.

Student achievement of the NRC content standards was assessed with both paper and pencil and hands-on performance tests. The paper and pencil test included both open-ended and multiple choice items, while performance tests included five lab stations and a

full investigation. The students in the SS&C and comparison classes performed equally well on all measures of science achievement.

The data were analyzed by school and sex to determine if the SS&C project differentially affected these sub-groups of students. On the analysis of the learning environment by school five of the eleven schools had learning environment differences favoring SS&C students, two schools had differences favoring comparison students, one school had mixed results, and three schools had no change. These results suggest that while most SS&C classes aligned their learning environments with the NRC Standards, there were varying degrees of change. The overall finding of no difference in achievement was generally true across schools, although there were a few individual differences. Considering all the achievement measures across the eleven participating schools, only eight differences between the students in the SS&C and comparison classes were found. The SS&C students at six schools had scores on one of the achievement measures that were significantly higher than the students in the comparison classes. Comparison students at two schools had scores on one of the achievement measures that were significantly higher than students in the SS&C classes. There were differences in the way boys and girls perceived the environment in the SS&C and comparison classes, but there were no differences in achievement measures in the SS&C and comparison classes by sex.

In summary, the SS&C project had a substantial effect on the learning environment in participating science classes, creating environments more consistent with the NRC standards. SS&C and comparison classes scored equally well on all measures of science achievement, suggesting that SS&C is as effective as traditional science teaching in meeting the NRC Standards.

II. INTRODUCTION

Scope, Sequence & Coordination (SS&C) is a national teacher enhancement and curriculum development project committed to developing activities that help students become more scientifically literate as defined by the National Science Education Standards (NRC, 1996). The SS&C project is guided by the following principles: 1) every student should study every science subject every year, 2) science should explicitly take into account students' prior knowledge and experience, 3) students should be provided with a sequence of content from concrete experiences and descriptive expression to abstract symbolism and quantitative expression, 4) concepts, principles, and theories should be revisited at successively higher levels of abstraction, and 5) learning should be coordinated in the four science subjects so as to interrelate basic concepts and principles. SS&C was funded by the National Science Foundation to develop and implement the second year of a four year set of activities and this evaluation was designed to document the effect of the SS&C project in relation to the NRC standards. (Grade 9 results are available in a separate evaluation report.)

The evaluation used a post-test only, quasi-experimental design. In this approach the performance of 10th grade students who received the treatment (in this case the SS&C activities) was compared to the performance of 10th grade students who did not receive the treatment. The comparison group was 1995-96 school year students in the same schools as those students who received the SS&C activities in 1996-97. In essence, it was a time-lag design where the prior year's tenth grade science students were compared to the present year's tenth grade science students.

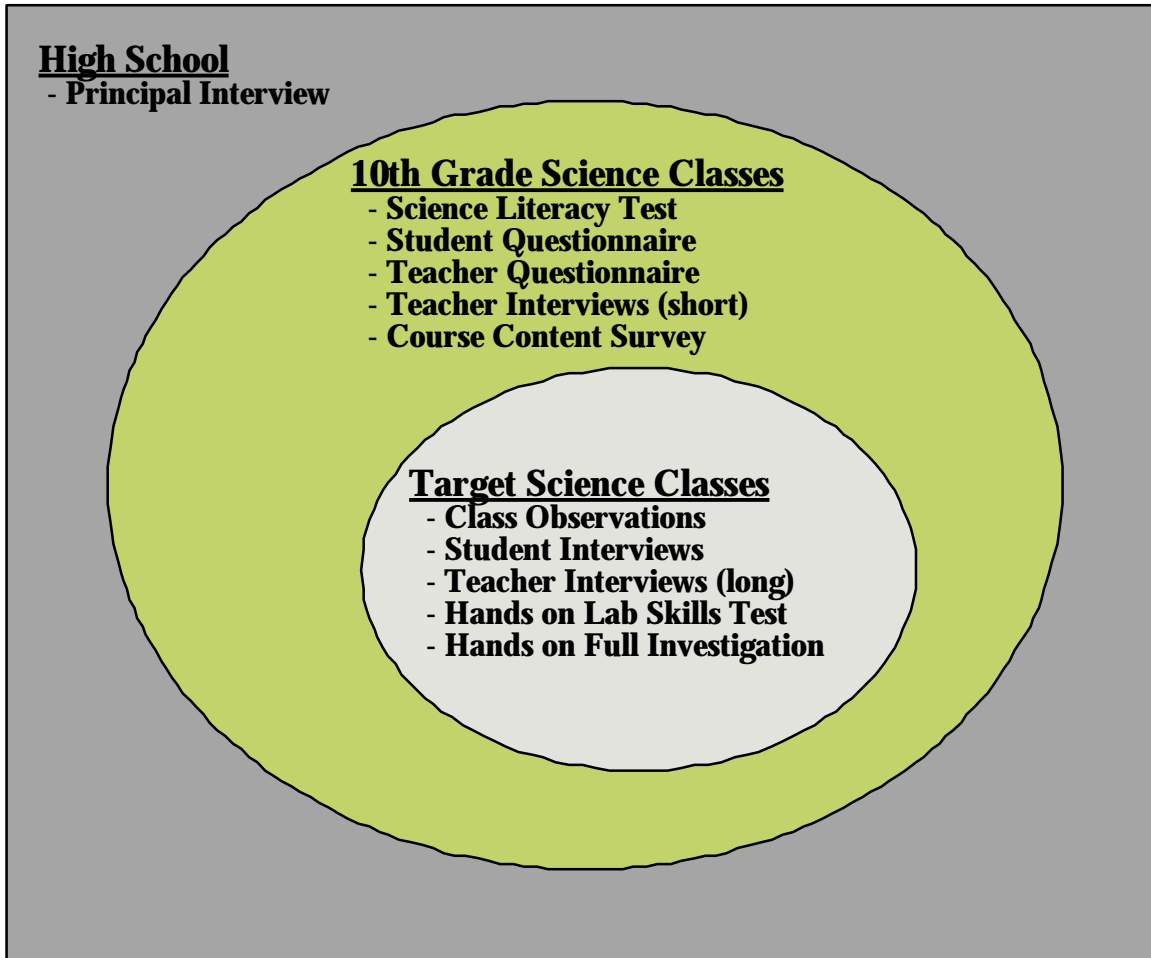
Eleven high schools were included in the evaluation. They were selected to be representative of the diversity in the US in terms of geographic areas, population and race/ethnicity. Three schools were located in Houston, TX; one in Sacramento, CA; one in Riverside, CA; two in a suburban area of IA; one in northeast NC; one in Kalispell, MT; one in White Plains, NY; and one in Washington, DC. Originally, there were thirteen schools in the project, however, one school decided not to participate and another school was dropped from the evaluation due to lack of student enrollment. There were approximately 25 teachers teaching 10th grade science classes at these schools and over 1,100 students being taught by these teachers each year. Tenth grade science courses at

these schools during the 1995-96 comparison school year were almost all biology courses. There were, however, a variety of scheduling options such as traditional 45 minute daily classes for the entire year, 90 minute block schedules with semester long classes, and 90 minute classes that met every other day.

The same nested data collection design that was used for the 9th grade evaluation was also used for the 10th grade evaluation. Data were gathered at the eleven school sites using ten instruments developed by the evaluation team. Contextual variables were assessed using a classroom observation schedule, principal, teacher and student interview protocols, a teacher questionnaire, a student questionnaire, and a course content survey. Because the major measure of the effectiveness of the SS&C project was student achievement, it was examined from several different perspectives. Students answered multiple choice and open ended science content items, participated in a five station hands-on laboratory skills test and designed and conducted an experiment. Standardized administration and scoring protocols were developed to ensure consistency and objectivity. Descriptions of all assessment instruments, the instrument development process, and the psychometric properties of the instruments are included in Appendix B of the ninth grade evaluation report.

At each school data were collected from all participating tenth grade students and teachers. In addition three tenth grade classes at each school were targeted for more comprehensive data collection. All the data were collected by the evaluation team during site visits, except for the science literacy test and the course content survey which were mailed to the schools near the end of the school year. During spring visits, the school principal and the tenth grade teachers were interviewed, and the three target classes were observed. In addition to the interviews and observations, most of the tenth grade students were given a questionnaire to complete. Those not taking the questionnaire were 6-12 of the students in each target class who were randomly selected to take the performance tests administered by the evaluators. One student from each target class was also interviewed. See Figure 1 for a schematic of the data collection instruments and sources of information.

▲ **Figure 1: Data Collection Instruments and Sources of Information**



As in the ninth grade evaluation, the evaluation team at the University of Minnesota functioned separately from the design and implementation of the SS&C project to maintain objectivity. Evaluators did not provide formative feedback on the design and implementation to project participants and all evaluation data were provided anonymously to project directors. As a further check of validity the evaluation was continuously monitored by a meta-evaluator, Dr. Wayne Welch, an expert in both science education and program evaluation.

Four questions guided the tenth grade SS&C evaluation:

- 1. Is the learning environment in the tenth grade SS&C science classes different from the learning environment in comparison tenth grade science courses?**
- 2. Are tenth grade SS&C students more motivated about science than tenth grade comparison students?**
- 3. Do tenth grade SS&C students have a better understanding of science concepts than tenth grade comparison students?**
- 4. Are there differences between tenth grade SS&C and comparison science classes when data are analyzed by school and sex of the students?**

III. EVALUATION RESULTS

The results of the evaluation are reported in a question and answer format followed by supporting evidence. Numerical results and test statistics are located in the appendix. Statistical differences at $p \leq .05$ level are noted with a single asterisk and differences at $p \leq .01$ level are noted with two asterisks. Although statistical significance is not necessarily equated with practical significance, test statistics were used to help interpret differences between groups whenever possible. Class means were used to analyze student data instead of student means because the treatment (SS&C in this case) was administered by class. Because of the large number of students in this evaluation, using student means could lead to a greater likelihood that small differences would be statistically significant. Using class means provides a more conservative comparison resulting in more confidence that statistical differences are indeed real differences between groups.

Two criteria had to be met before class means were used to analyze student data: 1) there had to be data available from at least four students in the class, and 2) at least four classes had to be available in each group. This meant that class means were used for the overall analyses of the Student Questionnaire, the Science Literacy Test and the Lab Skills Test. Student means were used to analyze student interviews and the Full Investigation Test because less than four students in each class completed these instruments. All analyses by school used student means because there were less than four classes available at some

schools. Some of the analyses by sex also used student means because there were less than four students and/or classes available for these comparisons. The analyses of principal interviews, teacher questionnaires, teacher interviews, class observations, and the course content survey were also all based upon individual responses.

Evaluation Question #1:

Is the learning environment in the tenth grade SS&C science classes different from the learning environment in comparison tenth grade science courses?

Answer to Evaluation Question #1:

The SS&C project had a substantial effect on the classroom learning environments. The results of class observations, student and teacher interviews, and student and teacher questionnaires consistently showed the learning environment in the SS&C classes was aligned with the learning environment recommended by the NRC standards.

■ School Culture & Demographics

The site visits, principal interviews and demographic information all showed that the school conditions during both the 1995-96 and 1996-97 school years were similar, supporting the assumption that the two groups are comparable. No marked differences in the school culture from year to year were observed by the evaluation team during site visits. The interviews with principals at each school showed only one significant change in the school culture or potential problems between the 1995-96 and 1996-97 school years: a lack of student discipline was perceived as more of a problem during the 1996-97 school year than during the 1995-96 school year. There were also no significant changes in the teacher demographics from year to year. See principal interview results in Table 1 and teacher demographic results in Table 2 in the appendix.

Analyses of the student demographic data revealed one significant difference in the characteristics of students. SS&C students had less homework than did comparison students. See Table 3 in the appendix.

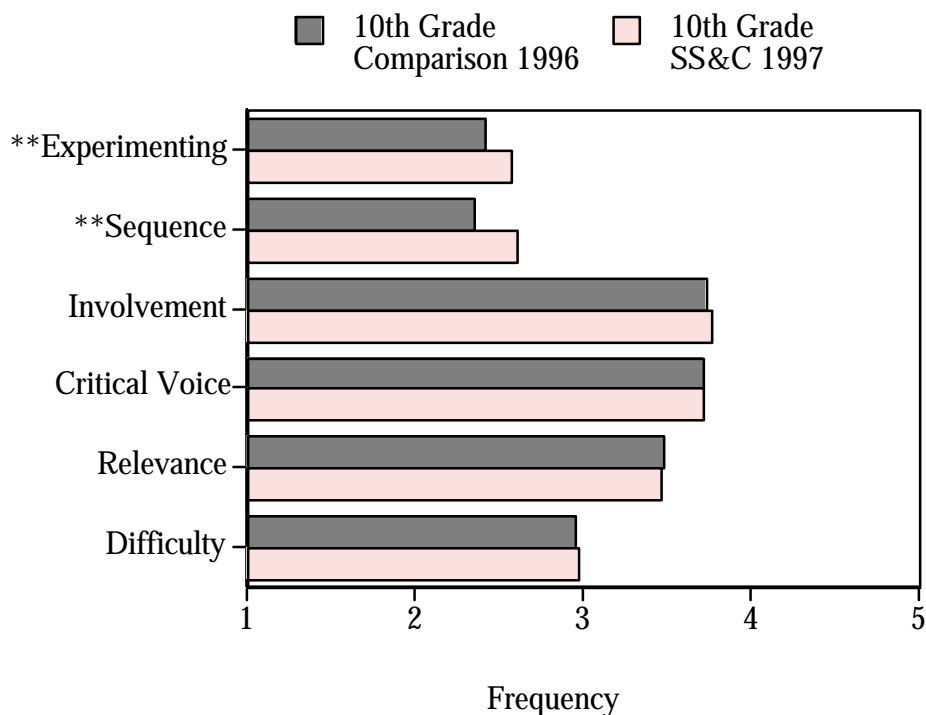
■ Amount of Time Spent Studying Science Topics

Each year teachers were asked to list the topics they covered in their tenth grade science class and to estimate the number of weeks they spent on each topic. In addition, the teachers were given a list of the NRC content standards and asked to specify the number of weeks they spent on each of them. The analyses indicated that there were several differences between the comparison and SS&C classes: The comparison classes spent significantly more time studying biology and measurement topics, while the SS&C classes spent significantly more time studying physics and earth science topics. Both groups spent the same amount of time studying chemistry and societal topics. (See Table 4). The analysis by NRC content standards showed that the comparison classes spent significantly more time studying life science topics. (See Table 5). These results are consistent with the fact that all but two of the tenth grade comparison classes were biology classes (the other two were chemistry classes), while the SS&C classes, on the other hand, used a coordinated approach and studied a variety of science topics throughout the year.

■ Students' Perceptions of the Classroom Learning Environment

The students in both groups completed a 53-item survey designed to measure the classroom learning environment. It included six sub-scales with a total of 37 items that measured various aspects of the psycho-social climate of the science class, and 16 items focused on students' perceptions of class activities. The results showed that students in SS&C classes believed the learning environment had more inquiry-oriented characteristics as recommended in the NRC standards. Significant differences were found on two of the six learning environment scales (See Figure 2). SS&C classes: 1) conducted more open-ended experiments, and 2) were more likely to use an inquiry-oriented sequence where hands-on activities are conducted before lectures. There were no significant differences on the other four scales which measured relevancy of the curriculum, difficulty of the course, students' critical voice (freedom to express opinions), and involvement of students (See Table 6).

▲ **Figure 2: Learning Environment Inventory Results**

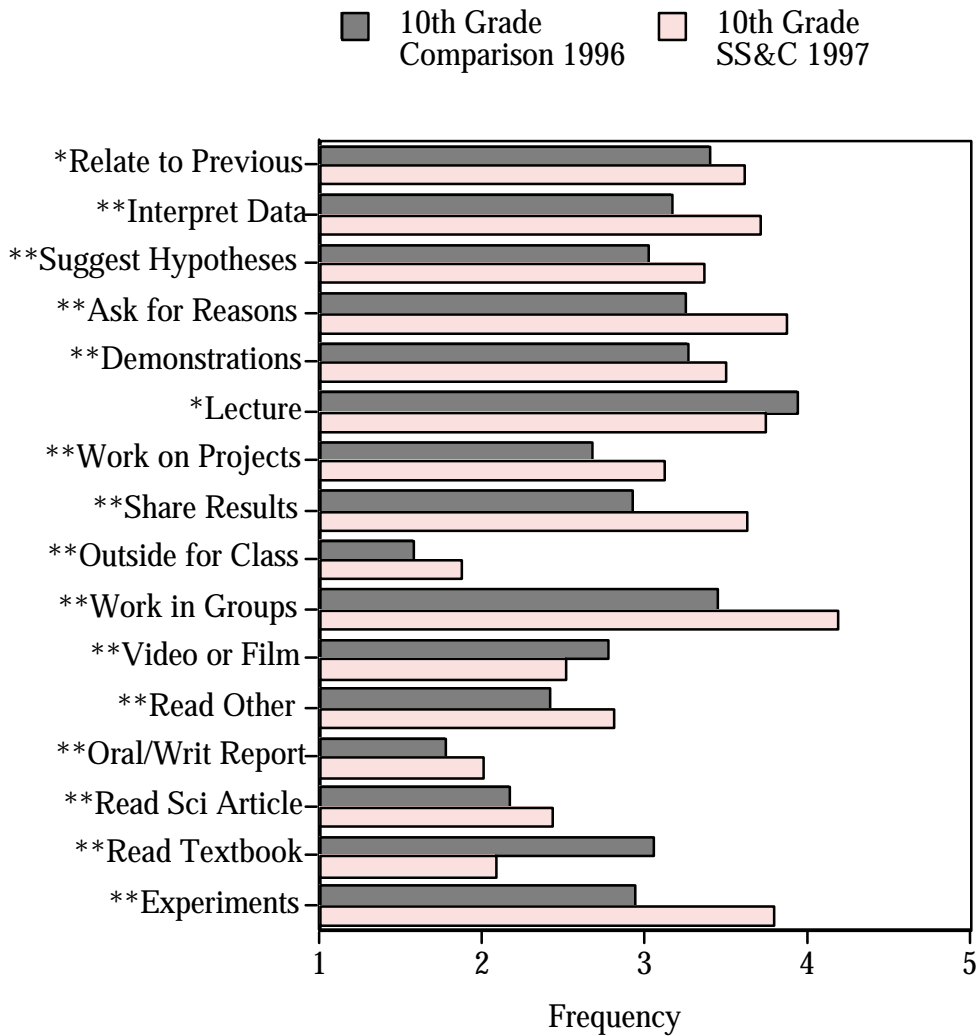


(1=Almost Never 2=Seldom 3=Sometimes 4=Often 5=Almost Always)

* $p \leq .05$ ** $p \leq .01$

There were differences favoring SS&C on all 16 items about class activities (See Figure 3 and Table 7). These results suggest that the SS&C classes were more inquiry-oriented than comparison classes and that the SS&C project significantly changed the characteristics of the instruction in the 10th grade science classes at the participating schools.

▲ **Figure 3: Time Spent on Class Activities**



(1=never 2=< once a wk 3=About once a wk 4=Several times a wk 5=Almost every day)

*p<.05 **p<.01

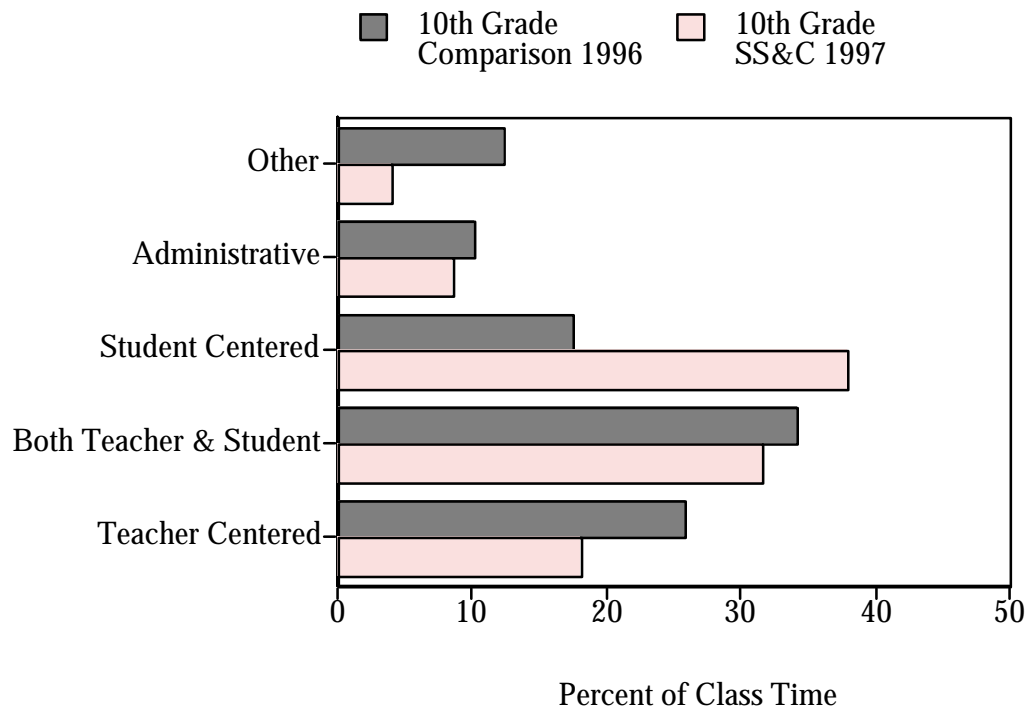
■ Interview, Questionnaire and Observation Results

Student interviews, teacher questionnaires, and class observations all corroborated the student reported learning environment differences between the SS&C group and the comparison group. During interviews, students reported that they found their SS&C science classes less difficult than did students from the comparison classes (See Table 8).

Significant differences between the comparison and SS&C classes were found on ten of the 34 items on the teacher questionnaire. Teachers reported the SS&C students: 1) did more experiments, 2) read less from the textbook, 3) did more science experiments, 4) wrote up more experiments, 5) did more hands-on activities, 6) had fewer lectures, 7) were asked for results of experiments more often, 8) were asked to interpret data more often, 9) had terms defined before hands-on work less often, and 10) were less likely to rely on textbooks. See Table 9. All these differences favor SS&C. Interviews with teachers at each school revealed significant differences between the comparison and SS&C years on course difficulty and student participation. Teachers thought the course was less difficult for SS&C students and that the SS&C students participated more in class activities and discussions (see Table 10).

Class observations conducted by the evaluation team confirmed many of the same learning environment differences indicated on the student and teacher questionnaires. The observed class activities were organized into five different categories: teacher-centered, both teacher and student centered, student-centered, administrative, and other. Teacher-centered activities included traditional lectures, teacher controlled textbook work or worksheets; student-centered activities included hands-on activities, experiments, or student group work; while both teacher and student centered activities included activities like demonstrations and discussions that involved shared participation. Administrative included logistic type tasks such as taking attendance, while the “Other” category included activities that did not fit in the above categories such as taking a test. The SS&C classes exhibited a significant shift toward more student-centered and less teacher-centered activities (See Figure 4 and Table 11). Ratings conducted by the observers indicated that the SS&C teachers used more inquiry-oriented activities, while comparison teachers showed greater rapport with students. There were no significant differences in student involvement, critical voice, relevancy, type of lab activity, or the type and number of student and teacher questions (See Table 12).

▲ **Figure 4: Observed Percent Time Spent on Teaching Styles**



Evaluation Question #2:

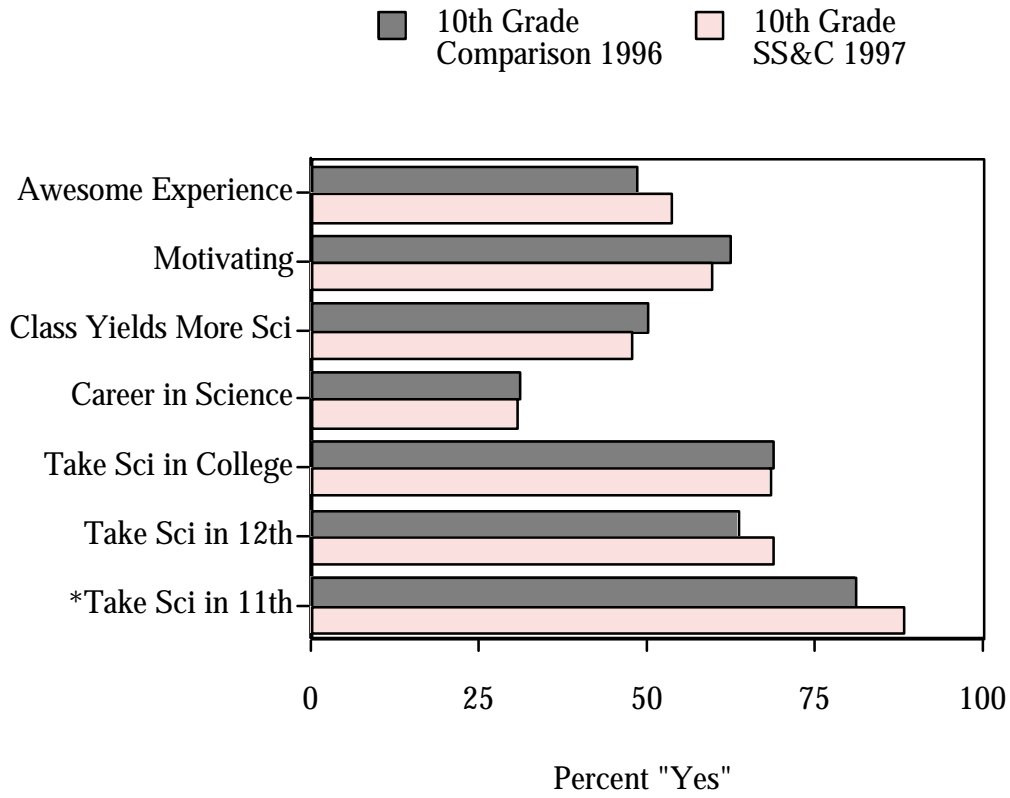
Are tenth grade SS&C students more motivated about science than tenth grade comparison students?

Answer to Evaluation Question #2:

There were no indications that students in SS&C found their classes more motivating than the comparison students. More SS&C students reported that they intend to study science in 11th grade, however, this difference appears to be mostly due to a change in course taking requirements at one school.

On the student questionnaire more SS&C students reported that they plan to take more science classes in 11th grade than comparison group students. This difference appears to be mostly due to the fact that SS&C students in one school were required to take three years of science, while comparison students were required to take only two years of science. There were no differences in the extent to which students found their science class motivating or in their intent to pursue careers in science (See Figure 5 and Table 13). There was one difference in the percent of students who participated in science activities outside of school; a larger percentage of comparison students reported they went bird watching. There were no differences on the other items about activities outside of school (See Table 14). There were also no differences between the two groups in students' responses to the six attitude items. (See Table 15).

▲ **Figure 5: Inclination to Study Science and Science Motivation**



* $p \leq .05$

Evaluation Question #3:

Do tenth grade SS&C students have a better understanding of science concepts than comparison students?

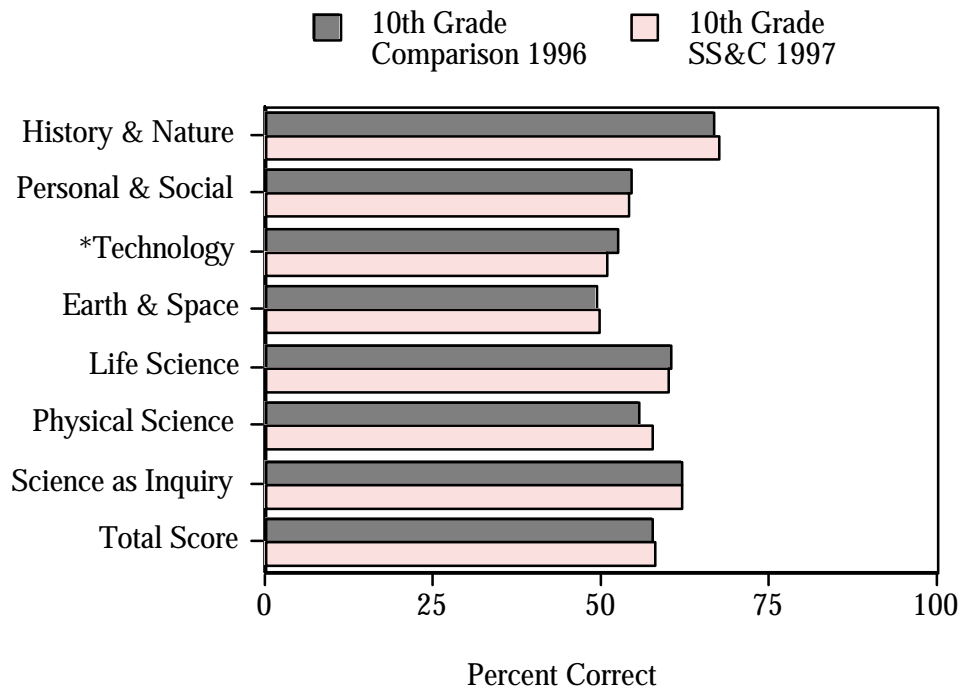
Answer to Evaluation Question #3:

Tenth grade SS&C students performed as well as the comparison students on all measures of science achievement.

■ Science Literacy Test Results

The Scientific Literacy Test included 160 multiple choice and 12 open ended items, all matched to the NRC standards. There were no significant differences between the SS&C and comparison group students on the total score of the multiple-choice items. Only one of the sub-scales matched to the NRC standards showed a significant difference, with comparison students scoring higher than SS&C students on the Technology sub-scale (See Figure 6 and Table 16). There were no significant differences between the two groups on the 12 open-ended items (See Table 17).

▲ Figure 6: Multiple-Choice Results by NRC Standards and Total Score

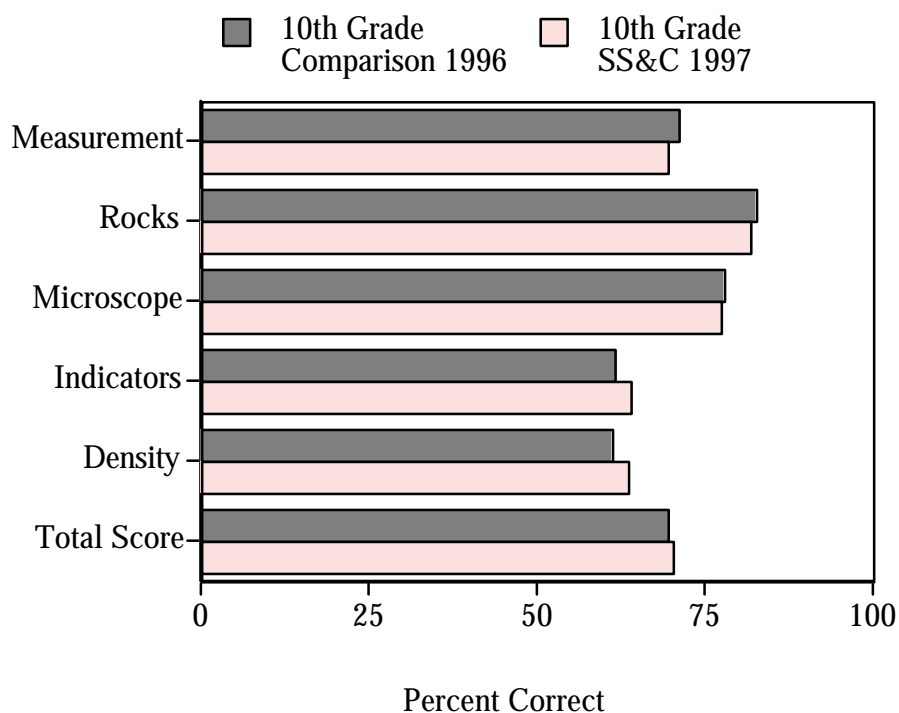


*p<.05

■ Hands On Lab Skills Test Results

A set of five hands-on lab skills stations were administered to a sample of students from both groups. The stations were matched to the NRC standards and focused on measurement, earth science, life science, chemistry and physics, respectively. There were no significant differences between the two groups on any of the stations (See Figure 7 and Table 18).

▲ Figure 7: Hands-On Lab Skills Test by Station and Overall



■ Full Investigation Test Results

A sample of students from both groups completed both hands-on and written versions of the Full Investigation Test. In both versions students were asked to describe in writing and drawing how they would conduct an experiment to determine in which of four environments sowbugs preferred to live. In the hands-on version of the test students actually conducted the experiment with materials, while in the written version students merely wrote about the experiment. There were no significant differences between the two groups on either the hands-on or written versions. These data were analyzed by student because only two students from each class completed the test (see Table 19 and 20).

Evaluation Question #4:

Are there differences between tenth grade SS&C and comparison science classes when data are analyzed by school and sex?

Answer to Evaluation Question #4:

There were differences by school and sex in the classroom learning environment. Of the eleven schools, five schools had learning environment differences favoring SS&C, two schools had differences favoring the comparison classes, three schools had no differences, and one school had mixed differences favoring both SS&C and comparison classes. Both male and female students reported that the SS&C classes had more sequencing than comparison classes, and female students reported that the SS&C classes were less relevant than comparison classes.

The SS&C project had some differential effects on students' science achievement by school but none by sex. On the multiple-choice test, three schools had significant achievement differences favoring SS&C students and two schools had significant differences favoring comparison students. On the open ended items, two schools had significant differences favoring SS&C students. On the lab skills test, one school had significant differences favoring SS&C students.

RESULTS BY SCHOOL

All of the results by school were analyzed using student means rather than class means because of the small number of classes available at some schools. This increases the chances of finding a significant differences as compared to using class means.

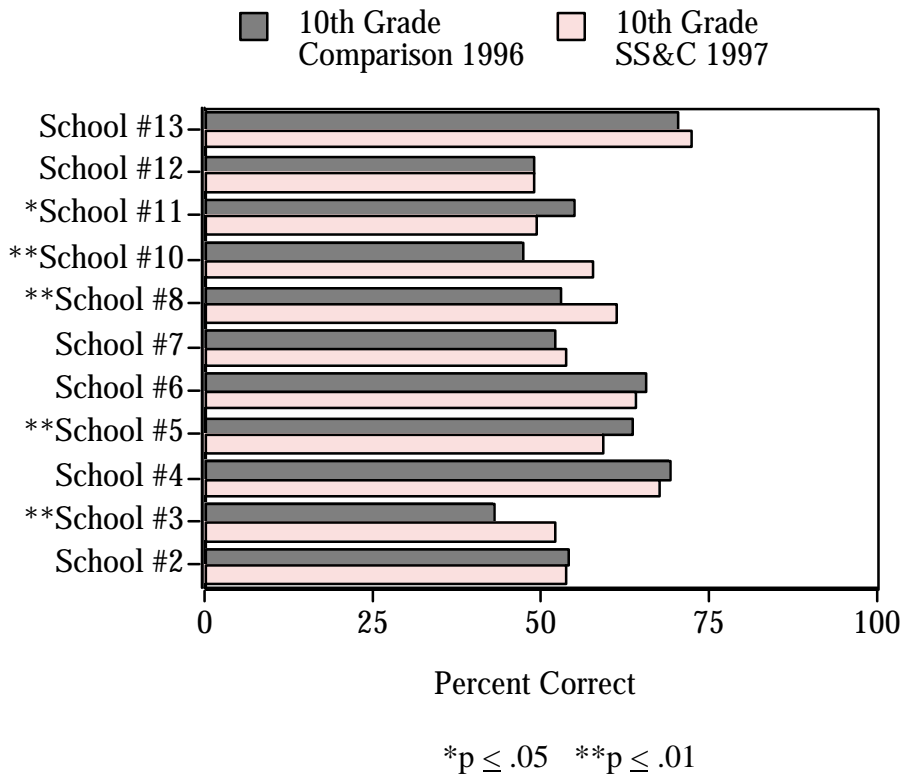
■ Learning Environment Results by School

There were significant differences favoring SS&C in learning environments at five out of eleven schools. At two out of eleven schools, there were significant differences favoring the comparison schools. Three of the eleven schools had no differences between groups, and one schools had mixed results with significant differences favoring both SS&C and comparison classes. These results suggest that most schools had favorable learning environment changes, however, there were schools with varying degrees of learning environment changes (See Table 21).

■ Multiple Choice Results by School

Five of the 11 schools had significant differences on the multiple-choice items (See Figure 8). The SS&C students at three schools scored significantly higher than comparison students, while at two schools the comparison students scored higher than SS&C students (See Table 22).

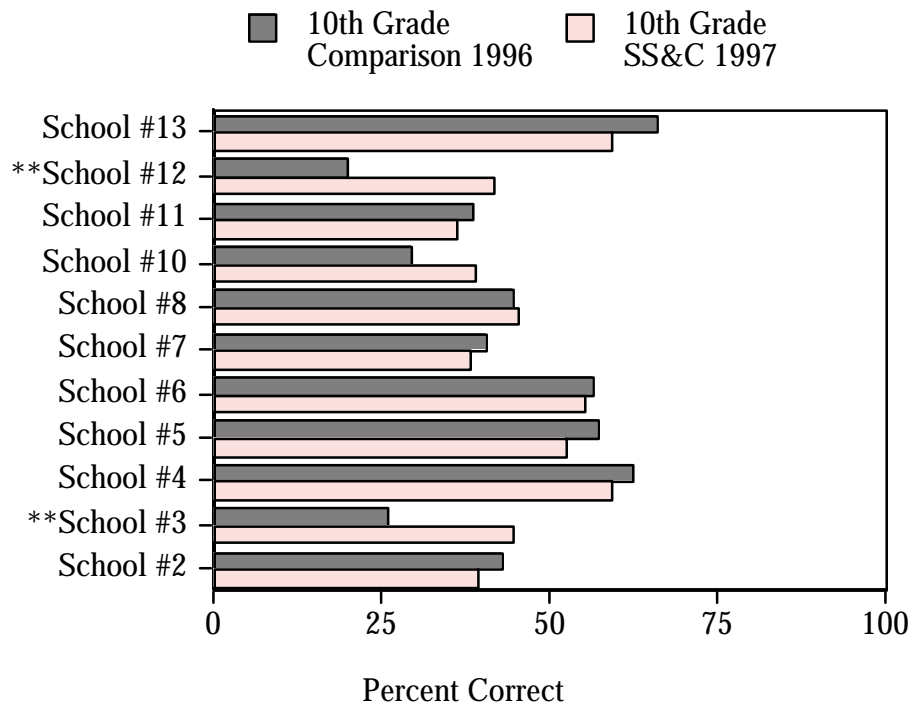
▲ Figure 8: Multiple Choice Total Score by School



■ **Open Ended Results by School**

There were significant differences on the open-ended items at 2 of the 11 schools (See Figure 9). At both schools the SS&C students had significantly higher scores than the comparison classes (See Table 23).

▲ **Figure 9: Open Ended Total Score by School**

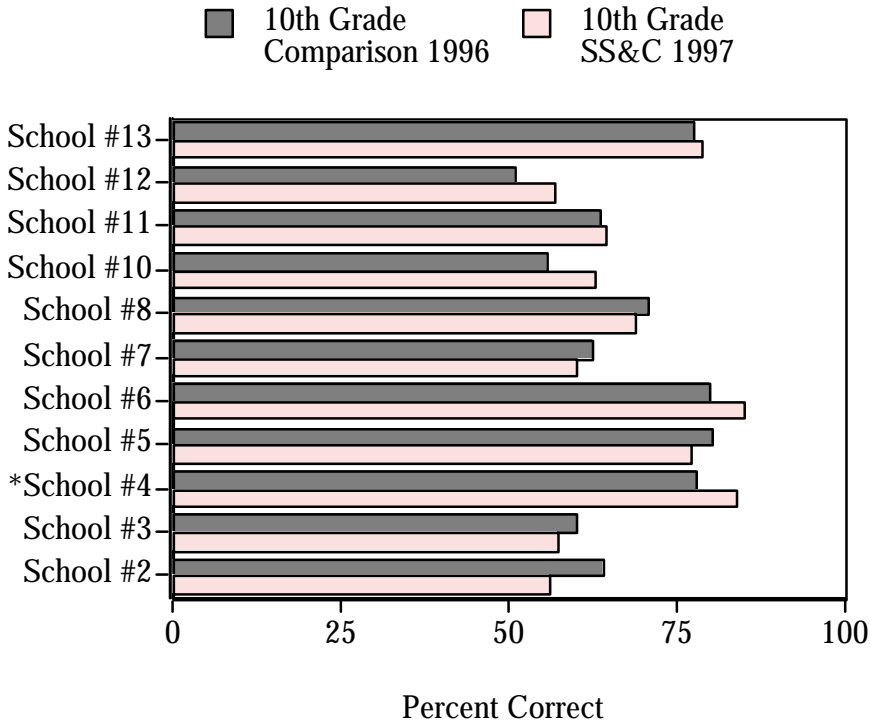


* $p \leq .05$ ** $p \leq .01$

■ **Lab Skills Test Results by School**

There were significant differences on the Lab Skills Test at one of the schools, favoring the SS&C students (See Figure 10 and Table 24). The Full Investigation Test was not analyzed by school because of the small numbers of students at each school who took the test.

▲ **Figure 10: Hands-On Lab Skills Test Total Score by School**



* $p \leq .05$ ** $p \leq .01$

RESULTS BY SEX OF STUDENTS

The results by sex were analyzed using either class or student means, depending upon the sample size. Class means were used when there were at least four classes in each group that had at least four female and four male students. If these criteria were not met, student means were used. Because of these criteria, the sample sizes for the analyses by sex are slightly smaller than the overall analyses. Class means were used to analyze the learning environment inventory and the science literacy test. Student means were used to analyze the open-ended items, the lab skills test, and the full investigation tests.

■ Learning Environment Results

There were significant differences on the Learning Environment Inventory between SS&C and comparison classes when analyzed by sex of the students. Both male and female students reported the SS&C classes used a more inquiry-oriented sequence than comparison classes. Female students reported that the SS&C classes were significantly less relevant, while male students reported no difference in relevancy. (See Table 25).

■ Science Achievement Results

There were no significant differences between SS&C and comparison male and female students' scores on multiple-choice items, open-ended items or the Lab Skills Test (See Table 26 - 28). There were also no differences by sex on the total score of both the hands-on and written versions of the Full Investigation Test (See Table 29 and Table 30).

IV. CONCLUDING REMARKS

The SS&C evaluation design was based on the premise that the learning environment affects student achievement and motivation. That is why classroom observations were conducted and teacher and student opinions of the learning environment were gathered. All indications are that the SS&C project produced substantial changes in the learning environment of participating classrooms, thus achieving the goal of creating a learning environment aligned with the NRC standards. The changes were part of the SS&C project in that the individual lessons required hands-on activities and were designed to create an inquiry-oriented classroom. Furthermore, the teachers were taught about these inquiry-oriented approaches during summer workshops. The data show that the SS&C project, the treatment in this case, was indeed implemented in a consistent manner. The classes were clearly more activity-based and more inquiry-oriented than the classes during the previous year.

While there were differences in the learning environment, student achievement in the two groups was quite similar. It may be that although different learning environments existed, these did not contain all of the elements necessary to promote higher achievement and attitude. Teachers reported that the activities were not always in the best format for instruction and that there was not always strong coherence between the different sets of activities. It is possible that if the tenth grade materials were reviewed and revised based on the feedback from the 1996-97 year, it could affect student achievement as well as the classroom environment. This notion is supported by the differences in achievement at some of the schools.

The differences in achievement suggest that although most schools did change their learning environments, some schools may have changed it in ways that produced more effects on achievement. The site visit information supports the notion that some schools had their own implementation methods. One school, for example, rearranged the activities to fit its own thematic approach. Furthermore, the SS&C activities might be more effective with students in schools that had substantially different types of curricula the prior year.

In summary, the SS&C project had a substantial effect on the learning environment of science classes, creating environments more consistent with the NRC standards. On the other hand, the learning environment differences did not significantly improve students' science achievement. The SS&C students performed as well as the comparison students, suggesting that SS&C is as effective as traditional science teaching in helping students achieve the NRC Standards. Additional analyses are currently being conducted to more closely examine the impact of SS&C at specific schools, and these results will be reported when they become available.

National Research Council (1996). National Science Education Standards. Washington, DC: National Research Council.

Appendix to Evaluation Report

**Scope, Sequence & Coordination:
10th Grade Science**

September, 1997

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Appendix

10th Grade Tables of Results

Introduction

The following tables include the means, standard errors and test statistics for each of the analyses conducted as part of the evaluation of tenth grade SS&C. All analyses used a two-tailed test with statistical significance defined as $p \leq .05$. Although statistical significance is not necessarily equated with practical significance, test statistics were used to help interpret differences between groups. Class means were used to analyze student data instead of student means because the treatment (SS&C in this case) was administered by class. Using class means also provides a more conservative comparison providing more confidence that statistical differences are indeed real differences between groups. Using student means, therefore, provides a less rigorous comparison and leads to a greater likelihood of finding statistically significant differences.

Two criteria had to be met before class means were used to analyze student data: 1) there had to be data available from at least four students in the class, and 2) at least four classes had to be available in each group. This meant that class means were used for the overall analyses of the Student Questionnaire, the Science Literacy Test and the Lab Skills Test. Student means were used to analyze student interviews and the Full Investigation Test because there were less than four students in the classes who completed these instruments. All analyses by school used student means because there were less than four classes available at some schools. Some of the analyses by sex also used student means because there were less than four students and/or classes available for these comparisons. The analyses of principal interviews, teacher questionnaires, teacher interviews, class observations, and the course content survey were also all based upon individual responses.

Table 1
School Principal's Judgments of School Problems
Comparison vs. SS&C

Variable	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 11		n = 11		Δ	t	p
	mean	s.e.	mean	s.e.			
Overcrowded classrooms	2.09	0.31	2.73	0.30	0.63	1.45	.16
Shortage of educational materials	1.82	0.23	2.55	0.34	0.73	1.78	.10
Student absenteeism	2.27	0.38	2.73	0.30	0.45	0.93	.36
Lack of student discipline	1.82	0.23	3.09	0.21	1.27	4.11	<.01

1 = Not a problem, 2 = Minor problem, 3 = Moderate problem, 4 = Serious problem

Table 2
Demographics of Teachers in SS&C and Comparison Classes

Variable	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
<i>Values</i>	max n = 25		max n = 28		X ²	p	
	freq	%	freq	%			
Gender					0.38	.54	
<i>Male</i>	14	56.0	18	64.3			
<i>Female</i>	11	44.0	10	35.7			
Race					1.16	.56	
<i>Asian</i>	0	0.0	0	0.0			
<i>Hispanic</i>	0	0.0	1	3.7			
<i>African-American</i>	5	20.8	4	14.8			
<i>Caucasian</i>	19	79.2	22	81.5			
	(n = 25)		(n = 28)		Δ	t	p
	mean	s.e.	mean	s.e.			
Years teaching	14.96	1.73	14.07	1.40	-0.89	-0.40	.69
Years teaching science	14.32	1.71	13.57	1.43	-0.75	-0.34	.74
Years at this school	10.44	1.35	9.29	1.21	-1.15	-0.64	.53

Table 3
Demographics of Students in SS&C and Comparison Classes

Item	Tenth Grade Comparison		Tenth Grade SS&C		Statistics			
<i>Values</i>	max n = 1383		max n = 1179		X ²	p		
	freq	%	freq	%				
Gender								
<i>Male</i>	671	48.5	571	48.5	0.00	.98		
<i>Female</i>	712	51.5	607	51.5				
Race								
<i>White</i>	710	52.4	593	51.6	6.65	.35		
<i>Black</i>	245	18.1	231	20.1				
<i>Hispanic</i>	255	18.8	198	17.2				
<i>Asian/ Pacific Islander</i>	76	5.6	67	5.8				
<i>American Indian /Alaska Native</i>	36	2.7	22	1.9				
<i>Other</i>	32	2.4	38	3.3				
Grades								
<i>A</i>	156	11.3	142	12.0			5.22	.63
<i>A and B</i>	287	20.8	269	22.8				
<i>B</i>	230	16.7	190	16.1				
<i>B and C</i>	365	26.4	289	24.5				
<i>C</i>	172	12.5	136	11.5				
<i>C and D</i>	126	9.1	103	8.7				
<i>D</i>	24	1.7	25	2.1				
<i>Below D</i>	20	1.4	25	2.1				
Time spent on homework								
<i>No homework assigned</i>	352	25.6	510	43.4	94.51	.00		
<i>Doesn't do homework</i>	137	10.0	102	8.7				
<i>1/2 hour or less</i>	588	42.8	388	33.0				
<i>1 hour</i>	233	17.0	125	10.6				
<i>2 hours</i>	40	2.9	30	2.6				
<i>More than 2 hours</i>	23	1.7	21	1.8				

Table 3: Demographics of Students in SS&C and Comparison Classes (continued)

Item	Tenth Grade Comparison		Tenth Grade SS&C		Statistics	
<i>Values</i>	max n = 1383		max n = 1179		X ²	p
	freq	%	freq	%		
How far did your mother go in school?						
<i>Did not finish high school</i>	184	13.4	157	13.4		
<i>High School</i>	301	22.0	258	22.1		
<i>Some education after high school</i>	283	20.6	242	20.7		
<i>College Grad</i>	399	29.1	341	29.1		
<i>Doesn't know</i>	204	14.9	172	14.7	0.02	.99
How far did your father go in school?						
<i>Did not finish high school</i>						
<i>High School</i>	152	11.1	131	11.2		
<i>Some education after high school</i>	252	18.4	222	18.9		
<i>College Grad</i>	245	17.9	212	18.1		
<i>Doesn't know</i>	436	31.8	345	29.4		
	285	20.8	262	22.4	2.00	.74
Is a language other than English spoken at home?						
<i>Yes</i>	359	26.1	311	26.4		
<i>No</i>	1019	73.6	868	73.6	0.03	.85
Are you a special education student?						
<i>Yes</i>	68	4.9	74	6.3		
<i>No</i>	1308	95.1	1104	93.7	2.17	.14

Table 4
Mean Number of Weeks Classes Taught Science Topics

Topic	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 10 weeks	s.e.	n = 10 weeks	s.e.	Δ	t	p
Chemistry	3.52	2.13	5.31	1.30	1.79	0.72	.48
Biology	26.91	4.16	10.36	1.92	-16.55	-3.62	<.01
Earth and Space	1.10	0.99	4.07	0.79	2.97	2.34	.03
Physics	0.20	0.20	6.28	0.83	6.08	7.13	<.01
Measurement	1.14	0.47	0.12	0.12	-1.02	-2.12	.05
Science & Society	0.76	0.42	11.79	8.77	11.04	1.26	.23
Miscellaneous	0.30	0.21	1.12	0.99	0.82	0.80	.43

*Note: School # 11 was not included because they did not complete the survey

Table 5
Mean Number of Weeks Classes Taught NRC Standards

NRC Science Standard	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 10 weeks	s.e.	n = 10 weeks	s.e.	Δ	t	p
Physical Science	4.56	1.58	8.07	1.18	3.51	1.78	.09
Life Science	15.53	2.01	9.43	1.46	-6.10	-2.45	.03
Earth and Space Science	1.72	0.46	2.04	0.38	0.32	0.55	.59
Science and Technology	0.68	0.29	1.13	0.67	0.45	0.62	.54
Science in Personal and Social Perspective	0.76	0.38	0.74	0.48	-0.02	-0.03	.98
Science as Inquiry	2.28	0.46	4.43	1.79	2.15	1.17	.26
History and Nature of Science	0.78	0.30	2.03	0.97	1.25	1.24	.23

*Note: School # 11 was not included because they did not complete the survey

Table 6
Learning Environment Inventory Results
 All Schools - Class Means

Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 79		n = 68		Δ	t	p
	mean	s.e.	mean	s.e.			
Difficulty	2.96	0.03	2.97	0.04	0.01	0.18	.86
Relevance	3.47	0.03	3.46	0.04	-0.01	-0.29	.77
Critical Voice	3.71	0.04	3.72	0.04	0.01	0.28	.78
Involvement	3.73	0.03	3.76	0.03	0.03	0.68	.50
Sequence	2.35	0.04	2.60	0.05	0.25	3.84	<.01
Experimenting	2.42	0.04	2.57	0.04	0.15	2.62	.01

1 = Almost Never, 2 = Seldom, 3 = Sometimes, 4 = Often, 5 = Almost Always.

Table 7
Student Questionnaire
Frequency of Class Activities in SS&C and Comparison Classes

Activity	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 79 mean	s.e.	n = 68 mean	s.e.	Δ	t	p
Do experiments with other students	2.93	0.07	3.79	0.08	0.85	8.44	<.01
Read science textbook	3.05	0.08	2.08	0.10	-0.97	8.11	<.01
Read articles on science	2.16	0.06	2.43	0.06	0.27	3.01	<.01
Do oral or written reports	1.77	0.05	2.00	0.06	0.22	2.82	<.01
Read other science materials	2.41	0.06	2.81	0.07	0.39	4.18	<.01
Watch films, slides, or videos	2.77	0.07	2.51	0.07	-0.27	-2.75	<.01
Work in groups	3.44	0.07	4.18	0.07	0.74	7.61	<.01
Go outside for classroom instruction	1.58	0.05	1.87	0.04	0.29	4.21	<.01
Share results from experiments	2.91	0.05	3.62	0.06	0.71	8.88	<.01
Work on projects	2.67	0.06	3.12	0.07	0.46	5.30	<.01

1 = Never, 2 = Less than once a week, 3 = About once a week,
4 = Several times a week, 5 = Almost every day.

Table 7: Student Questionnaire - Frequency of Class Activities (continued)

Teaching Strategy	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 79 mean	s.e.	n = 68 mean	s.e.	Δ	t	p
Lecture	3.93	0.06	3.74	0.07	-0.19	-2.23	.03
Demonstration of a scientific principle	3.27	0.06	3.49	0.05	0.22	2.76	<.01
Ask for reasons for the results of experiments	3.24	0.06	3.87	0.05	0.63	7.85	<.01
Ask students to suggest hypotheses	3.01	0.06	3.36	0.06	0.35	4.26	<.01
Ask students to interpret data	3.16	0.06	3.70	0.05	0.54	7.24	<.01
Relate previous work to current topics	3.40	0.05	3.60	0.05	0.20	2.76	<.01

1 = Never, 2 = Less than once a week, 3 = About once a week,
4 = Several times a week, 5 = Almost every day.

Table 8
Students' Responses to Interview Questions

Item	Tenth grade Comparison		Tenth Grade SS&C		Statistics	
<i>Values</i>	max n = 38		max n = 26		X ²	p
	freq	%	freq	%		
Do you like your science class?						
<i>A lot</i>	19	50.0	19	73.1	3.72	.16
<i>Some</i>	18	47.4	7	26.9		
<i>None</i>	1	2.6	0	0.0		
Do you feel like taking more science classes?						
<i>Yes</i>	20	52.6	18	69.2	1.76	.18
<i>No</i>	18	47.4	8	30.8		
Better understanding of world?						
<i>Yes</i>	34	89.5	23	88.5	0.02	.90
<i>No</i>	4	10.5	3	11.5		
Teacher tell you what will happen in an experiment?						
<i>Yes</i>	14	36.8	8	30.8	0.25	.62
<i>No</i>	24	63.2	18	69.2		
Do you decide how to do an experiment?						
<i>Yes</i>	11	28.9	11	42.3	1.22	.27
<i>No</i>	27	71.1	15	57.7		
Involved in class activities?						
<i>A lot</i>	23	60.5	16	61.5	0.01	.94
<i>Some</i>	15	39.5	10	38.5		
<i>None</i>	0	0.0	0	0.0		
Class hard?						
<i>Yes</i>	11	30.6	2	7.7	4.76	.03
<i>No</i>	25	69.4	24	92.3		
Challenge opinions in class?						
<i>Yes</i>	28	75.7	23	88.5	1.62	.20
<i>No</i>	9	24.3	3	11.5		

Table 9
Teachers' Responses to Questionnaire

Variable	Tenth Grade Comparison			Tenth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n	Δ	t	p
1 = Never 2 = Less than once a week 3 = About once a week 4 = Several times a week 5= Almost every day									
Do experiments with other students	3.16	0.16	25	4.14	0.11	28	0.98	5.12	<.01
Read from a science textbook	3.40	0.18	25	2.14	0.16	28	-1.26	-5.20	<.01
Read articles on science	2.60	0.19	25	2.82	0.18	28	0.22	0.85	.40
Do an oral or written report	2.36	0.18	25	2.57	0.21	28	0.21	0.76	.45
Use supplementary reading materials	2.80	0.22	25	2.71	0.14	28	-0.09	-0.34	.74
Discuss a science news event	2.92	0.19	25	2.96	0.13	28	0.04	0.19	.85
Do science experiments	3.21	0.13	24	3.75	0.14	28	0.54	2.74	.01
Design their own experiments	1.87	0.13	23	2.11	0.14	28	0.24	1.22	.23
Do projects for a week or more	1.88	0.09	25	2.04	0.14	28	0.16	0.91	.37
Write up experiments	2.64	0.18	25	3.32	0.23	28	0.68	2.32	.02
Do hands-on activities	3.60	0.15	25	4.36	0.13	28	0.76	3.82	<.01
Complete printed worksheets	3.04	0.20	25	2.50	0.22	28	-0.54	-1.78	.08
Debate different scientific explanations	2.79	0.19	24	2.86	0.18	28	0.07	0.25	.81
Lecture	3.64	0.22	25	2.82	0.19	28	-0.82	-2.89	<.01
Demonstrate some scientific principle	3.32	0.16	25	3.75	0.15	28	0.43	1.95	.06
Ask for reasons for results of experiments	3.52	0.14	25	4.11	0.11	28	0.59	3.33	<.01

Table 9: Teachers' Responses to Questionnaire (continued)

Variable	Tenth Grade Comparison			Tenth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n	Δ	t	p
Ask students to suggest hypotheses	3.40	0.15	25	3.75	0.15	28	0.35	1.62	.11
Ask students to interpret data	3.40	0.15	25	4.25	0.11	28	0.85	4.58	<.01
Conduct class discussions	4.24	0.13	25	3.96	0.16	28	-0.28	-1.32	.19
1=Almost never, 2 = Seldom, 3 = Sometimes, 4 = Often, 5 = Almost always									
Inform students what to expect in lab	2.52	0.25	25	2.82	0.21	28	0.30	0.93	.36
Allow students to go beyond lab	2.52	0.19	25	2.93	0.16	28	0.41	1.63	.11
Teach how science is part of life	4.24	0.15	25	4.00	0.12	28	-0.24	-1.31	.20
OK for students to complain about confusion	4.28	0.16	25	4.04	0.18	28	-0.24	-1.00	.32
Students pay attention to each other	3.76	0.13	25	4.14	0.14	28	0.38	1.95	.06
Terms defined before hands-on work	3.96	0.16	25	3.29	0.18	28	-0.67	-2.74	<.01
Encourage students to use science equipment their own way	2.56	0.22	25	2.64	0.16	28	0.08	0.31	.76
Make topics relevant to outside world	4.20	0.14	25	4.04	0.13	28	-.16	-0.85	.40
Students are free to express their opinions	4.64	0.10	25	4.86	0.07	28	0.22	1.86	.07
Most students participate	3.64	0.19	25	3.68	0.16	28	0.04	0.15	.88

Table 9: Teacher Responses to Questionnaire (continued)

Variable	Tenth Grade Comparison			Tenth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n	Δ	t	p
1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree									
I have freedom in teaching my science class	4.68	0.14	25	4.57	0.11	28	-0.11	-0.63	.53
Facilities for lab science are adequate	3.36	0.27	25	3.57	0.27	28	0.21	0.55	.59
Well supplied with instructional materials & resources	3.72	0.20	25	3.18	0.25	28	-0.54	-1.67	.10
I have freedom in decisions about curriculum	4.16	0.20	25	4.00	0.26	28	-0.16	-0.48	.63
I rely on textbooks to determine what I teach	2.60	0.22	25	1.61	0.16	28	-0.99	-3.77	<.01

Table 10
Teachers' Responses to Interview Questions

Item	Tenth Grade Comparison		Tenth Grade SS&C		Statistics	
<i>Values</i>	max n = 27		max n = 30		X ²	p
	freq	%	freq	%		
Do you have the resources available to teach your course?						
<i>Yes</i>	20	74.1	19	63.3	0.76	.38
<i>No</i>	7	25.9	11	36.7		
Flexibility you have for teaching the content of your course.						
<i>A lot</i>	18	69.2	22	81.5	1.11	.57
<i>Some</i>	6	23.1	4	14.8		
<i>None</i>	2	7.7	1	3.7		
Describe the pace of your class.						
<i>Fast</i>	3	11.1	4	13.3	0.15	.93
<i>Moderate</i>	21	77.8	22	73.3		
<i>Slow</i>	3	11.1	4	13.3		
Pleased with pace of class?						
<i>Yes</i>	16	64.0	18	69.2	0.16	.69
<i>No</i>	9	36.0	8	30.8		
Course is difficult for the students?						
<i>Yes</i>	16	64.0	10	33.3	5.15	.02
<i>No</i>	9	36.0	20	66.7		
Course is relevant to your students?						
<i>Yes</i>	25	96.2	24	82.8	2.53	.11
<i>No</i>	1	3.8	5	17.2		
Extent to which students participate in discussions and activities						
<i>A lot</i>	8	33.3	18	66.7	7.36	.03
<i>Some</i>	16	66.7	8	29.6		
<i>None</i>	0	0.0	1	3.7		

Table 11

Classroom Observations
Percent Time Spent by Teaching Style
Target Classes

Style	Tenth Grade Comparison		Tenth Grade SS&C		Statistics	
	n = 31		n = 27		X ²	p
	freq	%.	freq	%.		
Teacher Centered	71	25.8	45	18.1		
Both Teacher and Student	94	34.2	78	31.5		
Student Centered	48	17.5	94	37.9		
Administrative	28	10.2	21	8.5		
Other	34	12.4	10	4.0		
					35.01	<.01

Note: These frequencies represent five minute intervals during the observation period.

Table 12
Classroom Observation Ratings
 Target Classes

Item	Tenth Grade Comparison		Tenth Grade SS&C		Statistics	
<i>Values</i>	max n = 31		max n = 27		X ²	p
	freq	%	freq	%		
Student Involvement						
<i>Almost always</i>	16	51.6	14	53.8	0.03	.87
<i>Sometimes</i>	15	48.4	12	46.2		
Teacher Rapport						
<i>Yes</i>	28	96.6	20	74.1	5.77	.02
<i>No</i>	1	3.4	7	25.9		
Critical Voice						
<i>Yes</i>	0	0.0	2	7.4	2.32	.31
<i>No</i>	1	3.3	1	3.7		
<i>No evidence</i>	29	96.7	24	88.9		
Type of Instruction						
<i>Traditional</i>	28	93.3	15	57.7	10.48	<.01
<i>Mixed</i>	2	6.7	7	26.9		
<i>Inquiry</i>	0	0.0	4	15.4		
Relevancy						
<i>Almost always</i>	2	6.9	1	4.3	0.16	.92
<i>Sometimes</i>	7	24.1	6	26.1		
<i>Almost never</i>	20	69.0	16	69.6		
Lab Activity (Schwab's levels)						
<i>3rd. level</i>	0	0.0	0	0.0	2.08	.15
<i>2nd. level</i>	0	0.0	3	25.0		
<i>1st. level</i>	7	100.0	9	75.0		
Number of student questions (large group)						
<i>Many</i>	3	13.0	1	6.3	3.96	.14
<i>Some</i>	7	30.4	10	62.5		
<i>Almost none</i>	13	56.5	5	31.3		

Table 12: Classroom Observation Ratings (continued)

Item	Tenth Grade Comparison		Tenth Grade SS&C		Statistics	
<i>Values</i>	max n = 31		max n = 27		X ²	p
	freq	%	freq	%		
Types of questions						
<i>Open</i>	1	5.9	2	13.3	0.52	.47
<i>Closed</i>	16	94.1	13	86.7		
Number of student questions (small group)						
<i>Many</i>	1	5.9	1	5.6	2.50	.29
<i>Some</i>	8	47.1	13	72.2		
<i>Almost none</i>	8	47.1	4	22.2		
Types of questions						
<i>Opened</i>	0	0.0	0	0.0	n/a	
<i>Closed</i>	17	100.0	18	100.0		
Number of teacher questions (large group)						
<i>Many</i>	11	40.7	8	50.0	2.58	.28
<i>Some</i>	9	33.3	7	43.8		
<i>Almost none</i>	7	25.9	1	6.3		
Types of questions						
<i>Opened</i>	3	12.0	3	17.6	0.26	.61
<i>Closed</i>	22	88.0	14	82.4		
Number of teacher questions (small group)						
<i>Many</i>	0	0.0	2	12.5	2.17	.34
<i>Some</i>	13	81.3	11	68.8		
<i>Almost none</i>	3	18.8	3	18.8		
Types of questions						
<i>Opened</i>	1	6.3	5	31.3	3.28	.07
<i>Closed</i>	15	93.8	11	68.8		

Table 13
Student Questionnaire
Inclination to Continue Studying Science and Science Motivation
Class Means

Item	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 79		n = 68		Δ	z	p
	% yes	s.e.	% yes	s.e.			
Take a science class in 11th grade	81.09	1.78	87.98	1.66	6.89	2.83	.01
Take a science class in 12th grade	63.60	2.04	68.57	2.47	4.97	1.55	.12
Take a science class in college	68.74	1.68	68.24	2.00	-.50	-0.19	.85
Do you think you will pursue a career in science?	30.78	1.82	30.66	1.79	-.13	-0.05	.96
Have activities in science class made you want to take more science?	50.19	2.10	47.69	2.62	-2.50	-0.74	.46
Is your science class motivating?	62.39	2.42	59.42	2.94	-2.97	-0.78	.44
Have you ever had a “totally awesome” experience in your science class?	48.43	1.97	53.49	2.37	5.06	1.64	.10

Table 14
Student Questionnaire
Percent of Students Who Have Participated in
Science Activities Outside of Class

Item	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 79 % yes	s.e.	n = 68 % yes	s.e.	Δ	z	p
Talk about what you learn in science class	62.88	2.04	58.86	2.19	-4.02	-1.34	.18
Watch a science program on TV	61.39	2.19	59.97	1.91	-1.41	-0.49	.62
Go bird watching	14.06	1.18	10.65	1.16	-3.41	-2.06	.04
Go to a science museum	42.01	2.13	43.21	2.45	1.21	0.37	.71
Talk about science topics	57.23	2.16	52.95	2.77	-4.28	-1.22	.22
Build a telescope	4.08	0.72	6.02	1.10	1.94	1.48	.14
Read books about science	36.62	2.40	34.75	2.41	-1.87	-0.55	.58
Do a science experiment	35.62	2.08	35.56	2.19	-0.06	-0.02	.98
Write an article for a science journal	7.78	1.17	8.90	1.34	1.12	0.63	.53
Read a science magazine	40.83	1.87	39.53	2.16	-1.30	-0.46	.65

Table 15
Student Questionnaire
Students' Attitude Toward Science

Item	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	mean	s.e.	mean	s.e.	Δ	t	p
	n = 79		n = 68				
Science is useful to me outside of class.	3.39	0.05	3.43	0.05	0.04	0.56	.58
The things you learn in science relate to the real world.	3.93	0.04	3.86	0.05	-0.07	-1.10	.27
Much of what you learn in science classes will be useful in the future.	3.76	0.04	3.73	0.05	-0.03	0.51	.61
It is important to know some science in order to get a good job.	3.62	0.04	3.63	0.05	0.01	0.09	.93
Science class is interesting.	3.23	0.06	3.19	0.06	-0.05	-0.58	.56
Science class is fun.	3.35	0.05	3.31	0.05	-0.04	-0.55	.58

1=Strongly Disagree, 2=Disagree, 3=No opinion, 4=Agree, and 5=Strongly Agree.

Table 16
Science Literacy Test
Percent Correct on Multiple Choice Items
 Class Means

Variable	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	mean	s.e.	mean	s.e.	Δ	z	p
	n = 83		n = 74				
Total Score	57.62	0.98	57.84	1.11	0.22	0.15	.88
Science as Inquiry	61.88	1.16	62.03	1.30	0.15	0.09	.93
Physical Science	55.74	1.45	57.78	1.48	2.04	0.98	.33
Life Science	60.23	1.26	60.15	1.27	-0.08	-0.04	.97
Earth and Space Science	49.37	1.21	49.74	1.11	0.37	0.23	.82
Science and Technology	52.60	0.59	50.70	0.54	-1.90	-2.38	.02
Science in Personal and Social Perspective	54.66	1.54	53.99	1.46	-0.67	-0.32	.75
History and Nature of Science	66.79	0.81	67.69	0.81	0.90	.79	.43

Table 17
Science Literacy Test
Percent Correct on Open-Ended Items
 Target Classes - Class Means

	Tenth Grade Comparison			Tenth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n	Δ	z	p
Target Classes	45.82	2.82	20	49.73	2.23	23	3.91	1.09	.28

Table 18
Percent Correct on Hands-On Lab Skills Test
 Class Means

Variable	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 23		n = 27		Δ	z	p
	%	s.e.	%	s.e.			
Total Score	69.55	2.55	70.29	2.26	0.74	0.22	.83
Station 1: Density	61.00	3.54	63.69	3.29	2.69	0.56	.58
Station 2: Indicators	61.49	3.75	63.70	3.22	2.21	0.45	.65
Station 3: Microscope	77.62	2.96	77.34	3.17	-0.28	-0.06	.95
Station 4: Rocks	82.52	2.49	81.65	2.08	-0.87	-0.27	.79
Station 5: Measurement	71.14	2.10	69.47	1.91	-1.67	-0.59	.56

Table 19
Percent Correct on Hands-On Full Investigation Test
 Student Means

Variable	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 54		n = 49		Δ	z	p
	%	s.e.	%	s.e.			
Total Score	74.36	2.31	73.93	2.87	-0.43	-0.12	.90
Number of Conditions	88.15	2.87	81.22	4.06	-6.93	-1.40	.16
Access to Conditions	69.91	3.76	64.29	4.12	-5.62	-1.01	.31
Amount of Conditions	74.54	4.15	75.51	4.40	0.97	0.16	.87
Method of Measurement	69.44	4.06	72.45	4.39	3.01	0.50	.62
Number of Bugs	69.75	2.96	76.19	3.07	6.44	1.51	.13

Table 20
Percent Correct on Written Full Investigation Test
 Student Means

Variable	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 50		n = 49		Δ	z	p
	%	s.e.	%	s.e.			
Total Score	61.06	4.72	57.20	4.98	-3.86	-0.56	.58
Number of Conditions	70.80	6.03	73.06	5.82	2.26	0.27	.79
Access to Conditions	56.00	5.08	53.06	5.53	-2.94	-0.39	.70
Amount of Conditions	66.50	6.04	60.20	6.18	-6.30	-0.73	.47
Method of Measurement	52.00	6.22	39.80	6.84	-12.20	-1.32	.19
Number of Bugs	60.00	4.86	59.86	5.83	-0.14	-0.02	.98

Table 21
Learning Environment Inventory Results by School
 Student Means

Note: School #1 and School #9 did not participate in the 10th grade study.

School #2						
LEI Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics	
	n = 221		n = 212			
	mean	s.e.	mean	s.e.	Δ	t p
Difficulty	2.89	0.05	3.02	0.05	0.13	1.89 .06
Relevance	3.49	0.05	3.47	0.05	-0.02	-0.28 .78
Critical Voice	3.82	0.05	3.69	0.05	-0.13	1.77 .08
Involvement	3.74	0.04	3.70	0.05	-0.04	-0.61 .54
Sequence	2.36	0.04	2.57	0.05	0.21	3.08 <.01
Experimenting	2.50	0.05	2.71	0.05	0.21	3.15 <.01
School #3						
LEI Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics	
	n =6		n =15			
	mean	s.e.	mean	s.e.	Δ	t p
Difficulty	2.36	0.27	3.04	0.18	0.67	2.07 .05
Relevance	3.33	0.35	3.65	0.14	0.31	1.03 .32
Critical Voice	3.71	0.35	3.68	0.14	-0.04	-0.12 .90
Involvement	2.78	0.34	3.57	0.14	0.80	2.59 .02
Sequence	2.71	0.40	2.52	0.17	-0.19	-0.52 .61
Experimenting	1.77	0.26	2.37	0.20	0.60	1.71 .10
School #4						
LEI Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics	
	n = 126		n = 177			
	mean	s.e.	mean	s.e.	Δ	t p
Difficulty	3.11	0.07	3.41	0.06	0.31	3.24 <.01
Relevance	3.33	0.06	3.15	0.06	-0.18	-2.15 .03
Critical Voice	3.66	0.07	3.55	0.06	-0.11	-1.15 .25
Involvement	3.66	0.05	3.61	0.05	-0.05	-0.67 .50
Sequence	2.56	0.06	3.05	0.06	0.50	5.86 <.01
Experimenting	2.24	0.05	2.18	0.04	-0.07	-1.05 .29

1=almost never 2=seldom 3=sometimes 4=often 5=almost always

Table 21: Learning Environment Inventory by School (continued)

School #5						
LEI Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics	
	n = 83		n = 101			
	mean	s.e.	mean	s.e.	Δ	t p
Difficulty	3.11	0.08	3.04	0.08	-0.08	-0.66 .51
Relevance	3.30	0.09	3.41	0.08	0.11	0.97 .34
Critical Voice	3.38	0.08	3.66	0.07	0.28	2.64 <.01
Involvement	3.66	0.08	3.72	0.08	0.06	0.56 .58
Sequence	2.42	0.08	2.80	0.08	0.38	3.43 <.01
Experimenting	2.30	.07	2.61	0.07	0.31	3.10 <.01
School #6						
LEI Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics	
	n = 255		n = 80			
	mean	s.e.	mean	s.e.	Δ	t p
Difficulty	2.97	0.05	2.92	0.08	-0.05	-0.48 .63
Relevance	3.62	0.05	3.53	0.08	-0.09	-0.95 .34
Critical Voice	3.73	0.05	3.68	0.09	-0.05	-0.55 .59
Involvement	3.78	0.04	3.66	0.08	-0.12	-1.48 .14
Sequence	2.32	0.04	2.81	0.09	0.49	5.33 <.01
Experimenting	2.49	0.04	2.46	0.08	-0.03	-0.33 .74
School #7						
LEI Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics	
	n = 14		n = 7			
	mean	s.e.	mean	s.e.	Δ	t p
Difficulty	3.01	0.18	2.59	0.34	-0.42	-1.19 .25
Relevance	3.51	0.19	3.27	0.12	-0.24	-0.84 .41
Critical Voice	3.38	0.17	3.96	0.20	0.58	2.02 .06
Involvement	3.86	0.18	3.62	0.15	-0.24	-0.87 .40
Sequence	2.13	0.20	2.49	0.22	0.35	1.08 .30
Experimenting	2.63	0.24	2.75	0.18	0.12	0.31 .76

1=almost never 2=seldom 3=sometimes 4=often 5=almost always

Table 21: Learning Environment Inventory by School (continued)

School #8							
LEI Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 11		n = 17		Δ	t	p
	mean	s.e.	mean	s.e.			
Difficulty	3.33	0.22	3.57	0.18	0.24	0.84	.41
Relevance	3.60	0.16	3.47	0.19	-0.13	-0.46	.65
Critical Voice	3.35	0.25	3.76	0.18	0.41	1.37	.18
Involvement	3.26	0.17	3.63	0.14	0.37	1.70	.10
Sequence	2.25	0.14	3.21	0.19	0.96	3.56	<.01
Experimenting	1.95	0.16	2.66	0.14	0.71	3.19	<.01
School #10							
LEI Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 85		n = 23		Δ	t	p
	mean	s.e.	mean	s.e.			
Difficulty	2.85	0.06	3.01	0.07	0.17	1.41	.16
Relevance	3.51	0.07	3.29	0.12	-0.22	-1.57	.12
Critical Voice	3.88	0.07	3.68	0.16	-0.20	1.25	.22
Involvement	3.78	0.07	3.44	0.11	-0.34	-2.37	.02
Sequence	2.20	0.07	2.25	0.11	0.05	0.38	.70
Experimenting	2.40	0.08	2.24	0.12	-0.16	-0.91	.36
School #11							
LEI Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 76		n = 22		Δ	t	p
	mean	s.e.	mean	s.e.			
Difficulty	3.07	0.08	2.96	0.12	-0.11	-0.66	.51
Relevance	3.28	0.09	3.41	0.15	0.13	0.75	.45
Critical Voice	3.54	0.10	3.57	0.14	0.03	0.13	.90
Involvement	3.77	0.07	3.67	0.13	-0.10	-0.69	.49
Sequence	2.32	0.10	2.19	0.11	-0.13	-0.71	.48
Experimenting	2.30	0.08	2.61	0.19	0.31	1.71	.09

Table 21: Learning Environment Inventory by School (continued)

School #12						
LEI Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics	
	n = 113		n = 165			
	mean	s.e.	mean	s.e.	Δ	t p
Difficulty	2.75	0.06	2.68	0.05	-0.07	-0.99 .32
Relevance	3.62	0.07	3.55	0.05	-0.06	-0.76 .45
Critical Voice	3.90	0.07	3.88	0.05	-0.02	-0.28 .78
Involvement	3.87	0.06	3.94	0.05	0.07	0.93 .36
Sequence	2.06	0.09	2.22	0.07	0.15	1.44 .15
Experimenting	2.72	0.08	2.69	0.06	-0.03	-0.29 .77
School #13						
LEI Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics	
	n = 18		n = 31			
	mean	s.e.	mean	s.e.	Δ	t p
Difficulty	3.23	0.14	2.54	0.13	-0.69	3.45 <.01
Relevance	3.23	0.22	3.41	0.12	0.19	0.81 .42
Critical Voice	4.13	0.11	3.38	0.15	-0.75	-3.45 <.01
Involvement	4.01	0.17	3.90	0.10	-0.11	-0.61 .54
Sequence	2.86	0.15	2.63	0.10	-0.23	-1.35 .18
Experimenting	2.64	0.19	2.56	0.10	-0.08	-0.42 .68

1=almost never 2=seldom 3=sometimes 4=often 5=almost always

Table 22
Science Literacy Test
Percent Correct on Multiple Choice Items by School
 Student Means

School	Tenth Grade Comparison			Tenth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n	Δ	z	p
School #2	54.11	0.84	271	53.72	1.09	205	-0.39	-0.28	.78
School #3	43.18	2.58	24	52.33	2.69	15	9.15	2.45	.01
School #4	69.26	0.89	147	67.49	0.88	216	-1.77	-1.41	.16
School #5	63.55	1.08	119	59.21	1.22	133	-4.34	-2.66	.01
School #6	65.75	0.85	236	64.24	1.23	97	-1.51	-1.01	.31
School #7	52.25	2.93	20	53.68	2.78	18	1.43	0.35	.73
School #8	52.82	2.18	27	61.16	2.07	29	8.34	2.77	.01
School #10	47.30	1.32	109	57.87	1.42	67	10.57	5.45	.00
School #11	54.90	1.48	52	49.34	2.12	34	-5.56	-2.15	.03
School #12	48.83	1.02	126	49.17	1.17	161	0.34	0.22	.83
School #13	70.49	2.07	33	72.55	1.27	49	2.06	0.85	.40

Table 23
Science Literacy Test
Percent Correct on Open-Ended Items by School
 Student Means

School	Tenth Grade Comparison			Tenth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n	Δ	z	p
School #2	42.98	5.17	19	39.24	3.36	24	-3.74	-0.61	.54
School #3	25.93	5.07	9	44.44	5.49	9	18.51	2.48	.01
School #4	62.08	3.98	20	59.23	3.34	28	-2.85	-0.55	.58
School #5	57.29	3.35	24	52.33	3.97	25	-4.96	-0.95	.34
School #6	56.48	5.29	9	55.13	7.25	13	-1.35	-0.15	.88
School #7	40.28	4.67	6	38.10	8.27	7	-2.18	-0.23	.82
School #8	44.44	4.95	15	45.00	5.63	10	0.56	0.07	.94
School #10	29.44	3.99	15	38.89	3.69	15	9.45	1.74	.08
School #11	38.33	6.70	10	36.11	4.87	9	-2.22	-0.27	.79
School #12	19.79	4.19	8	41.67	4.86	18	21.88	3.41	.00
School #13	65.91	2.84	11	58.89	5.33	15	-7.02	-1.16	.24

Table 24
Percent Correct on Hands-On Lab Skills Test by School
 Student Means

School	Tenth Grade Comparison			Tenth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n	Δ	z	p
School #2	63.98	3.76	17	56.06	2.65	28	-7.92	-1.72	.09
School #3	60.00	5.11	5	57.43	3.94	16	-2.57	-0.40	.69
School #4	77.79	2.32	20	83.98	1.63	30	6.19	2.18	.03
School #5	80.36	1.78	25	77.37	1.74	28	-2.99	-1.20	.23
School #6	79.90	1.87	13	85.10	2.05	15	5.20	1.87	.06
School #7	62.67	5.28	6	60.16	3.18	9	-2.51	-0.41	.68
School #8	70.75	4.07	13	68.66	3.65	10	-2.09	-0.38	.70
School #10	55.79	6.36	12	62.95	4.11	19	7.16	0.95	.34
School #11	63.81	3.55	13	64.65	5.49	13	0.84	0.13	.90
School #12	51.17	4.25	13	56.97	3.48	27	5.80	1.06	.29
School #13	77.40	2.69	12	78.96	2.39	15	1.56	0.43	.67

Table 25
Learning Environment Inventory Results by Sex
 Class Means

MALE							
Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 53		n = 40		Δ	t	p
	mean	s.e.	mean	s.e.			
Difficulty	2.93	0.04	3.02	0.06	0.08	1.23	.22
Relevance	3.41	0.05	3.34	0.06	-0.07	-0.87	.38
Critical Voice	3.64	0.04	3.59	0.05	-0.05	-0.81	.42
Involvement	3.66	0.05	3.59	0.06	-0.07	-1.00	.32
Sequence	2.35	0.05	2.69	0.07	0.34	4.23	<.01
Experimenting	2.45	0.05	2.47	0.06	0.02	0.28	.78
FEMALE							
Subscale	Tenth Grade Comparison		Tenth Grade SS&C		Statistics		
	n = 53		n = 40		Δ	t	p
	mean	s.e.	mean	s.e.			
Difficulty	2.97	0.05	3.05	0.06	0.09	1.14	.26
Relevance	3.56	0.04	3.43	0.05	-0.13	-2.04	.04
Critical Voice	3.79	0.04	3.74	0.05	-0.06	-0.87	.38
Involvement	3.84	0.03	3.77	0.04	-0.07	-1.37	.17
Sequence	2.27	0.05	2.65	0.07	0.38	4.53	<.01
Experimenting	2.47	0.04	2.52	0.06	0.05	0.69	.49

1 = Almost Never, 2 = Seldom, 3 = Sometimes, 4 = Often, 5 = Almost Always.

Table 26
Science Literacy Test
Percent Correct on Multiple Choice Items by Sex of Student
 Class Means

Sex	Tenth Grade Comparison			Tenth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n	Δ	z	p
Male	59.46	1.29	60	58.89	1.29	53	-0.57	-0.31	.76
Female	59.43	1.37	60	59.60	1.36	53	0.17	0.09	.93

Table 27
Science Literacy test
Percent Correct on Open-Ended Items by Sex of Student
 Student Means

Sex	Tenth Grade Comparison			Tenth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n	Δ	z	p
Male	47.67	2.51	68	46.12	2.43	73	-1.55	-0.44	.66
Female	49.36	2.84	65	49.18	2.45	88	-0.18	-0.05	.96

Table 28
Percent Correct on Hands-On Lab Skills Test by Sex of Student
 Student Means

Sex	Tenth Grade Comparison			Tenth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n	Δ	z	p
Male	70.77	1.90	70	71.99	1.79	79	1.22	0.47	.64
Female	68.71	1.87	77	70.21	1.81	93	1.50	0.58	.56

Table 29
Percent Correct on Hands-On Full Investigation Test
by Sex of Student
 Student Means

Sex	Tenth Grade Comparison			Tenth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n	Δ	z	p
Male	77.28	2.63	29	72.37	4.30	26	-4.91	-0.97	.33
Female	70.76	4.07	24	75.70	3.80	23	4.94	0.89	.37

Table 30
Percent Correct on Written Full Investigation Test
by Sex of Student
 Student Means

Sex	Tenth Grade Comparison			Tenth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n	Δ	z	p
Male	59.47	6.04	27	56.02	7.03	27	-3.45	-0.37	.71
Female	62.93	7.53	23	58.64	7.14	22	-4.29	-0.41	.68