Evaluation Report

Scope, Sequence & Coordination: 9th Grade Science

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Frances Lawrenz & Douglas Huffman
University of Minnesota

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The evaluation of SS&C would not have been possible without the conscientious and diligent effort of many people. We'd like to thank the SS&C site directors for their support and all of the science teachers for welcoming us into their classrooms. We'd also like to thank the graduate students at the University of Minnesota who helped conduct this evaluation including: Kirsten Bancroft, Steve Fifield, Jenice Gasior, Mark Minger, Dan Mugge, Jennifer Robey, Howie Shuckhart and Marsha Traynor. Finally, we'd like to thank Wayne Welch for his advice and consultation on the design and implementation of 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 ninth grade student achievement of the National Science Education Standards (NRC, 1995). 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 9th grade students in the 1994-95 school year) were compared with those of the students studying SS&C (the 9th grade students in the 1995-96 school year). The two groups of students were compared on several measures administered each year.

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, classroom observations and a case study of three teachers. 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 three significant differences on the six scale Learning Environment Inventory: 1) lab activities in SS&C classes were more open-ended, 2) SS&C classes were more likely to do hands-on activities before lectures, and 3) SS&C classes were perceived as less difficult. There were numerous significant differences favoring SS&C on the type of activities used in class. For example, students in SS&C reported that they did more experiments with other students, shared results of experiments, and interpreted 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 self report data on surveys. More students in SS&C classes than in comparison classes reported that their science class was motivating and that they had a "totally awesome" scientific experience. Additionally more students in SS&C classes reported doing science experiments and writing about science outside of class. These more positive perceptions and experiences, however, did not appear to produce longer term school related effects, since there were no differences between the two groups in terms of students' willingness to take more science in the future.

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. Additionally, SS&C students generally performed as well as the comparison students on multiple choice items matched to the topics studied by the comparison classes. For example, on physical science items SS&C students, who studied all science topics, scored just as well as comparison students in 9th grade physical science who studied just physical science. This pattern of no difference was true for physical, earth and integrated science, but on the life science items comparison students outperformed the SS&C students.

The data were analyzed by school, sex and race/ethnicity to determine if the SS&C project differentially affected these sub-groups of students. The analysis of the learning environment by school indicated that the overall findings were consistent throughout the schools; SS&C classes at all but one school reported that their classes were more inquiry and hands-on oriented than the comparison classes at those same schools. The findings for achievement by school, however, showed the overall finding of no difference was apparently due to different patterns of achievement at the participating schools rather than a consistent pattern of no differences. Considering all of the achievement measures across the thirteen participating schools, thirteen differences between the students in the SS&C and the comparison classes were found. The SS&C students at nine schools had scores on one of the achievement measures that were significantly higher than the students in the comparison classes, while comparison students at four schools had scores on one of the achievement measures that were significantly higher than students in the SS&C classes. There were no consistent indications of differences between boys and girls or between students of different racial/ethnic backgrounds in the SS&C and comparison classes.

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. Perhaps because of these learning environment differences, SS&C students found their science classes more motivating. On the other hand, the environmental differences did not encourage more students to pursue science in the future. SS&C and comparison classes scored equally well on measures of achievement. Given that these results were representative of only the first year of what was envisioned as a four year project, they suggest that the SS&C project has good potential for helping students achieve 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, 1995). 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 first 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.

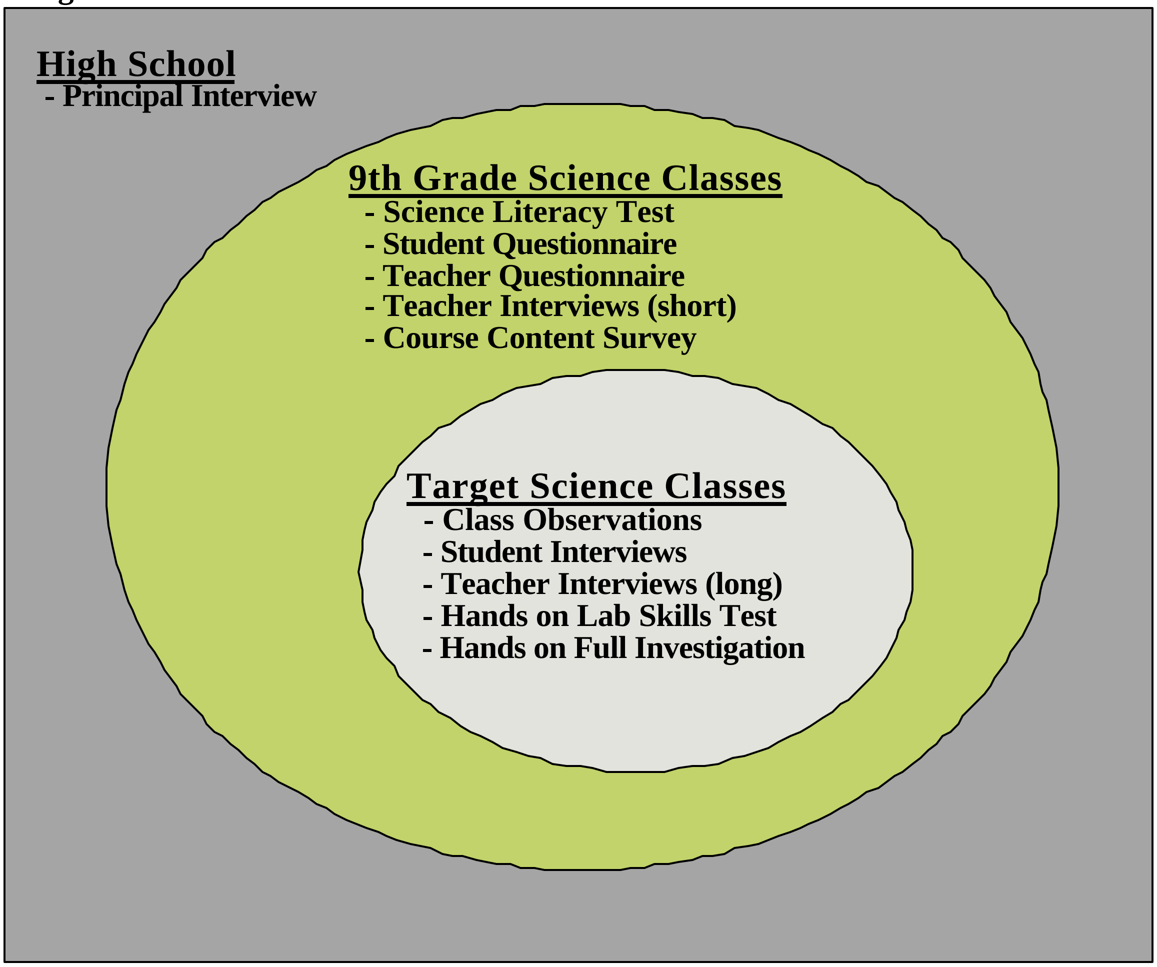
The evaluation used a post-test only, quasi-experimental design. In this approach the performance of 9th grade students who received the treatment (in this case the SS&C activities) was compared to the performance of students who did not receive the treatment. The comparison group was 1994-95 school year students in the same schools as those students who received the SS&C activities in 1995-96. In essence, it was a time-lag design where the prior year's ninth grade science students were compared to the present year's ninth grade science students.

Thirteen 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 San Francisco, CA; one in Riverside, CA; two in a suburban/rural area of IA; two in northeast NC; one in Kalispell, MT; one in White Plains, NY; and one in Washington, DC. There were approximately 50 teachers teaching 9th grade science classes at these schools and over 2,000 students being taught by these teachers each year. Ninth grade science courses at these schools during the 1994-95 comparison school year were quite diverse: some courses concentrated on a single science area such as physical science, life science or earth and space science, while other courses included various arrangements of the sciences such as integrated and coordinated science; some courses were a year long and met everyday for 45 minutes, while other courses were only a semester long and met 90 minutes each day.

A nested data collection design was used to gather information at each of the thirteen 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.

At each school data were collected from all participating ninth grade students and teachers. In addition three ninth grade classes at each school were targeted for more comprehensive data collection. Except for the science literacy test and the course content survey which were mailed to the schools near the end of the school year, the data were collected by the evaluation team during site visits. During the fall and spring visits, all ninth grade teachers were interviewed and the three target classes were observed. During the spring visit in addition to the interviews and observations, most of the ninth 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. One student from each target class was also interviewed. The school principal was interviewed only during the fall site visit. See Figure 1 for a schematic of the data collection instruments and sources of information. In addition to this by school data collection, case studies were conducted with three randomly selected teachers in the project to gather more detailed information about the teachers' experiences over the two years (See Appendix C).

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



The evaluation team 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, Wayne Welch, a nationally recognized expert in both science education and program evaluation.

Four questions guided the SS&C evaluation:

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

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 Appendix A. 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. 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 which 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 and race 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 SS&C science classes different from the learning environment in comparison ninth grade science courses?

Answer to Evaluation Question #1:
The SS&C project had a substantial effect on the classroom learning environment. 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.

n School Culture & Demographics

The site visits, principal interviews and demographic information all showed that the school conditions during both the 1994-95 and 1995-96 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 principals at each school reported no significant changes in the school culture or potential problems such as absenteeism between the 1994-95 and 1995-96 school years. 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 Appendix A.

For reasons that are unclear to the evaluation team, there was a broader spectrum of student backgrounds in the SS&C classes than in the comparison classes. Analyses of the student demographic data revealed three significant differences in the characteristics of students. There was a smaller proportion of white students enrolled in the SS&C classes, more SS&C students had no homework assigned, and more SS&C students spoke a language other than English at home. See Table 3 in Appendix A.

n Amount of Time Spent Studying Science Topics

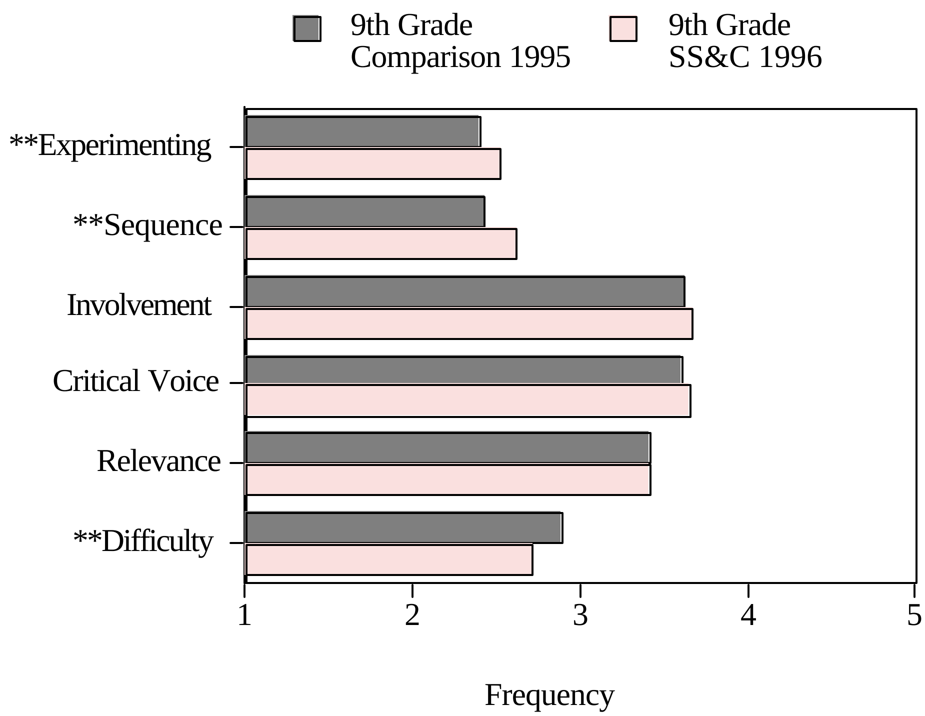
Each year teachers were asked to list the topics they covered in their 9th grade science class and to estimate the number of weeks they spent on each topic. In addition, the teachers were given a list of the NRC content standards and asked to specify the number of weeks they spent on each of them. The analyses indicated that, on average, the two groups spent the same amount of time studying various science topics except for earth & space science, where the comparison classes spent more time than SS&C classes. Both groups also spent the same amount of time studying the concepts in the NRC standards. See Table 4 and Table 5.

However, even though the average amount of time studying science topics was quite similar, the comparison and SS&C groups had very different types of science classes. The SS&C classes used a coordinated approach and studied a variety of science topics throughout the year, while the majority of comparison classes focused on a single science subject the entire year. In fact during the comparison year, there were 51 physical science classes, 27 earth science classes, 11 life science classes and 35 integrated science classes. As a result, the average amount of time that comparison classes spent studying a topic was not representative of what went on in a single class. The SS&C average was more representative of what went on in an individual science class.

n 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 three of the six learning environment scales (See Figure 2). Students in the SS&C group: 1) found their classes less difficult, 2) were more likely to do hands-on activities before lectures, and 3) found their lab activities more open-ended than during the comparison year. There were no significant differences on the other three scales which measured relevancy of the curriculum, students' critical voice (freedom to express opinions), and involvement of students (See Table 6 in Appendix A).

s Figure 2: Learning Environment Inventory Results

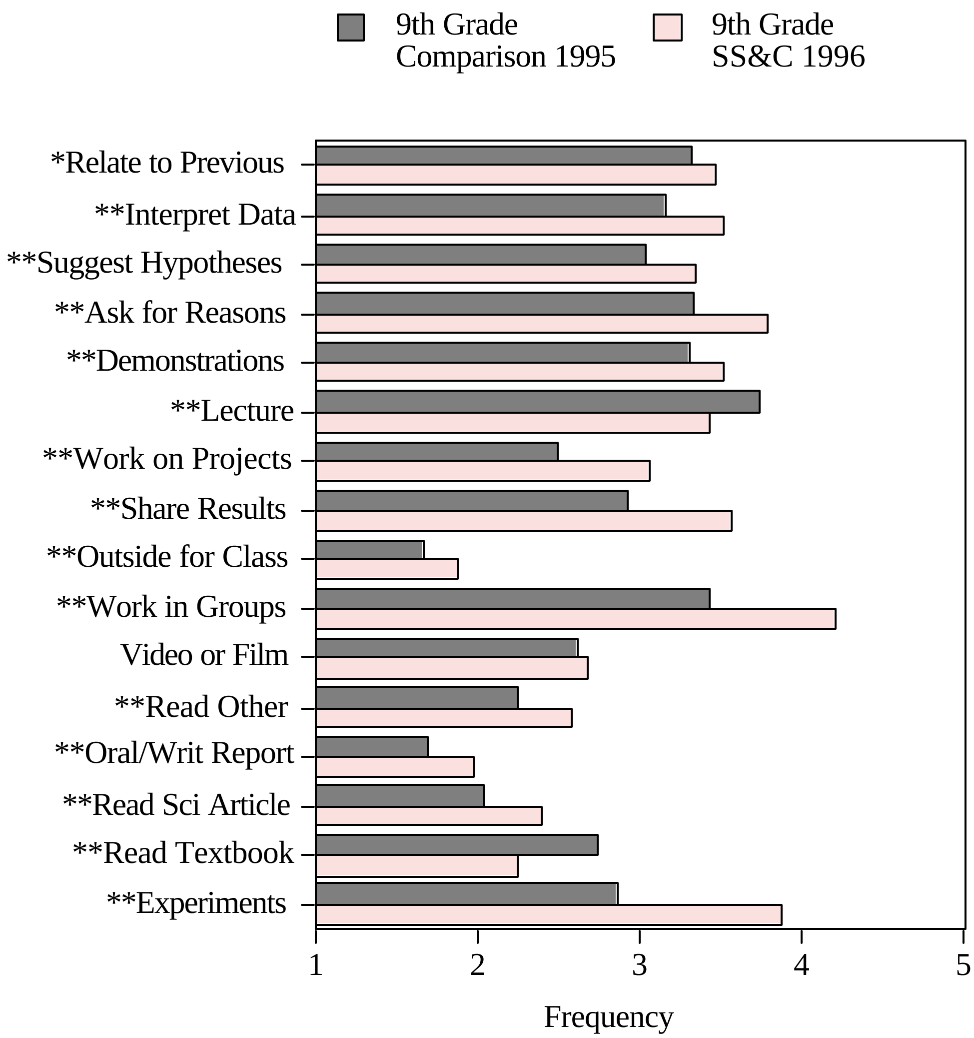


(1=Almost Never 2=Seldom 3=Sometimes 4=Often 5=Almost Always)

*p≤.05 **p≤.01

There were differences favoring SS&C on 15 out of the 16 items about class activities (See Figure 3 and Table 7). These results showed that the SS&C classes were more inquiry oriented than comparison classes and suggest that the SS&C project implemented the activities as intended and significantly changed the type of instruction in the 9th grade science classes at the participating schools.

s **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

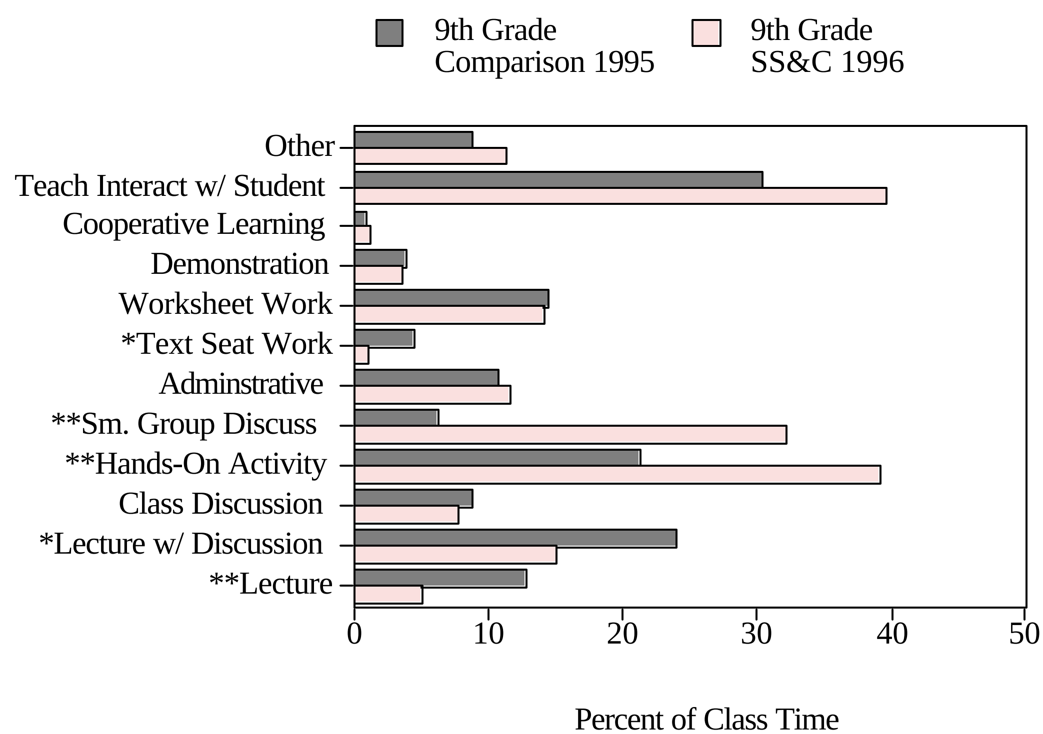
n Interview and Observation Results

Student interviews, teacher questionnaires, the case study 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 SS&C teachers used a more open-ended instructional sequence where students were given the opportunity to determine the results of experiments for themselves rather than have the teacher tell them what would happen (See Table 8).

Significant differences between the comparison and SS&C classes were found on nearly half 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) read more articles on science, 4) did more hands-on activities, 5) completed fewer worksheets, 6) had less lectures,
7) were asked for results of experiments more often, 8) were asked to interpret data more often, 9) were informed in advance of the outcomes of experiments less often, 10) had less critical voice, 11) were less likely to have terms defined before doing hands-on activities, and 12) did more science experiments. The teachers also reported that during the SS&C year they had less freedom in teaching their science classes, their lab facilities were better, and they were less likely to rely on textbooks. The only difference not favoring SS&C was the teachers reported that their students had less critical voice (See Table 9). Interviews with teachers at each school did not reveal any significant differences between the comparison and SS&C years (see Table 10), although the case study results suggest that some differences may have existed (See Appendix C).

Class observations conducted by the evaluation team confirmed many of the same learning environment differences indicated on the student and teacher questionnaires. Of the 12 activities observed, the SS&C classes used: 1) less lecture, 2) less lecture with discussion, 3) more hands-on activities, 3) more small group discussions, and 4) less textbook seat work than the comparison classes (See Figure 4 and Table 11). Ratings conducted by the evaluation team indicated that the SS&C classes were more inquiry-oriented and had more open-ended lab activities, while the comparison classes were more relevant and gave students more critical voice. There were no significant differences in student involvement, teacher rapport, or the type and number of student and teacher questions (See Table 12).

s **Figure 4: Observed Percent Time Spent on Activities**



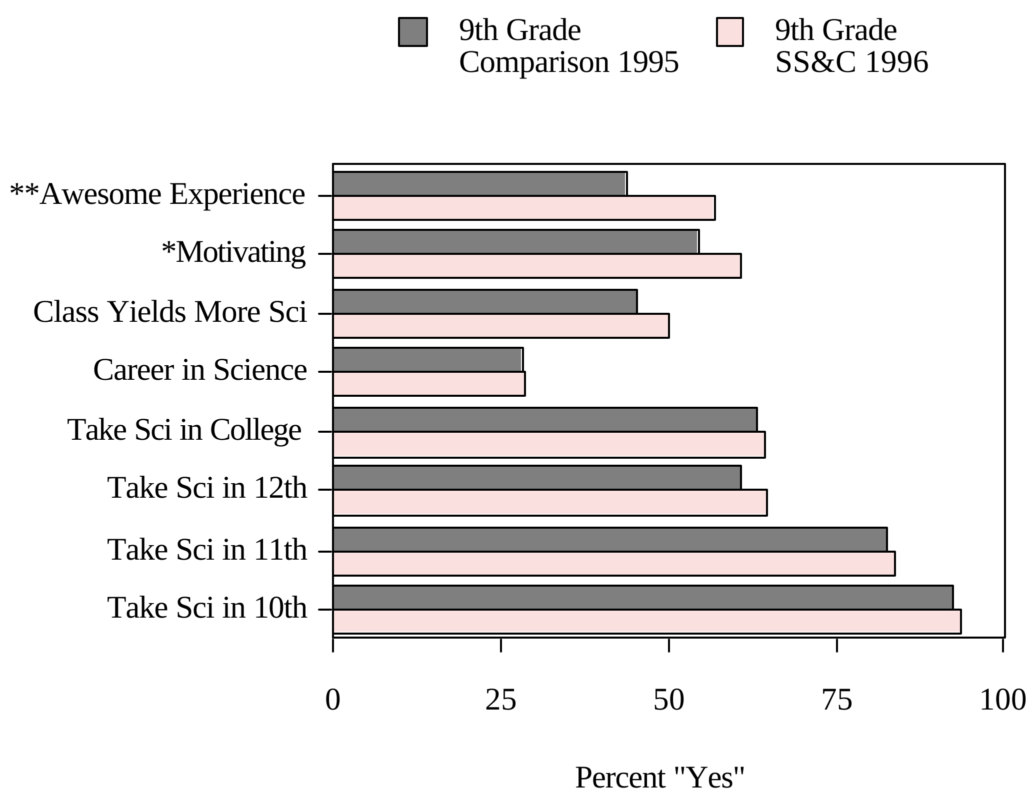
*p≤.05 **p≤.01

<u>Evaluation Question #2</u>:
Are SS&C students more motivated about science than comparison students?

<u>Answer to Evaluation Question #2:</u>
There were indications that students in SS&C found their classes more motivating than the comparison students. However, there were no differences in students' attitudes toward science or intent to study more science in the future.

On the student questionnaire more SS&C students reported that their science classes were motivating and that they had a "totally awesome" scientific experience, however, there were no differences in students' intent to take more science classes or pursue careers in science (See Figure 5). More SS&C students reported that outside of class they did science experiments and wrote about science. There were no differences between the two groups in students' responses to the six attitude items. See Tables 13 - 15.

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



<u>Evaluation Question #3:</u>

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

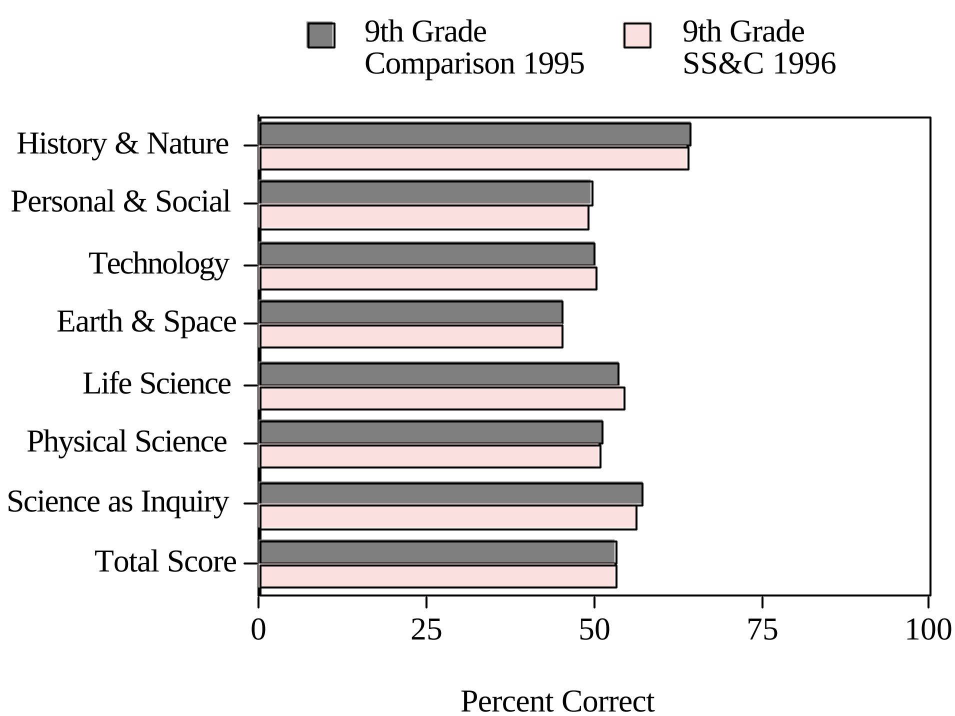
<u>Answer to Evaluation Question #3:</u>

SS&C students perform as well as the comparison students on all measures of science achievement.

n 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 or on any of the sub-scales matched to the NRC standards (See Figure 6 and Table 16). There were also no significant differences between the two groups on the 12 open-ended items (See Table 17).

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



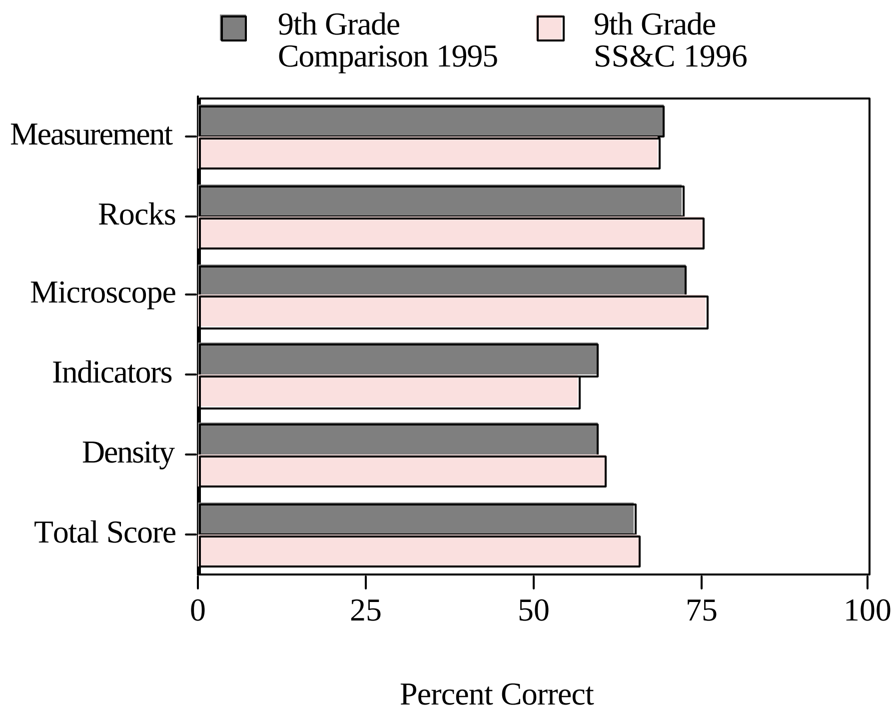
SS&C students performed as well as the comparison students on multiple choice items matched to the science topics studied by the comparison classes. For this analysis, SS&C classes were matched by school to comparison classes, and only scores on specific standards were compared. For example, for the earth science analysis the 27 earth science classes from the comparison year were compared to the SS&C classes from the same schools using scores on the 24 multiple choice items matched to the earth science standard. A similar analysis was conducted with the 51 physical science classes, 11 life science classes, and 35 integrated science classes.

SS&C students scored as well as comparison students on physical and earth science multiple choice items matched to the NRC standards even though the comparison students spent more time studying those topics. Consistent with the overall analyses, there were no difference between SS&C and integrated science classes on all multiple choice items. On life science questions, however, comparison students outperformed the SS&C students (See Table 18).

n 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 19).

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



n 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 draw a picture of 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 20 and 21).

<u>Evaluation Question #4</u>:
Are there differences between SS&C and comparison science classes when data are analyzed by school, sex and race/ethnicity?

<u>Answer to Evaluation Question #4:</u>
There were differences by school, sex and race/ethnicity in the classroom learning environment. All but one of the schools had learning environment changes favoring SS&C, female students reported that the SS&C classes were less difficult than comparison classes, and white students reported that the SS&C classes were less relevant than comparison classes.

The SS&C project had some differential affects on students' science achievement by school and sex. Nine schools had significant achievement differences favoring SS&C students and four schools had significant differences favoring comparison students. Only the Written Full Investigation showed a difference by sex, with female students in comparison classes outperforming female students in SS&C classes. There were no differences among white, black and Hispanic students' science achievement.

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.

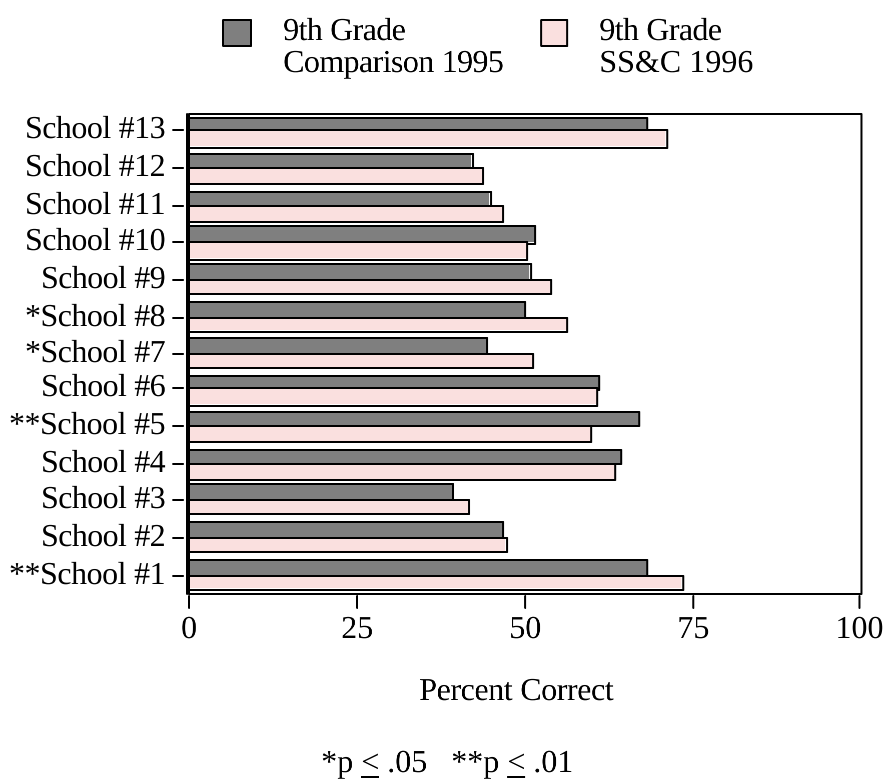
n Learning Environment Results by School

There were significant differences favoring SS&C in the learning environment at every school except one. The differences support the notion that SS&C consistently created learning environments that were more in line with the NRC standards (See Table 22).

n Multiple Choice Results by School

Four of the 13 schools had significant differences on the multiple-choice items (See Figure 8). The SS&C students at three school scored significantly higher than comparison students, while at one school the comparison students scored higher than SS&C students (See Table 23).

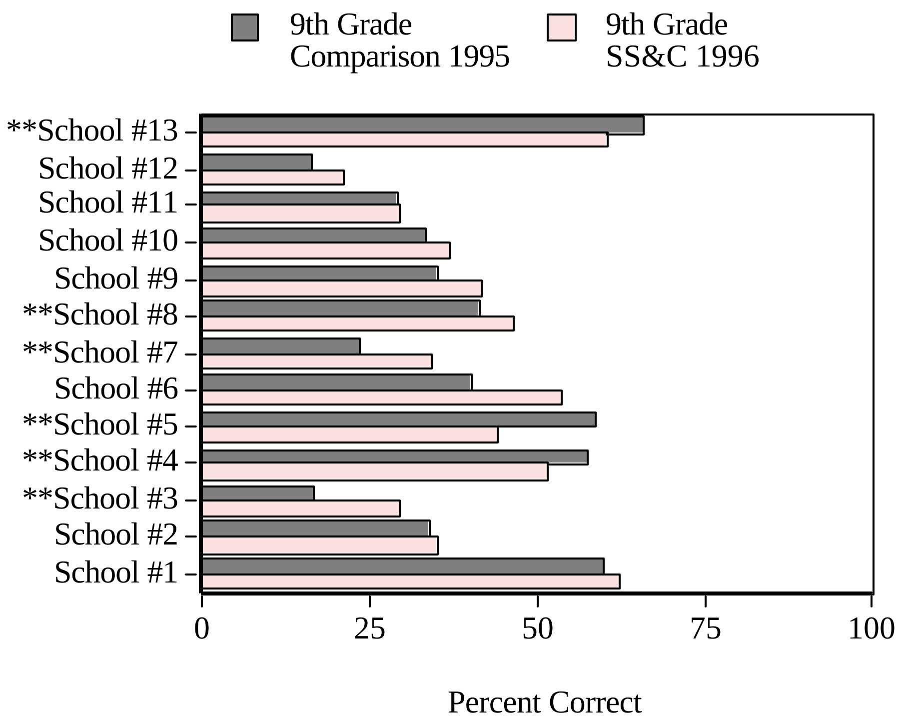
s Figure 8: Multiple Choice Total Score by School



n Open Ended Results by School

There were significant differences on the open-ended items at 6 of the 13 schools (See Figure 9). At three schools the SS&C students had significantly higher scores than the comparison classes, while at three other schools comparison students had significantly higher scores than SS&C students (See Table 24).

s Figure 9: Open Ended Total Score by School

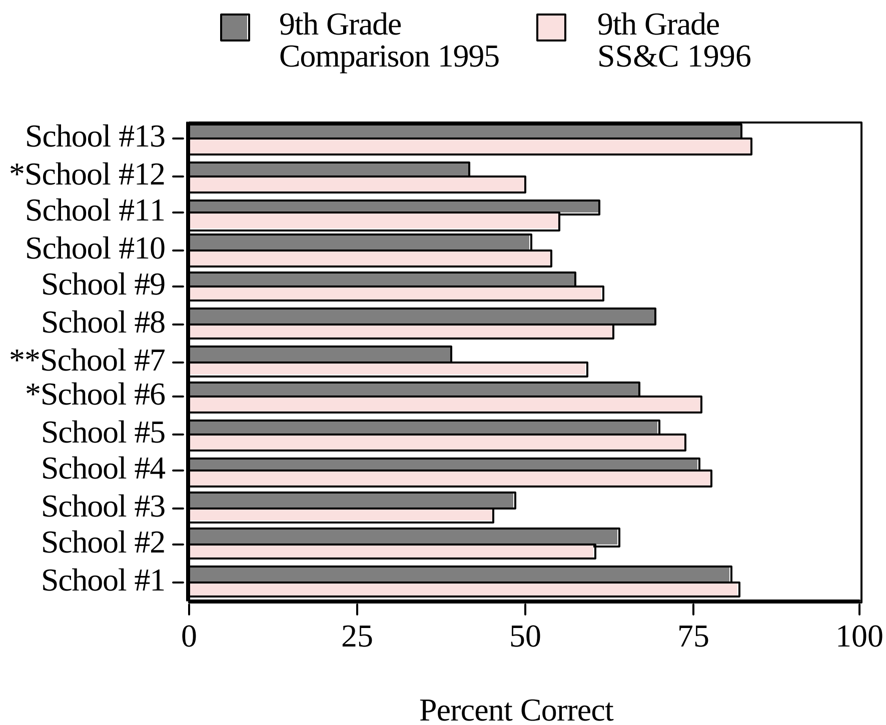


*p≤.05 **p≤.01

n Lab Skills Test Results by School

There were significant differences on the Lab Skills Test at three of the schools, all favoring the SS&C students (See Figure 10 and Table 25). The Full Investigation Test was not analyzed by school because of the small numbers of students at each school who took the test.

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



* p ≤ .05 ** p ≤ .01

RESULTS BY SEX OF STUDENTS

■ Learning Environment Results

There were several significant differences on the Learning Environment Inventory when analyzed by sex of the students. Both male and female students reported the SS&C classes had more open-ended experiments and used a more inquiry oriented sequence than comparison classes. However, female students reported that the SS&C classes were significantly less difficult, while male students reported no difference in difficulty between the two years (See Table 26).

■ Science Achievement Results

There were no significant differences between male and female students' scores on multiple-choice items, open-ended items or the Lab Skills Test (See Table 27 - 29). There were also no differences by sex on the total score of the hands-on version of the Full Investigation Test, however, on the written version of the Full Investigation Test female students in the comparison group scored significantly higher than female students in the SS&C group (See Table 30 and Table 31). The Full Investigation Test was analyzed by student instead of by class because of the small number of students in each class who took the test.

RESULTS BY RACE / ETHNICITY OF STUDENTS

The analyses by race/ethnicity were conducted only with classes that contained at least four students of different races/ethnicities. There were only four schools in the SS&C project that met this criteria. The schools with classes containing both black and white students were used for the analysis of black and white students, while schools with classes containing both Hispanic and white students were used for the analysis of Hispanic and white students. There were not enough classes with both black and Hispanic students to conduct a black and Hispanic comparison.

n Learning Environment Results

White students reported that the comparison classes were more relevant than SS&C classes. Black students did not report any differences in the learning environment from year to year. The white and Hispanic students also did not report any significant differences between the two years on any of the learning environment scales (See Table 32 and 33).

n Science Literacy Test Results

There were no significant differences by race / ethnicity on either the multiple-choice or the open-ended items. Although the black / white analyses were conducted with class means, the white/Hispanic analysis of the open-ended items was conducted with student means due to the small sample size. There were not enough classes with students of different race / ethnicity to analyze the Lab Skills Test or the Full Investigation Test (See Table 34 and Table 35).

[redacted]

IV. CONCLUDING REMARKS

One premise of the SS&C evaluation design was 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 with a high degree of consistency and validity. The classes were clearly more activity based and more inquiry oriented than the classes during the previous year. This change, however, was not without a cost.

The case study results portray the teachers implementing the SS&C project as working very hard to maintain the high level of activities they believed were required by the project. The numerous hands-on activities required the teachers to spend more time and energy finding lab equipment and preparing for class. They also experienced significant dissonance about whether or not the approach to teaching science advocated by the project was the best one.

Although this evaluation was not formative in nature, evaluation information about the implementation of the project was received coincidentally. The interactions with the teachers and the sites showed that the participants believed the SS&C activities were not as well developed or organized as they might have been. This is not surprising given this was the first time the activities were used, but this may have contributed in part to the teachers' feelings of dissonance. The high level of engagement required to select and prepare the new activities may have contributed to the finding that SS&C students had less critical voice in the classroom. The teachers were just deciding for themselves what to do, and may not have been able to consider the input of the students.

The few differences found in students' attitudes toward science seem directly tied to the documented changes in the classroom environment. Certainly it seems reasonable that students who were more actively engaged in science activities would have more motivating and "awesome" experiences. Students' positive perceptions of the SS&C experience is some evidence for the effectiveness of the project. On the other hand, these experiences did not appear to convince the students to pursue more science in the future. Perhaps this desire would increase after a second year of exposure to the new environment.

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. Perhaps the newness of the curriculum and the "first time" nature of the implementation inhibited the development of higher achievement. 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 the revised SS&C ninth grade activities, based on the feedback from the 1995-96 year, would enhance student achievement as well as change the classroom environment.

There were differences in achievement when the data were examined for each of the 13 schools. This suggests that although the learning environment data show consistency of implementation of SS&C, some schools may have used the activities differently than others. The site visit information supports this interpretation. 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.

From a different perspective, the SS&C activities appeared to be equally effective for boys and girls, and therefore may help to meet gender achievement goals. Also, it is encouraging to note that for the most part, the activities appeared to be perceived in the same way by students of different race and ethnicity, and no differential effects on achievement were found among these groups.

A particularly intriguing finding was that in three out of four cases the comparison group students who studied a topic for a whole year didn't perform any better on content specific items than the SS&C students who studied the topic for only a portion of the year. This implies the SS&C approach may be more efficient at producing general science understanding than comparison group approaches. This also supports the notion that the sciences could be presented in a coordinated fashion rather than in the current layer cake approach.

In summary, the SS&C project had a substantial effect on the learning environment, creating environments more consistent with the NRC standards. Perhaps because of these learning environment differences, SS&C students found their science classes slightly more motivating. On the other hand, the environmental differences did not encourage more students to pursue science in the future nor did it significantly improve students' science achievement. However, the SS&C students performed at least as well as the comparison students, even when the comparison students spent more time studying the subject. Given that these results were representative of only the first year of what was envisioned as a four year project, they suggest that the SS&C curriculum has good potential for helping students achieve the NRC standards.

National Research Council (1995). National Science Education Standards. Washington, DC: National Research Council.

Appendices to Evaluation Report

Scope, Sequence & Coordination: 9th Grade

A National Curriculum Development Project

October, 1996

Frances Lawrenz & Douglas Huffman
University of Minnesota

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Appendix A
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 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 analyzed 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 and race 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	Ninth Grade Comparison		Ninth Grade SS&C		Statistics		
	n = 13		n = 13				
	mean	s.e.	mean	s.e.		t	p
Overcrowded classrooms	2.38	0.29	2.08	0.29	-0.30	-0.75	.46
Shortage of educational materials	2.00	0.20	1.85	0.25	-0.15	-0.49	.63
Student absenteeism	2.54	0.29	2.31	0.33	-0.23	-0.53	.60
Lack of student discipline	2.08	0.23	1.85	0.22	-0.23	-0.74	.47

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	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Statistics**	
Values	freq	%	freq	%	X^2	p
Gender						
Male	21	53.8	22	57.9		
Female	18	46.2	16	42.1	0.08	.78
Race						
Asian	0	0.0	2	5.7		
Hispanic	1	2.6	1	2.9		
African-American	9	23.1	5	14.3		
Caucasian	29	74.4	27	77.1	3.01	.39
	(n = 39)		(n = 35)			
	mean	s.e.	mean	s.e.	t	p
Years teaching	17.5	1.9	15.3	1.9	0.79	.43
Years teaching science	16.4	1.9	14.0	1.8	0.92	.36
Years at this school	10.9	1.7	10.3	1.8	0.29	.77

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

Item	Ninth Grade Comparison		Ninth Grade SS&C		Test Statistics	
Values	freq	%	freq	%	X^2	p
Gender						
Male	1102	50.0	1037	50.0		
Female	1102	50.0	1035	50.0	0.00	.98
Race						
White	1108	46.9	855	42.2		
Black	476	22.1	440	21.7		
Hispanic	435	20.2	430	21.2		
Asian/Pacific Islander	136	6.3	172	8.5		
American Indian/Alaska Native	38	1.8	56	2.8		
Other	57	2.7	75	3.7	20.57	<.01
Grades						
A	262	12.1	255	12.4		
A and B	470	21.6	427	20.7		
B	324	14.9	276	13.4		
B and C	551	25.4	516	25.0		
C	206	9.5	224	10.9		
C and D	227	10.5	223	10.8		
D	75	3.5	78	3.8		
Below D	56	2.6	65	3.1	5.96	.55
Time spent on homework						
No homework assigned	1020	46.6	1178	57.0		
Doesn't do homework	232	10.6	155	7.5		
1/2 hour or less	594	27.2	495	24.0		
1 hour	258	11.8	187	9.1		
2 hours	63	2.9	31	1.5		
More than 2 hours	20	0.9	20	1.0	54.50	<.01
Is a language other than English spoken at home?						
Yes	621	28.4	669	32.3		
No	1569	71.6	1404	67.7	7.74	.01

Are you a special education student?						
Yes	142	6.5	159	7.7		
No	2041	93.5	1905	92.3	2.32	.13

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

Item	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Test Statistics**	
Values	freq	%	freq	%	X^2	p
How far did your mother go in school?						
Did not finish high school	329	15.1	274	13.4		
High School	490	22.5	44	21.6		
Some education after high school	420	19.2	385	18.8		
College Grad	586	26.9	549	26.8		
Doesn't know	357	16.4	399	19.5	8.30	.08
How far did your father go in school?						
Did not finish high school	272	12.5	252	12.3		
High School	411	18.9	355	17.3		
Some education after high school	326	15.0	310	15.1		
College Grad	639	29.3	567	27.6		
Doesn't know	530	24.3	567	27.6	7.00	.14

Table 4
Mean Number of Weeks Classes Taught Science Topics

Topic	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	weeks	s.e.	n	weeks	s.e.	n		t	p
Chemistry	6.78	1.56	13	8.61	1.20	12	-1.83	0.92	.37
Biology	9.55	2.80	13	8.29	1.81	12	-1.26	-0.37	.72
Earth and Space	11.05	3.21	13	3.62	0.89	12	-7.43	-2.15	.04
Physics	8.04	2.32	13	9.85	1.64	12	1.81	0.63	.54
Measurement	1.02	0.45	13	0.25	0.25	12	-0.77	-1.44	.16
Science & Society	2.46	0.79	13	6.25	5.98	12	3.79	0.65	.52
Miscellaneous	1.15	0.59	13	3.08	2.99	12	1.93	0.66	.52

Table 5
Mean Number of Weeks Classes Taught NRC Standards

NRC Science Standard	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	weeks	s.e.	n	weeks	s.e.	n		t	p
Physical Science	9.59	2.08	12	9.39	1.07	12	-0.20	-0.08	.93
Life Science	8.10	5.35	12	5.85	0.73	12	-2.25	-0.42	.68
Earth and Space Science	2.84	0.84	12	2.27	0.57	12	-0.57	-0.56	.58
Science and Technology	1.00	0.39	12	0.75	0.32	12	-0.25	-0.50	.62
Science in Personal and Social Perspective	4.89	1.37	12	2.16	0.45	12	-2.73	-1.90	.07
Science as Inquiry	3.76	1.28	12	3.76	1.64	12	0.00	0.00	1.00
History and Nature of Science	2.54	0.85	12	3.99	2.57	12	1.45	0.54	.60

Table 6
Learning Environment Inventory Results
All Schools - Class Means

Subscale	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Statistics**		
	n = 113		n = 114				
	mean	s.e.	mean	s.e.		t	p
Difficulty	2.89	0.03	2.73	0.03	- 0.16	-3.58	<.01
Relevance	3.41	0.03	3.41	0.03	0.00	0.04	.97
Critical Voice	3.60	0.03	3.65	0.03	0.05	0.99	.32
Involvement	3.62	0.03	3.66	0.03	0.04	1.02	.31
Sequence	2.43	0.03	2.62	0.04	0.19	3.51	<.01
Experimenting	2.39	0.03	2.52	0.03	0.13	3.00	<.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	Ninth Grade Comparison		Ninth Grade SS&C		Statistics		
	n = 113		n = 114				
	mean	s.e.	mean	s.e.		t	p
Do experiments with other students	2.86	0.07	3.87	0.07	1.01	10.16	<.01
Read science textbook	2.74	0.09	2.25	0.08	-0.49	-4.35	<.01
Read articles on science	2.03	0.05	2.39	0.56	0.36	4.91	<.01
Do oral or written reports	1.69	0.04	1.96	0.06	0.27	3.85	<.01
Read other science materials	2.24	0.06	2.57	0.05	0.33	4.43	<.01
Watch films, slides, or videos	2.61	0.06	2.67	0.06	0.06	0.75	.45
Work in groups	3.43	0.08	4.20	0.07	0.77	7.48	<.01
Go outside for classroom instruction	1.66	0.04	1.87	0.05	0.21	3.17	<.01
Share results from experiments	2.92	0.06	3.56	0.06	0.64	7.73	<.01
Work on projects	2.49	0.06	3.05	0.07	0.56	6.35	<.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	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Statistics**		
	n = 113		n = 114				
	mean	s.e.	mean	s.e.		t	p
Lecture	3.73	0.06	3.42	0.06	-0.31	-3.82	<.01
Demonstration of a scientific principle	3.29	0.04	3.50	0.05	0.21	3.31	<.01
Ask for reasons for the results of experiments	3.32	0.06	3.79	0.05	0.40	6.56	<.01
Ask students to suggest hypotheses	3.03	0.05	3.34	0.05	0.31	4.23	<.01
Ask students to interpret data	3.15	0.05	3.51	0.05	0.36	5.04	<.01
Relate previous work to current topics	3.31	0.04	3.46	0.05	0.15	2.38	.02

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	Ninth grade Comparison		Ninth Grade SS&C		Test Statistics	
	n = 45		n = 43			
Values	freq	%	freq	%	X^2	p
Do you like your science class?						
A lot	19	42.2	21	48.8		
Some	22	48.9	20	46.5		
None	4	8.9	2	4.7	0.82	.68
Do you feel like taking more science classes?						
Yes						
No	31	70.5	32	74.4		
	13	29.5	11	25.6	0.17	.68
Better understanding of world?						
Yes	37	82.2	34	79.1		
No	8	17.8	9	20.9	0.14	.71
Teacher tell you what will happen in an experiment?						
Yes	28	63.6	8	18.6		
No	16	36.4	35	81.4	18.18	<.01
Do you decide how to do an experiment?						
Yes	19	42.2	22	51.2		
No	26	57.8	21	48.8	0.71	.40
Involved in class activities?						
A lot	2045.5		23	53.5		
Some	2045.5		20	46.5		
None	49.1		0	0.0	4.19	.12
Class hard?						
Yes	1125.0		9	20.9		
No	3375.0		34	79.1	0.20	.65
Challenge opinions in class?						
Yes	3477.3		39	90.7		
No	1022.7		4	9.3	2.90	.09

Table 9
Teachers' Responses to Questionnaire

Variable	Ninth Grade Comparison		Ninth Grade SS&C		Test Statistics		
	(n = 39)		(n = 38)				
	mean	s.e.	mean	s.e.		t	p
1 = Never 2 = Less that once a week 3 = About once a week 4 = Several times a week 5= Almost every day							
Do experiments with other students	3.46	0.16	4.39	0.12	0.93	4.78	<.01
Read from a science textbook	3.21	0.21	1.87	0.15	-1.34	-5.05	<.01
Read articles on science	2.26	0.14	2.89	0.15	0.63	3.20	<.01
Do an oral or written report	2.15	0.15	2.42	0.17	0.27	1.43	.16
Use supplementary reading materials	2.66	0.14	2.84	0.18	0.18	0.84	.40
Discuss a science news event	2.77	0.11	2.76	0.17	-0.01	-0.13	.89
Do science experiments	3.32	0.15	4.29	0.13	0.97	4.99	<.01
Design their own experiments	1.74	0.10	2.00	0.12	0.26	1.67	.15
Do projects which take a week or more	1.87	0.10	1.74	0.10	-0.13	-0.90	.37
Write up experiments	2.69	0.16	3.13	0.21	0.44	1.69	.10
Do hands-on activities	3.69	0.16	4.66	0.09	0.97	5.23	<.01
Complete printed worksheets	2.82	0.19	2.11	0.16	0.71	2.79	.01
Debate different scientific explanations	2.44	0.15	2.41	0.16	-0.03	-0.24	.81
Lecture	3.15	0.18	2.53	0.19	-0.62	2.09	.04
Demonstrate some scientific principle	3.21	0.16	3.47	0.18	0.26	1.14	.26
Ask for reasons for results of experiments	3.56	0.16	4.39	0.12	0.83	4.50	<.01

Table 9: Teachers' Responses to Questionnaire (continued)

Variable	Ninth Grade Comparison		Ninth Grade SS&C		Test Statistics		
	(n = 39)		(n = 38)				
	mean	s.e.	mean	s.e.		t	p
Ask students to suggest hypotheses	3.51	0.15	3.87	0.15	0.36	1.91	.06
Ask students to interpret data	3.54	0.15	4.13	0.12	0.59	3.06	<.01
Conduct class discussions	3.90	0.17	4.11	0.15	0.21	1.35	.18
1=Almost never, 2 = Seldom, 3 = Sometimes, 4 = Often, 5 = Almost always							
Inform students what to expect in lab	2.81	0.24	1.97	0.17	-0.84	-2.91	.01
Allow students to go beyond lab	2.97	0.22	3.16	0.14	0.19	0.65	.52
Teach how science is part of life	4.03	0.14	3.95	0.15	-0.08	-0.42	.68
OK for students to complain about confusion	4.64	0.10	4.21	0.13	-0.41	-2.45	.02
Students pay attention to each other	3.92	0.14	3.74	0.14	-0.18	-1.05	.30
Terms defined before hands-on work	3.78	0.20	2.71	0.19	-1.07	-3.86	<.01
Encourage students to use science equipment their own way	2.31	0.20	2.53	0.16	0.22	0.98	.33
Make topics relevant to outside world	4.17	0.17	4.08	0.12	-0.09	-0.39	.70
Students are free to express their opinions	4.69	0.08	4.55	0.10	-0.14	-1.18	.24
Most students participate	3.50	0.14	3.58	0.14	0.08	0.64	.52

Table 9: Teacher Responses to Questionnaire (continued)

Variable	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Test Statistics**		
	(n = 39)		(n = 38)				
	mean	s.e.	mean	s.e.		t	p
1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree							
I have freedom in teaching my science class	4.69	0.07	4.26	0.17	-0.43	-2.31	.02
Facilities for lab science are adequate	3.03	0.24	3.71	0.21	0.68	2.18	.03
Well supplied with instructional materials & resources	3.15	0.22	3.39	0.20	0.24	0.71	.48
I have freedom in decisions about curriculum	4.23	0.17	3.84	0.18	-0.39	1.69	.26
I rely on textbooks to determine what I teach	2.42	0.21	1.42	0.12	-1.00	-4.41	<.01

Table 10
Teachers' Responses to Interview Questions

Item	Ninth Grade Comparison		Ninth Grade SS&C		Statistics	
	n = 79		n = 70			
Values	freq	%	freq	%	X^2	p
Do you have the resources available to teach your course?						
Yes	59	76.6	49	71.0		
No	49	23.4	20	29.0	0.59	.44
Flexibility you have for teaching the content of your course.						
A lot	58	81.7	53	81.7		
Some	9	12.7	11	16.7		
None	4	5.6	2	3.0	0.91	.63
Describe the pace of your class.						
Fast	12	15.2	10	14.3		
Moderate	48	60.8	48	68.6		
Slow	19	24.1	12	17.1	1.22	.54
Pleased with pace of class?						
Yes	51	73.9	46	71.9		
No	18	26.1	18	28.1	0.07	.79
Course is difficult for the students?						
Yes	25	31.6	20	29.0		
No	54	68.4	49	71.0	0.12	.73
Course is relevant to your students?						
Yes	70 88.6		63	90.07		
No	9 11.4		7	10.0	0.08	.78
Extent to which students participate in discussions and activities.						
A lot	4056.3		40	60.6		
Some	2738.0		25	37.9		
None	4 5.6		1	1.5	1.70	.43

Table 11
Classroom Observations
Mean Percent Time Spent on Class Activities
Target Classes

Activity	Ninth Grade Comparison		Ninth Grade SS&C		Statistics		
	n = 78		n = 83				
	mean	s.e.	mean	s.e.		t	p
Lecture	12.76	2.21	4.94	1.09	-7.82	-3.23	<.01
Lecture with Discussion	23.92	3.22	15.13	2.54	-8.79	-2.16	.03
Class Discussion	8.68	2.26	7.67	2.06	-1.01	0.33	.74
Hands-on Activity	21.15	3.42	39.01	3.39	17.86	3.71	<.01
Small Group Discussion	6.06	1.92	32.17	3.63	26.11	6.24	<.01
Administra-tive Tasks	10.79	1.03	11.59	0..89	0.80	0.59	.56
Text Seat Work	4.30	1.40	1.06	0.65	-3.24	2.15	.03
Worksheet Work	14.55	3.03	14.07	2.93	-0.48	-0.11	.91
Demonstration	3.73	1.17	3.59	0.99	-0.14	-0.09	.93
Cooperative Learning	0.75	0.75	1.20	0.86	0.45	0.40	.69
Teacher Interacting with Student	30.31	3.46	39.63	3.67	9.32	1.84	.07
Other	8.73	2.22	11.32	2.39	2.59	0.79	.43

Table 12
Classroom Observation Ratings
Target Classes

Item	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Test Statistics**	
	n = 78		n = 83			
Values	freq	%	freq	%	X^2	p
Student Involvement						
Almost always	43	57.3	56	66.7		
Sometimes	31	41.3	25	29.8		
Almost Never	1	1.3	3	3.6	2.85	.24
Teacher Rapport						
Yes	66	84.6	69	83.1		
No	12	15.4	14	16.9	0.07	.80
Critical Voice						
Yes	23	29.1	9	10.7		
No	12	15.2	5	6.0		
No evidence	44	55.7	70	83.3	14.80	<.01
Type of Instruction						
Traditional						
Mixed	65	84.4	38	46.3		
Inquiry	11	14.3	31	37.8		
	1	1.3	13	15.9	26.76	<.01
Relevancy						
Almost always	12	16.7	3	3.7		
Sometimes	25	34.7	29	35.8		
Almost never	35	48.6	49	60.5	7.53	.02
Lab Activity (Schwab's levels)						
3rd. level	26.3		0	0.0		
2nd. level	39.4		16	29.6		
1st. level	27 84.4		38	70.4	768	.02
Number of student questions (large group)						
Many	68.7		1	1.5		
Some	2231.9		21	31.3		
Almost none	459.4		45	67.2	3.75	.10

Table 12: Classroom Observation Ratings (continued)

Item	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Test Statistics**	
	n = 78		n = 83			
Values	freq	%	freq	%	X^2	p
Types of questions						
Open						
Closed	23.6		2	4.2		
	5496.4		46	95.8	.02	.87
Number of student questions (small group)						
Many	510.0		914.3			
Some	3162.0		3352.4			
Almost none	1428.0		21	33.3	1.12	.60
Types of questions						
Opened						
Closed	12.1		00.0			
	4697.9		58	100.0	1.24	.26
Number of teacher questions (large group)						
Many	3647.4		2633.8			
Some	2836.8		3342.9			
Almost none	1215.8		18	23.4	3.21	.20
Types of questions						
Opened						
closed	1318.3		1926.8			
	5881.7		52	73.2	1.45	.23
Number of teacher questions (small group)						
Many	612.2		710.9			
Some	3469.4		4570.3			
Almost none	918.4		12	18.8	0.05	.98
Types of questions						
Opened						
Closed	817.8		1422.6			
	3782.2		48	77.4	0.37	.54

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

All Schools - Class Means

Item	Ninth Grade Comparison		Ninth Grade SS&C		Statistics		
	n = 113		n = 114				
	% yes	s.e.	% yes	s.e.		z	p
Take a science class in 10th grade	92.40	0.90	93.68	0.80	1.28	1.06	.29
Take a science class in 11th grade	82.43	1.19	83.91	1.28	1.48	0.85	.40
Take a science class in 12th grade	60.80	1.77	64.68	1.65	3.88	1.60	.11
Take a science class in college	63.26	1.64	64.10	1.71	0.84	0.35	.73
Do you think you will pursue a career in science?	28.24	1.57	28.41	1.56	0.17	0.08	.94
Have activities in science class made you want to take more science?	45.35	1.89	50.18	2.00	4.83	1.76	.08
Is your science class motivating?	54.39	2.06	60.71	2.05	6.32	2.17	.03
Have you ever had a “totally awesome” experience in your science class?	43.49	1.95	56.82	2.10	13.33	4.65	<.01

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

Item	Ninth Grade Comparison		Ninth Grade SS&C		Statistics		
	n = 113		n = 114				
	% yes	s.e.	% yes	s.e.		z	p
Talk about what you learn in science class	54.00	1.84	55.80	1.91	1.80	0.68	.50
Watch a science program on TV	55.34	1.60	57.52	1.59	2.18	1.28	.20
Go bird watching	13.65	1.00	14.33	0.98	0.68	0.49	.62
Go to a science museum	40.98	1.59	42.49	1.61	1.51	0.67	.50
Talk about science topics	44.30	1.69	48.74	1.93	4.44	1.73	.08
Build a telescope	4.46	0.62	4.38	0.62	-0.08	-0.09	.93
Read books about science	38.44	1.74	39.10	1.85	0.66	0.26	.79
Do a science experiment	41.06	1.79	46.84	1.82	5.78	2.26	.02
Write an article for a science journal	6.75	1.00	15.24	1.62	8.49	4.44	<.01
Read a science magazine	41.29	1.43	40.88	1.71	-0.41	-0.18	.86

Table 15
Student Questionnaire
Students' Attitude Toward Science

Item	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Statistics**		
	n = 113		n = 114				
	mean	s.e.	mean	s.e.		t	p
Science is useful to me outside of class.	3.31	0.04	3.35	0.04	0.04	0.75	.45
The things you learn in science relate to the real world.	3.85	0.04	3.82	0.04	-0.03	-0.61	.54
Much of what you learn in science classes will be useful in the future.	3.75	0.04	3.80	0.03	0.05	1.17	.24
It is important to know some science in order to get a good job.	3.69	0.03	3.67	0.03	-0.02	-0.41	.68
Science class is interesting.	3.04	0.05	3.15	0.05	0.11	1.51	.13
Science class is fun.	3.17	0.05	3.29	0.05	0.12	1.69	.09

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

Variable	Ninth Grade Comparison		Ninth Grade SS&C		Statistics		
	n = 122		n = 108				
	%	s.e.	%	s.e.		z	p
Total Score	53.41	0.93	53.14	1.03	-0.27	-0.19	.85
Science as Inquiry	57.26	1.23	56.38	1.18	-0.88	-0.05	.96
Physical Science	51.28	1.26	50.75	1.36	-0.53	-0.29	.77
Life Science	53.75	1.14	54.47	1.12	0.72	0.45	.65
Earth and Space Science	45.49	1.07	45.17	1.01	-0.32	-0.22	.83
Science and Technology	50.25	0.49	50.47	0.50	0.22	0.31	.76
Science in Personal and Social Perspective	49.73	1.23	49.25	1.27	-0.48	-0.27	.79
History and Nature of Science	64.46	0.74	64.07	0.86	-0.39	-0.34	.73

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

	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n		z	p
Target Classes	39.22	2.60	39	42.39	2.00	37	3.27	0.97	.33

Table 18
Percent Correct on Multiple Choice Items
by Type of Comparison Class

Subject	**Ninth Grade Comparison**			**Ninth Grade SS&C**			**Statistics**		
	%	s.e.	n	%	s.e.	n		z	p
Life Science	75.99	1.98	11	68.20	1.76	14	-7.79	-2.94	<.01
Earth Science	52.84	1.71	27	49.30	1.58	20	-3.54	-1.52	.13
Physical Science	42.38	1.33	49	46.07	2.02	45	3.69	1.53	.13
Integrated Science	53.49	1.37	35	54.24	1.40	36	0.75	0.38	.70

Table 19
Percent Correct on Hands-On Lab Skills Test

Variable	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Statistics**		
	n = 37		n = 33				
	%	s.e.	%	s.e.		z	p
Total Score	65.21	2.46	65.79	2.32	0.58	0.17	.87
Station 1: Density	59.33	2.92	60.76	3.47	1.43	0.02	.98
Station 2: Indicators	59.56	3.27	56.90	3.27	-0.34	-0.58	.56
Station 3: Microscope	72.50	2.59	75.95	2.33	3.45	0.99	.32
Station 4: Rocks	72.13	2.72	75.29	1.90	3.16	0.95	.34
Station 5: Measurement	69.42	2.35	68.67	1.85	-0.75	-0.25	.80

Table 20
Percent Correct on Hands-On Full Investigation Test

Variable	Ninth Grade Comparison		Ninth Grade SS&C		Statistics		
	n = 72		n = 70				
	%	s.e.	%	s.e.		z	p
Total Score	65.19	2.97	70.72	2.57	5.53	1.41	.16
Number of Conditions	69.44	4.24	78.86	3.59	9.42	1.70	.09
Access to Conditions	57.99	3.82	58.57	3.77	0.58	0.11	.91
Amount of Conditions	67.01	3.95	77.14	3.62	10.13	1.89	.06
Method of Measurement	63.89	3.31	65.71	3.88	1.82	0.36	.72
Number of Bugs	67.59	3.61	73.33	3.15	5.74	1.20	.23

Table 21
Percent Correct on Written Full Investigation Test

Variable	Ninth Grade Comparison		Ninth Grade SS&C		Statistics		
	n =65		n = 70				
	%	s.e.	%	s.e.		z	p
Total Score	58.98	4.08	53.28	4.12	-5.70	-0.98	.33
Number of Conditions	63.38	5.35	57.71	5.41	-5.67	-0.75	.45
Access to Conditions	45.77	4.09	42.50	4.17	-3.27	-0.56	.58
Amount of Conditions	65.77	5.41	55.71	5.39	-10.06	-1.32	.19
Method of Measurement	50.77	5.08	48.57	5.66	-2.20	-0.29	.77
Number of Bugs	69.23	4.22	61.90	4.20	-7.33	-1.23	.22

Table 22
Learning Environment Inventory Results by School

School #1									
LEI Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n		t	p
Difficulty	2.91	0.08	31	2.75	0.08	71	-0.16	-1.24	.22
Relevance	3.69	0.08	31	3.89	0.07	71	0.20	1.66	.10
Critical Voice	3.83	0.12	31	4.18	0.07	71	0.35	2.69	<.01
Involvement	3.69	0.10	31	3.99	0.06	71	0.30	2.67	<.01
Sequence	2.34	0.12	31	2.49	0.08	71	0.15	1.02	.31
Experimenting	3.02	0.10	31	3.16	0.07	71	0.14	1.05	.30
School #2									
LEI Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n		t	p
Difficulty	2.99	0.04	298	2.80	0.04	395	-0.19	-3.36	<.01
Relevance	3.38	0.04	298	3.41	0.04	395	0.03	0.62	.54
Critical Voice	3.61	0.05	298	3.65	0.04	395	0.04	0.52	.60
Involvement	3.55	0.04	298	3.62	0.04	395	0.07	1.33	.18
Sequence	2.53	0.05	298	2.68	0.05	395	0.15	2.12	.03
Experimenting	2.47	0.04	298	2.66	0.04	395	0.19	3.37	<.01
School #3									
LEI Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n		t	p
Difficulty	2.88	0.15	10	2.90	0.10	47	0.02	0.11	.91
Relevance	3.53	0.21	10	3.33	0.12	47	0.20	0.74	.46
Critical Voice	3.64	0.18	10	3.53	0.10	47	-0.11	-0.49	.63
Involvement	3.46	0.20	10	3.27	0.10	47	-0.19	-0.84	.41
Sequence	2.61	0.31	10	2.70	0.11	47	0.09	0.31	.75
Experimenting	2.32	0.19	10	2.42	0.10	47	0.10	0.43	.67
School #4									
LEI Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n		t	p
Difficulty	2.77	0.06	195	2.84	0.05	189	0.07	0.95	.34
Relevance	3.29	0.05	195	3.33	0.05	189	0.04	0.56	.57
Critical Voice	3.50	0.05	195	3.67	0.05	189	0.17	2.31	.02
Involvement	3.61	0.05	195	3.63	0.05	189	0.02	0.33	.74
Sequence	2.50	0.05	195	2.85	0.05	189	0.35	4.92	<.01
Experimenting	2.20	0.04	195	2.29	0.04	189	0.09	1.55	.12

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

Table 22: Learning Environment Inventory by School (continued)

School #5									
LEI Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n		t	p
Difficulty	3.20	0.07	157	2.92	0.07	163	-0.28	-2.83	<.01
Relevance	3.38	0.06	157	3.30	0.06	163	-0.08	-1.08	.28
Critical Voice	3.29	0.06	157	3.21	0.08	163	-0.08	-0.74	.46
Involvement	3.73	0.05	157	3.54	0.06	163	-0.19	-2.50	.01
Sequence	2.64	0.06	157	2.89	0.06	163	-0.25	-3.09	<.01
Experimenting	2.16	0.05	157	2.35	0.05	163	0.19	2.57	.01
School #6									
LEI Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n		t	p
Difficulty	3.16	0.05	236	2.92	0.07	104	-0.24	-2.50	.01
Relevance	3.45	0.05	236	3.40	0.08	104	-0.05	-0.67	.50
Critical Voice	3.52	0.05	236	3.70	0.07	104	0.18	2.10	.04
Involvement	3.64	0.04	236	3.72	0.06	104	0.08	1.01	.31
Sequence	2.59	0.05	236	2.80	0.08	104	0.21	2.39	.02
Experimenting	2.46	0.04	236	2.37	0.06	104	-0.09	-1.24	.21
School #7									
LEI Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n		t	p
Difficulty	3.23	0.22	10	2.68	0.18	15	-0.55	-1.93	.07
Relevance	3.86	0.32	10	3.84	0.17	15	0.02	0.07	.95
Critical Voice	4.20	0.16	10	3.77	0.18	15	-0.43	-1.67	.11
Involvement	4.26	0.20	10	3.75	0.21	15	-0.51	-1.65	.11
Sequence	1.85	0.12	10	2.63	0.16	15	0.78	3.51	<.01
Experimenting	2.38	0.21	10	2.37	0.17	15	-0.01	0.03	.98
School #8									
LEI Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n		t	p
Difficulty	2.95	0.11	45	2.88	0.14	29	-0.07	0.41	.68
Relevance	3.34	0.10	45	3.36	0.13	29	0.02	0.14	.89
Critical Voice	3.39	0.12	45	3.57	0.16	29	0.18	0.97	.34
Involvement	3.44	0.10	45	3.50	0.15	29	0.06	0.38	.71
Sequence	2.63	0.12	45	3.23	0.18	29	0.60	2.88	<.01
Experimenting	2.13	0.11	45	2.40	0.13	29	0.27	1.60	.11

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

Table 22: Learning Environment Inventory by School (continued)

School #9									
LEI Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n		t	p
Difficulty	2.47	0.09	71	2.48	0.09	72	0.01	0.11	.91
Relevance	3.88	0.10	71	3.36	0.09	72	-0.52	-4.01	<.01
Critical Voice	3.68	0.10	71	3.56	0.10	72	-0.12	-0.80	.42
Involvement	3.75	0.09	71	3.64	0.09	72	-0.11	-0.91	.36
Sequence	2.10	0.10	71	2.77	0.09	72	0.67	4.91	<.01
Experimenting	2.56	0.09	71	2.52	0.10	72	0.04	0.32	.75
School #10									
LEI Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n		t	p
Difficulty	2.49	0.05	120	2.59	0.06	120	0.10	1.22	.22
Relevance	3.68	0.06	120	3.41	0.06	120	-0.27	-3.15	<.01
Critical Voice	3.92	0.06	120	3.63	0.07	120	-0.29	-2.92	<.01
Involvement	3.84	0.05	120	3.60	0.06	120	-0.24	-2.96	<.01
Sequence	2.03	0.05	120	2.59	0.08	120	0.56	5.52	<.01
Experimenting	2.48	0.06	120	2.45	0.06	120	-0.03	0.30	.76
School #11									
LEI Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n		t	p
Difficulty	2.66	0.05	157	2.62	0.06	168	-0.04	-0.42	.68
Relevance	3.31	0.05	157	3.28	0.06	168	-0.03	-0.39	.69
Critical Voice	3.72	0.05	157	3.68	0.06	168	-0.04	-0.49	.63
Involvement	3.65	0.05	157	3.58	0.06	168	-0.07	-0.78	.43
Sequence	2.15	0.06	157	2.34	0.07	168	0.19	2.18	.03
Experimenting	2.55	0.06	157	2.38	0.05	168	-0.17	-2.15	.03
School #12									
LEI Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n		t	p
Difficulty	2.76	0.05	215	2.71	0.03	294	-0.05	-0.93	.35
Relevance	3.25	0.05	215	3.38	0.04	294	0.13	2.10	.04
Critical Voice	3.64	0.05	215	3.76	0.04	294	0.12	-2.43	.02
Involvement	3.41	0.05	215	3.68	0.04	294	0.27	4.20	<.01
Sequence	2.46	0.06	215	2.21	0.05	294	-0.25	-3.15	<.01
Experimenting	2.28	0.05	215	2.62	0.05	294	0.36	4.73	<.01

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

Table 22: Learning Environment Inventory by School (continued)

School #13									
LEI Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	mean	s.e.	n	mean	s.e.	n		t	p
Difficulty	3.19	0.13	42	1.88	0.12	36	-1.31	-7.05	<.01
Relevance	3.45	0.12	42	3.22	0.11	36	-0.23	-1.42	.16
Critical Voice	3.53	0.10	42	3.45	0.12	36	-0.08	-0.51	.61
Involvement	4.06	0.10	42	4.06	0.09	36	0.00	0.00	1.00
Sequence	2.56	0.09	42	2.98	0.13	36	0.42	2.81	<.01
Experimenting	2.30	0.09	42	2.40	0.08	36	0.10	0.75	.45

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

Table 23
Science Literacy Test
Percent Correct on Multiple Choice Items by School
Student Means

School	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n		z	p
School #1	68.57	1.60	55	73.57	0.89	103	5.00	2.73	<.01
School #2	47.15	0.85	326	47.56	0.89	329	0.41	0.33	.74
School #3	39.49	2.69	22	42.01	1.64	41	2.52	0.80	.42
School #4	64.48	0.79	228	63.75	0.94	226	0.73	0.59	.56
School #5	67.32	0.81	194	59.97	1.18	188	-7.35	5.14	<.01
School #6	61.39	0.85	288	61.00	1.17	126	-0.39	0.27	.79
School #7	44.62	2.23	30	51.33	2.07	31	6.71	2.21	.03
School #8	50.31	1.75	61	56.44	1.73	53	6.13	2.49	.01
School #9	50.90	1.21	100	54.06	1.57	76	3.16	1.59	.11
School #10	51.64	0.96	145	50.44	0.97	134	-1.20	0.88	.38
School #11	44.99	0.81	192	47.11	0.97	157	2.12	1.68	.09
School #12	42.11	0.76	217	44.00	1.05	156	1.89	1.46	.14
School #13	68.53	1.30	50	71.25	1.44	55	2.72	1.40	.16

Table 24
Science Literacy Test
Percent Correct on Open-Ended Items by School
Student Means

School	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n	p	z	
School #1	60.00	3.58	30	62.50	1.71	78	2.50	0.63	.53
School #2	33.94	1.44	69	35.28	4.84	47	1.34	0.03	.98
School #3	16.67	3.98	19	29.46	0.66	28	12.79	3.17	<.01
School #4	57.81	1.22	64	51.72	2.17	68	-6.09	2.45	<.01
School #5	59.10	3.82	65	44.34	1.73	53	-14.76	3.52	<.01
School #6	40.36	7.32	51	53.79	1.90	33	13.43	1.78	.08
School #7	23.66	2.88	31	34.14	0.77	31	10.48	3.52	<.01
School #8	41.42	0.73	34	46.71	0.71	43	5.29	5.19	<.01
School #9	35.03	2.33	54	41.67	3.40	38	6.64	1.61	.11
School #10	33.52	1.35	44	37.21	2.65	58	3.69	1.24	.22
School #11	29.10	1.88	59	29.46	3.48	43	0.36	0.09	.93
School #12	16.29	5.15	22	21.08	1.11	17	4.79	0.91	.36

School #13	66.22	1.05	37	60.71	1.48	42	-5.51	3.04	<.01

Table 25
Percent Correct on Hands-On Lab Skills Test by School
student means

School	**Ninth Grade Comparison**			**Ninth Grade SS&C**			**Statistics**		
	%	s.e.	n	%	s.e.	n		z	p
School #1	80.90	2.92	14	82.03	1.92	30	1.13	0.32	.75
School #2	64.12	3.01	29	60.43	2.80	27	-3.69	1.18	.24
School #3	48.63	4.83	14	45.39	3.42	24	-3.24	0.55	.58
School #4	75.93	2.26	28	78.00	1.86	29	2.07	0.71	.48
School #5	70.05	2.20	29	74.04	2.17	28	3.99	1.29	.20
School #6	67.29	3.56	29	76.58	2.26	29	9.29	2.20	.03
School #7	38.95	4.50	16	59.14	5.83	10	20.19	2.74	<.01
School #8	69.57	3.98	22	63.36	4.23	19	-6.21	1.07	.28
School #9	57.73	3.19	27	61.81	3.28	18	4.08	0.89	.37
School #10	50.91	3.78	26	54.34	2.65	23	3.43	0.74	.46
School #11	61.20	3.53	27	55.45	3.44	23	-5.75	1.17	.24
School #12	41.76	2.83	13	50.00	3.13	17	8.24	1.96	.05
School #13	82.16	2.35	19	83.93	2.49	14	1.77	0.52	.60

Table 26
Learning Environment Inventory Results by Sex

MALE							
Subscale	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Statistics**		
	n = 99		n = 96				
	mean	s.e.	mean	s.e.		t	p
Difficulty	2.85	0.04	2.76	0.04	-0.09	-1.61	.11
Relevance	3.38	0.03	3.34	0.04	-0.04	-0.90	.37
Critical Voice	3.53	0.04	3.60	0.04	0.07	1.26	.21
Involvement	3.54	0.03	3.58	0.04	0.04	0.76	.45
Sequence	2.47	0.04	2.68	0.05	0.21	3.35	<.01
Experimenting	2.36	0.03	2.52	0.04	0.16	3.30	<.01
FEMALE							
Subscale	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Statistics**		
	n = 89		n = 99				
	mean	s.e.	mean	s.e.		t	p
Difficulty	2.93	0.04	2.72	0.04	-0.21	-3.76	<.01
Relevance	3.41	0.04	3.42	0.03	0.01	0.21	.84
Critical Voice	3.64	0.04	3.69	0.04	0.05	0.78	.44
Involvement	3.70	0.03	3.73	0.03	0.03	0.72	.47
Sequence	2.41	0.04	2.55	0.05	0.14	2.19	.03
Experimenting	2.41	0.04	2.54	0.04	0.13	2.42	.02

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

Table 27
Science Literacy Test
Percent Correct on Multiple Choice Items by Sex of Student
Class Means

Sex	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n		z	p
Male	53.19	1.07	115	54.19	1.09	94	1.00	0.65	.52
Female	55.04	0.96	107	55.41	1.01	90	0.37	0.39	.70

Table 28
Science Literacy test
Percent Correct on Open-Ended Items by Sex of Student
Class Means

Sex	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n		z	p
Male	43.53	2.70	29	45.04	1.98	29	1.51	0.15	.88
Female	44.58	3.10	29	46.64	2.01	29	2.06	0.66	.51

Table 29
Percent Correct on Hands-On Lab Skills Test by Sex of Student
Student Means

Sex	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n		z	p
Male	63.08	1.88	109	66.01	1.58	122	2.93	1.19	.23
Female	66.29	1.64	117	67.53	1.63	127	1.24	0.54	.59

Table 30
Percent Correct on Hands-On Full Investigation Test
by Sex of Student

Student Means

Sex	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n		z	p
Male	63.95	4.23	43	70.90	4.18	35	6.95	1.17	.24
Female	67.02	3.93	29	70.54	3.04	35	3.52	0.71	.48

Table 31
Percent Correct on Written Full Investigation Test
by Sex of Student

Student Means

Sex	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n		z	p
Male	52.97	5.40	37	57.31	6.24	34	4.34	0.53	.60
Female	66.93	5.99	28	49.47	5.43	36	-17.46	2.16	.03

Table 32
Learning Environment Results by Race
White & Black Students
class means

White Students							
Subscale	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Statistics**		
	n = 9		n = 6				
	mean	s.e.	mean	s.e.		t	p
Difficulty	2.53	0.14	2.27	0.24	-0.26	-1.02	.33
Relevance	3.76	0.15	3.22	0.11	-0.54	-2.70	.02
Critical Voice	3.75	0.17	3.71	0.08	-0.04	-0.19	.85
Involvement	3.89	0.11	3.64	0.14	-0.25	-1.40	.18
Sequence	2.26	0.17	2.77	0.14	0.51	2.10	.06
Experimenting	2.70	0.08	2.44	0.17	-0.26	-1.52	.15
Black Students							
Subscale	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Statistics**		
	n = 9		n = 6				
	mean	s.e.	mean	s.e.		t	p
Difficulty	2.62	0.13	2.41	0.12	-0.21	-1.11	.29
Relevance	3.69	0.16	3.34	0.12	-0.35	-1.60	.14
Critical Voice	3.61	0.13	3.77	0.15	0.05	0.77	.46
Involvement	3.52	0.08	3.69	0.11	0.14	1.35	.20
Sequence	2.26	0.13	2.60	0.05	0.34	2.08	.06
Experimenting	2.38	0.16	2.58	0.23	0.20	0.78	.45

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

Table 33
Learning Environment Results by Race / Ethnicity
White & Hispanic Students
class means

White Students							
Subscale	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Statistics**		
	n = 10		n = 11				
	mean	s.e.	mean	s.e.		t	p
Difficulty	2.60	0.09	2.79	0.09	0.19	1.47	.16
Relevance	3.40	0.10	3.44	0.08	0.04	0.33	.75
Critical Voice	3.76	0.19	3.69	0.15	-0.07	-0.28	.78
Involvement	3.65	0.09	3.76	0.08	0.11	0.98	.34
Sequence	2.47	0.14	2.77	0.14	0.30	1.51	.15
Experimenting	2.50	0.09	2.60	0.10	0.10	0.73	.47
Hispanic Students							
Subscale	**Ninth Grade Comparison**		**Ninth Grade SS&C**		**Statistics**		
	n = 10		n = 11				
	mean	s.e.	mean	s.e.		t	p
Difficulty	3.02	0.13	2.97	0.08	-0.05	-0.32	.75
Relevance	3.38	0.07	3.38	0.10	0.00	0.03	.97
Critical Voice	3.71	0.15	3.72	0.08	0.01	0.09	.93
Involvement	3.50	0.15	3.49	0.10	-0.01	-0.07	.94
Sequence	2.43	0.18	2.64	0.15	0.21	0.92	.37
Experimenting	2.44	0.13	2.57	0.05	0.13	1.06	.30

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

Table 34
Percent Correct on Multiple-Choice Items by Race / Ethnicity
class means

Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n		z	p
White	54.75	.90	9	55.40	1.85	8	0.65	0.32	.75
Black	46.46	1.07	9	46.45	2.59	8	-0.01	0.00	1.00
White	56.01	2.36	7	54.02	1.55	10	-1.99	0.70	.48
Hispanic	44.27	1.47	7	40.71	1.87	10	-3.56	1.50	.13

Table 35
Percent Correct on Open-Ended Items by Race / Ethnicity
student means

Subscale	Ninth Grade Comparison			Ninth Grade SS&C			Statistics		
	%	s.e.	n	%	s.e.	n		z	p
White	42.24	6.62	14	40.48	4.67	7	-4.76	0.22	.65
Black	38.54	9.46	8	22.92	5.18	4	-5.62	1.45	.15
White	40.60	2.99	47	50.00	4.04	13	9.40	1.87	.06
Hispanic	24.35	2.41	51	30.83	4.73	10	-6.48	1.22	.22

Appendix B
Instrument Descriptions

INTRODUCTION

This appendix describes the development and characteristics of the instruments used in the summative evaluation of the SS&C project. The SS&C project is a teacher enhancement process and set of materials for science education in grades 9-12, but the SS&C project and this evaluation were funded by the National Science Foundation for only the ninth grade portion. The SS&C project is committed to developing activities that produce students that are better prepared according to the National Research Council's Science Education Standards. As a result, these content and teaching standards served as the guidelines for the development of the assessment instruments used in this evaluation (National Research Council, 1995). This means that the SS&C project was evaluated on how well the curriculum prepared students based on the standards not on the specific goals or objectives of SS&C. The seven science education content standards have specific goals and objectives for the various grade levels: K-4, 5-8 and 9-12. The content standards are: science as inquiry, life science, physical science, earth and space science, science and technology, science in social and personal perspectives and history and nature of science.

The evaluation gathered data about students, teachers and schools at 13 sites nationally over a two year time frame. During the first year of the evaluation effort data were collected from students similar to those who would be receiving the SS&C curriculum during the second year. During the second year data were collected from SS&C students at the same schools where data were collected during the first year. All sites were visited by evaluation team members in the fall and spring of both years. Ten instruments were developed to assess student understanding of the content standards, student attitudes and motivation and the classroom environment in which these understandings were developed: a classroom observation schedule, principal, teacher and student interview protocols, a teacher questionnaire, a course content survey, a student questionnaire, a student hands-on full investigation test, a student laboratory performance test, and a student science literacy test. In addition to using these instruments to assess the project a case study of three teachers involved in the implementation over the two years was also conducted.

The primary goal of the evaluation was to assess understanding of the content standards, therefore achievement was assessed in a variety of ways to help ensure validity of the findings. The students completed traditional multiple choice items, open ended items, a series of hands-on laboratory stations, a hands-on full investigation and a written full investigation. All of the assessment devices were administered by members of the evaluation team during site visits except the science literacy tests. The literacy tests were mailed out to the sites for the teachers to administer. To maintain confidentiality the tests were counted into classroom sets with class lists before mailing. Teachers were asked to not make copies of the tests and to return all used and unused copies. Standardized administration protocols were developed and read to the students at the beginning of each testing situation to insure consistency of administration.

Individual descriptions of each instrument follow. The student outcome measure instruments will be described first, followed by descriptions of those instruments designed to provide descriptive and environmental information.

STUDENT OUTCOME MEASURES

Science Literacy Test

The purpose of the science literacy test was to assess comparison and SS&C student understanding of the seven NRC science content standards. It was critical that this test contain science items deemed appropriate by a national audience so the items for the science literacy test were selected from existing tests such as NAEP, SISS, and IAEP. The items for those tests had been developed through a rigorous consensus and review process and thus represented a national perspective on appropriateness. Additionally the national data available for some of the items could be used as a comparison for the results from this evaluation. A team of science educators went through all of the available items independently and rated them on their relevancy to the new NRC standards and their appropriateness for ninth graders. The independent ratings were combined and any controversial items were discussed by the team to determine the value of including them. Care was taken to select both open-ended and multiple choice questions and to not overlap on content. Outside science education experts reviewed all of the finally selected items to confirm that the items were, indeed, consistent with the NRC standards. A draft version of the Science Literacy Test was pilot tested locally with 9th grade students at both a suburban and an urban school to assess the length and difficulty of the test.

Twenty-six items were selected for each of the seven NRC science content standards, except for the technology standard which had only 16 items because additional national assessment items that matched the standard could not be located. Of the 172 items administered to students, 12 were open-ended and 160 were multiple-choice. Approximately 40% of the items were higher level reasoning items requiring at least application level understanding as defined by Bloom (1956) and Madaus (1989). The items were used to construct two parallel forms of the science literacy test. Half of the students in each class took form A of the test while the other half took form B. The test was administered to students by their teachers near the end of the school year over two 45-minute class sessions.

Multiple-choice items on the science literacy test were scored as either correct or incorrect. Because two parallel forms of the science literacy test were administered to students, standard errors were estimated using the bootstrap method (Efron & Tibshirani, 1993). The bootstrap method estimates the overall standard error of both forms of the test by taking the average of 200 randomly sampled standard errors. Comparisons between years were made on the total score of all multiple-choice items, and on the multiple-choice items for each of the seven content standards. In the SS&C year, the Cronbach alpha reliability for the multiple choice items was .89 for form A and .88 for form B.

The 12 open-ended items on the science literacy test were scored only for those classes that were selected for observations at each site. The evaluation team developed a coding scheme for the items based on the recommended scoring rubrics and the uniqueness of these students' responses. Team members individually scored some of the tests and then the team discussed their coding to verify interpretations. This coding was then applied to the full set of tests. For final scoring the codes were collapsed into categories of completely correct, partially correct, or incorrect. The complete set of items was scored by four member of the evaluation team; two members scored the items from the comparison year and two different members scored the items from the SS&C year. Intra-rater and inter-rater reliabilities for the comparison year were assessed based on a random sample of 20 form A tests and 20 form B tests. For the comparison year the average intra-rater reliability for the two scorers was 93%, and the inter-rater reliability was 95%.

The same procedure was used to calculate reliabilities for the two scorers in the SS&C year. For the SS&C year the average intra-rater reliability was 93%, and the inter-rater reliability was 91%. The average inter-rater reliability between the comparison and SS&C years was assessed by having the SS&C year scorers rescore a random sample of 20 tests of form A and 20 tests of form B from the comparison year. The average inter-rater reliability between the SS&C and comparison year scorers was 91%.

Lab Skills Test

The purpose of the hands-on lab skills test was to determine if there were any differences in the laboratory skills of the comparison and SS&C year students. As with the science literacy test, in order to assure national acceptance of the items used, the instrument was developed from already existing and validated items. Each station was selected from existing national performance tests including the International Assessment of Educational Progress, the Assessment of Performance Unit (APU, 1981) and the British Columbia Science Performance Test (Bartley, Carlisle & Erickson, 1993). The five stations included determining density, chemical testing of starch and sugar solutions, using a microscope, testing and identifying rocks, and using measuring instruments. A draft version of the lab skills test and the full investigation described below were pilot tested locally with 9th grade students at both a suburban and an urban school to assess the length and difficulty of the items, along with appropriateness of equipment and presentation.

The stations were administered by members of the evaluation team during the spring site visits and all of the equipment except for triple beam balances and microscopes were provided by the evaluation team to insure consistency of the test administration. At each school site, the students who took the lab skills test were randomly selected from the three classes that were observed resulting in approximately 300 students completing the test each year. Students who did not take the lab skills test were asked to complete the student questionnaire described below. The lab stations were set up in a classroom and the selected students rotated through the stations spending seven minutes working on each one. Each of the five stations were scored using the scoring scheme devised by the developers of that test. To calculate the score for each station, the various codes within each station were equally weighted. The scores on all five stations were equally weighted to calculate the total lab skills score. The score represents the mean percentage of possible points earned by the students. The intra-rater reliability of the scoring was assessed by re-scoring a random sample of 20 tests for each year. The 20 tests from the comparison year were also scored by another member of the research team to assess inter-rater reliability. The mean intra-rater reliability over both years was 93%, and the inter-rater reliability for the comparison year was 91%. The Cronbach alpha reliability for the lab skills test in the SS&C year was .84.

Full Investigation Test

The purpose of the hands-on full investigation was to demonstrate student ability to conduct an experiment as proposed in the NRC inquiry standard. The test asked students to design and conduct a complete experiment based on the classic "bugs test" developed by the Assessment of Performance Unit in the United Kingdom (APU, 1981). Students were given approximately 35 minutes to design, carry out and report the results of an experiment to determine which of the following environments isopods prefer: light and dry, light and wet, dark and dry, or dark and wet.

Each year two students were randomly selected to complete this assessment from each of the three classes observed at each site The students were given the necessary experimental apparatus and asked to draw their experimental set-up, describe it in writing and state their conclusions. Isopods, and various types of equipment like timers, sponges, black paper, containers, etc. were provided. A written version of this test (see the description of the student questionnaire below) was administered to students who did not take the hands-on test. The written version was identical to the hands-on test, except students did not have materials and were instead asked to imagine and describe how they would perform the experiment.

The hands-on and written versions of the experimental design tests were scored in an identical manner using the APU scoring rubric that focused on aspects of the design and implementation of experiments. Five aspects of conducting an experiment were scored: 1) the number of environmental conditions presented to the isopods, 2) the extent to which access to different conditions was controlled, 3) the extent to which the amount (i.e. the area or volume) of each environmental condition was controlled, 4) the primary method of measurement, and 5) the number of isopods used to conduct the experiment. Each of the five parts of the score were equally weighted and placed on a scale from 0 to 10. A total score was calculated by adding the five parts of the score thus creating a score that ranged from 0 to 50.

Inter-rater and intra-rater reliability of the scoring of the hands-on full investigation test was checked by re-scoring a random sample of 20 tests from both the comparison year and the SS&C year. For the comparison year the inter-rater reliability was 85%, and the average intra-rater reliability was 91%. For the SS&C year the Cronbach alpha reliability for the hands-on full investigation test was .75.

Student Questionnaire

The purpose of the student questionnaire was to assess both students' perceptions of the learning environment as described in the NRC standards and students' attitudes and motivation. The questionnaire was 12 pages long and took about 30 minutes to complete. All of the appropriate ninth graders at each site except those selected for the hands-on testing completed the questionnaire. Responses to the items were directly inputted from the questionnaire and average ratings were calculated and compared across years.

The bulk of the questionnaire was a six scale learning environment inventory containing 37 items. The 5-point Likert scale items measured six aspects of the learning environment: 1) involvement, 2) difficulty, 3) relevancy, 4) critical voice, 5) experimental design, and 6) sequence. The involvement scale assessed students' perceived personal involvement in the classroom. The difficulty scale measured the students' perception of the academic difficulty in their classroom. The relevancy scale concerned the perceived relevance of school science to students' out-of-school experiences. The critical voice scale assessed the extent to which students believe it is acceptable and beneficial to question a teacher's methods and knowledge claims. The experimental design scale examined the students' perception of the degree of open-endedness in the design of the experiments that were conducted in the classroom. The sequence scale measured the perceived sequence of classroom instruction, for example, whether or not the teacher used hands-on activities before lecturing to the class. All items were written in the personal form as recommended by Fraser and Tobin (1991), in order to more accurately elicit students' perceptions. The personal relevance and critical voice scales were taken intact from Taylor, Fraser and White's (1994) Constructivist Learning Environment Scale. The other four scales, experiment design, student involvement, sequence and difficulty, were developed by the evaluation team. The development consisted of selection, modification or invention of items based on other environment inventories. This was followed by a series of two field tests with samples of both urban and suburban 9th graders, reliability estimations and factor analyses. Based upon the results of the reliability analysis and the factor analysis, modifications were made to the items and the new items were field tested again with another sample of students. All items were also checked for readability and interpretation before field testing. The Cronbach alpha reliability for each scale on the learning environment instrument in the SS&C year was as follows: involvement, .70; difficulty, .79; relevancy, .76; critical voice, .80; experimental design, .55 and sequence, .61.

In addition to the learning environment items, the student questionnaire also requested demographic information; contained 24 items related to students' attitudes toward science; and contained the written version of the full investigation test. In the attitude section students were asked; what science activities they engaged in outside of school; what science courses they planned to take in the future; and their perception of the class as fun, interesting, relevant etc. The attitude and motivation items were responded to using a "yes-no" or 5 point, Likert format.

Both the written and hands-on full investigation tests were based on the classic “bugs test” developed by the Assessment of Performance Unit in the United Kingdom (APU, 1981). (The hands-on version of the full investigation test and the scoring applied to both was described previously.) The test asked students to design an experiment to determine which of the following environments isopods prefer: light and dry, light and wet, dark and dry, or dark and wet. The item was individually scored by a member of the evaluation team. Inter-rater and intra-rater reliability of the scoring of the written full investigation test was checked by re-scoring a random sample of 20 written tests from both the comparison year and the SS&C year. For the comparison year the inter-rater reliability was 85%, and the average intra-rater reliability was 92% . The Cronbach alpha reliability for the written full investigation test in the SS&C year was .88.

DESCRIPTIVE MEASURES

Classroom Observations

Classroom observations were conducted to verify implementation of the SS&C curriculum and to document the behaviors in an actual classroom setting. In both the comparison and the SS&C years each site was visited twice, once in the fall and again in the spring. During each visit three classes, taught by three different teachers if possible, were observed. Classroom observations typically lasted for 45-50 minutes, depending upon the length of the class period. Given the limited number of classroom observations, these were viewed as supporting documentation, rather than as a primary data source.

The classroom observation form was developed from the descriptions of ideal science classrooms in the standards. The observation schedule was two pages long and had forty different items documenting several aspects of the learning environment including: student involvement, student and teacher questioning behavior, teacher rapport, cooperative group work as defined by Johnson and Johnson (1991), type of laboratory work as based on Schwab's levels of involvement, relevancy of content to the "real world", and critical voice of the students (i.e., the extent to which students believe it is acceptable and beneficial to question the teacher's methods and knowledge claims). The form also included items describing the setting and the equipment available. Throughout each observation period, the observers documented the most common form(s) of instruction that occurred during every 5-minute interval. In order to ensure consistency of use of the instrument, all of the evaluation team observed several classes locally using the schedule before it was finalized to achieve consensus of opinion on categorizations. As a final check after the first use of the schedule at the sites, the evaluation team members discussed what had been observed and decided how to best represent that on the schedule. As an additional attempt at consistency, the same observers conducted the site visits both years whenever possible.

Class profiles were created from the observation data by calculating the average percent of class time spent on various activities. The comparison year and SS&C year class profiles were compared to determine if there were a significant difference in the type of class activities. In addition, the ratings of teacher rapport, student involvement, critical voice, level of open-endedness, relevancy, and type and number of teacher and student questions were compared between years.

<u>Principal, Teacher and Student Interviews</u>

The interviews were designed to corroborate data from the other instruments and to allow participants the opportunity to describe things in their own way. Interviews were conducted one-on-one with members of the evaluation team during the site visits. Interview questions were matched to questions asked of the students on other instruments and those used on the observation schedule so cross verification is possible. The principals were interviewed once in the fall. The teachers were interviewed in both the spring and the fall. The three teachers at each site whose classes had been selected for observation were interviewed using the long form while other ninth grade teachers were interviewed using the short form. One student in each of the observed classes was interviewed during the spring site visit. The results of all interviews were analyzed by tallying responses to questions and comparing the responses between years.

The school principal interview was designed to obtain a general description of the school and community, and to elicit the principal's perceptions of the stability of their school populations as a check on the validity of between-year comparisons. The protocol was about one page long, included 20 questions and took approximately 15 minutes to administer.

Student interviews were conducted to verify student perception of the learning environment in the course they were taking and their attitudes toward science. The interview protocol was two pages long, included fourteen questions and took approximately 15 minutes to administer.

Teacher interviews were designed to obtain teachers' perceptions of their classroom activities and the learning environment in their classrooms. The long form interview was administered to the three observed teachers at each site, and the short form was used for any additional teachers. The long form asked questions specifically about the class that had been observed as well as questions about the teachers' approaches to teaching science. The long form was three pages long, contained 17 different questions and took about 30 minutes to administer. The short form was identical to the long form except that ten of the more specific questions were removed.

Teacher Questionnaire

The teacher questionnaire requested demographic information, teachers' ratings of how often they used various instructional techniques, and teachers' perceptions of the learning environment of their classrooms. These questions matched students' questions (see the student questionnaire) and classroom observations. Results were analyzed by examining responses between the comparison and SS&C years. The four page questionnaire had 47 five option Likert scale rating questions and was completed individually by the teachers.

Course Content Survey

The course content survey was used to document the topics taught during the comparison and SS&C years. One teacher at each school was asked to list the topics they taught in their science classes and to estimate the number of weeks spent on each topic. In addition, teachers were asked to examine a list of twenty-eight topics from the NRC standards and estimate the number of weeks spent on each topic. The survey was three pages long and was mailed out for the teachers to complete with the literacy tests near the end of the school year. The course content survey was analyzed by sorting the topics listed as taught by the responding teachers into seven categories: life science, physical science, earth science, environmental science, interdisciplinary, history or nature of science, and measurement. The percent of time spent by each teacher on each category was examined both within and between the comparison and SS&C years, and the extent to which the topics matched the recommendations of the standards was noted.

Case Study

The goal of the case study was to enrich the data collected by other means by looking more closely at the experiences of a few teachers and students. To select schools for the case studies, the 13 participating schools were placed into three categories; urban, suburban/rural, and special population. One school was then randomly selected from each category. The three schools selected were Sacramento High School, Sacramento, CA (urban), Pleasant Valley High School, Iowa (suburban/rural); and Sherman Indian School, California (special population). One teacher was selected from each of the schools to participate in a series of interviews that were conducted during the 1994-95 and 1995-96 school years. To select these teachers, the SS&C contact person at each of the three sites was asked to recommend a list of teachers according to these criteria: the teachers are 1) likely to teach the SS&C 9th-grade curriculum during the 1995-96 year, 2) not heavily involved in the SS&C planning nor well established within the SS&C development organization, and 3) willing to volunteer extra time to answer questions during the 1994-95 and 1995-96 school years. One 9th-grade science teacher at each of the three sites was randomly selected from the list of recommendations supplied by the SS&C contact person.

The interviews explored the relationships among the participants' knowledge and beliefs about course content, pedagogy, learners, and instructional settings. All of the case study participants completed the long form of the teacher interview. In addition, telephone interviews were conducted with the case study participants in November, February, March, May and June of both years. The June interviews were conducted immediately following the end of the school year. Several additional questions pertaining to the implementation of the SS&C curriculum were included in the interviews during the SS&C year (1995-96). In addition, three students from each of the three case study participants' classes were interviewed in the spring of both years.

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Appendix C

Case Study Report[0]

METHODS

Background

The evaluation of the 9th grade portion of the four-year Scope, Sequence & Coordination (SS&C) project was implemented in thirteen high schools during the 1994-95 and 1995-96 school years. The multi-layered evaluation used a variety of specific instruments including multiple choice tests, performance tests, classroom environment questionnaires, teacher interviews, principal interviews, and on-site classroom observations. In addition, a case study of three 9th grade science teachers was conducted to gain a richer description of the SS&C experience. The results of the case studies are presented below.

Case Study Plan

Three schools were randomly chosen from the thirteen schools involved in the national study. The schools were placed into three categories: urban, suburban/rural, and special populations. One school was picked randomly from each category. The schools selected included Sacramento High School, Sacramento, CA (urban), Pleasant Valley High School, Bettendorf, IA (suburban/rural), and Sherman Indian School, Riverside, CA (special population).

One teacher was selected from each school (see details in the next section) and interviews were conducted throughout the 1994-95 school year--the comparison year. The same interview questions were used with the teachers again in 1995-96, the year in which the SS&C activities were implemented. Several additional questions relating directly to SS&C were added during the second year of the evaluation.

Participants

The selection of the three teachers was purposeful. In the fall of 1994, the SS&C contact person at each site was asked to recommend teachers that might be interested in

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[0] The cases studies were conducted by Mark Minger. Editorial assistance was provided by Wayne Welch.

participating in the case study and were likely to teach SS&C in the ninth grade during the 1995-96 year. They were not overly involved in the SS&C planning, not well established within the SS&C development organization, and willing to volunteer extra time to answer questions throughout both school years. One 9th grade science teacher from each school was chosen randomly from the list of recommendations.

One participating teacher retired after the first year of the evaluation and was replaced by another teacher who taught the SS&C course in 1995-96. It was decided to use the replacement teacher for the second year of the case study. The same teachers at the other two sites were followed during both years.

Interview and Observation Protocols

The interview protocol was designed to investigate three main areas, setting, pedagogy and curriculum. The setting included a description of the teacher, the classroom environment, the teachers' impressions of their students and the administrative support given to the program. Pedagogy focused on the philosophy of education of the teacher, teaching methods, the pace of the course, individualization and critical voice (student involvement) permitted in the course. The third category, curriculum, included descriptions of the courses used during the pre-SS&C and SS&C years. Also included in this category was the anticipated impact the SS&C activities would have and the actual impact of these activities on the teachers and their students. Project relevancy was also included within the curriculum category. See Table 1 for an outline of the three categories included in the study.

Table 1. Categories of Focus for the Case Studies

PEDAGOGY
- Philosophy of Education
  - Focus of instruction
  - Pace of instruction
  - Individualization
  - Critical voice (student involvement)
  - Teacher/Student interaction
- Teaching Methods
  - Sequencing instructional strategies
  - Inquiry/hands-on approach
  - Lecture/discussion

SETTING
- Teacher Description
- Classroom Description
- Teacher's Views of the Students
- Administration Support
  - Supplies & resources

CURRICULUM
- Influence on students
- Influence on teachers
- Relevancy
- Difficulty
- Influence of SS&C

Case study teachers were interviewed by telephone in November, February, March, May and June of both years. In addition, interviews and classroom observations were conducted during site visits in the fall and spring of each year. The spring interviews were conducted immediately following the end of the school year.

RESULTS

The case study results are presented in four sections. Section one includes a comparison of the findings and interpretations for the two years. The second section contains a description of the teachers' experiences during the pre-SS&C year and the third describes their reactions while carrying out the SS&C course in 1995-96. Finally, a brief description of the participating teachers is presented.

Comparison of Pre-SS&C and SS&C Years

During both years, the teachers' responses and behaviors revealed them to be careful professionals deeply concerned about providing quality education for their students. In the comparison year, the teachers were consistent in their views and actions and generally content with their pedagogy and curriculum. However, during the SS&C year, these teachers reported major changes in their beliefs and actions. The dissonance of this year was in sharp contrast to the stability that characterized their experiences during the previous year. The sources of the dissonance were, (1) a lack of the 'big picture', including the pace of the course, (2) teaching strategies and delivery, (3) perception of the students, (4) the number of activities and attendant preparation time, and (5) the relevancy and difficulty level of the activities.

A feeling of frustration was reported by all three teachers because they did not know how the entire year was to unfold. They did not understand the entire sequence, scope and coordination of the SS&C program. This made it difficult to plan which activities to use from the many available in the micro-units. As a result, the teachers struggled with the pace of use. This struggle was tied to their perception of the academic freedom they had about what should be taught and how long it should be taught. This was a major contrast to how the teachers felt about the pace of their courses during the previous year.

The teachers were uncertain about the number of activities in the micro-units their students should do. They were frustrated trying to decide which activities to use and how long they should teach them. They felt their professional judgment was hampered some by trying to follow the micro-units and the set activities. One teacher said: "I feel a little constrained by the topics provided by SS&C," while another teacher stated: "We stick with the format but the curriculum should have had more teacher instructions."

Part of the frustration about the proper pace of instruction was a result of not knowing where they were going from one lesson to the next. This was exacerbated by not having all of the micro-units at the beginning of the year.[0]

The teachers struggled with the implementation of the SS&C activities. Concern about their lack of training was a key factor in their struggle. This was in contrast to their teaching experience the previous year when all reported that they were quite comfortable with how they presented their course.

The teachers felt they understood the preferred method of teaching the SS&C lessons. Students are given an activity before terms were defined and ideas discussed. The teachers said they believed this “hands-on first” sequence was a sound approach for teaching science. Despite being able to articulate this understanding, all three teachers continued to question the method throughout the second year.

For one teacher, it was a struggle to convince himself that a hands-on method really worked. During the middle of the second year he said, "I understand we are giving the students an activity based experience and that we are not suppose to give them definitions first . . . I think I like the idea of more activity first, then summary. I think it works." The teacher appeared to agree that he should be teaching the material one way, but making the change was difficult for him. At the end of the SS&C year, he said: "I really believe that more instructions [to the students] at the beginning would be good. The way it was written in the micro-units did not work well for me, it needed more directions, more instructions first, then the activity." Clearly, this teacher did not win the internal struggle that he experienced. He did not fully accept the instructional sequence recommended by SS&C at the end of the year.

The teachers' views of their students were different in the second year of the study. They felt the group of students enrolled in SS&C was less motivated and had more behavior problems than the previous year. They thought the problem was due to differences in the

[0] Units were being written by the development during the year and distributed to schools as they were finished.

student population instead of an outcome of the new curriculum. However, it might be that the dissonance and frustration felt by the teachers in setting up the new course may have contributed to this problem.

All three teachers stressed in their interviews that the SS&C project, with its abundance of student hands-on activities, took an enormous amount of preparation time. This was much different than the previous year. One teacher said: "But this year is very different in the amount of work we are putting into this class, it's very busy . . . we are having to put a lot of time in prepping for all of the classes." For another teacher, who did not have the benefit of working with a team of teachers, the time required for the number of activities was problematic. She stated:

> Setting up for the activities is very time consuming. I am working hard and it seems that I am not getting to all of the activities that I maybe should be getting to . . . I think being the only teacher doing it this year is even harder.

One suggestion by the teachers was to include more thorough instructions for setting up the activities. These teachers definitely struggled with the time it took to prepare for their classes. They believed that changes are needed to make the SS&C approach more user-friendly. One teacher said, "but some of the instructions, even for the teachers were totally inadequate . . . 'use this equipment and set this up', with no further explanation. Very frustrating for the teacher." The activities were viewed as difficult to prepare for when the teachers worked as a team and even more so for a teacher working alone.

The teachers had mixed feelings about the relevancy of the SS&C course. All three were consistent in reporting that the curriculum they used during the first year was relevant to their students' needs but they still believed their courses could be made more relevant to the students. In contrast, during the second year, their ideas of relevancy were mixed and one teacher changed her view during the year.

When asked if the SS&C activities were relevant, one teacher reported: "Yes, I think so, a lot of what we have done they can see within their daily lives, like gases, we spent time on that, and I think it relates to their everyday lives." However, another teacher responded: "No, I think they are doing the same experiments from 50 years ago. I think this is a very weak point in SS&C. I don't think the activities are relevant." The third teacher believed the SS&C activities were relevant during the fall site visit, but during the spring visit responded: “No. What's relevant to a 9th grader? I don't think it was as relevant this year as it could have been, but part of that is my fault, next year I plan to include more cultural beliefs into the course.”

A related area of relevance raised by one teacher continually throughout the interviews was the lack of inclusion of multicultural beliefs and ideas into the lessons. She stated, "I want to add some emphasis [on this issue] to the SS&C project next year, it doesn't have any that I can see.”

During the first year, two of the three teachers expected the SS&C project to be appropriate for all students. The other teacher believed the SS&C project was designed for the non college bound student. After implementing SS&C, two of the teachers viewed the activities as appropriate for low to average students, while one teacher thought they were better suited for the upper level, college bound students. The teacher who viewed the material as too difficult for the average student was referring directly to the reading difficulty of the materials and the independence required to complete some activities. She also considered the lack of apparent sequence, scope and coordination of the activities to be a negative factor for helping her students achieve success in her class.

The two teachers who viewed the SS&C project as relevant for low to average students saw the benefits of not only having an activity-based course but also of one that included several disciplines. They believed this would benefit the student who may not take additional science courses in high school or college.

Overall, the teachers had a positive view toward the SS&C activities. However, they also suggested the need for changes. They thought the SS&C project was deficient in reading materials and appropriate assessments. For example, when asked about this, one teacher stated, "I have used very little of the reading materials. [They are] too difficult to read for many of our students. Some are OK. Others are not appropriate."

The lack of what they considered high quality and relevant reading materials to supplement the activities was a constant frustration for all of the teachers. They did not feel they had the time to supplement the reading materials they received given the large amount of preparation time required. All three teachers were dissatisfied with the assessment options given to them and used other assessment strategies throughout the year they considered more appropriate.

At the end of year one, the teachers had anticipated changes for the better in their current curricula. Mr. D stated, "I am looking forward to making some changes on my part, and the entire staff is looking forward to getting this program." One expected change was an increase in the number of hands-on activities that would be available. Also, the teachers were anticipating changes in the content. SS&C includes all of the sciences throughout the year rather than just one subject. Despite the many frustrations and problems these teachers encountered, they all reported that if the suggested changes were made, they were generally happy with the SS&C project and were looking forward to using it again next year.

One teacher said, "Overall, I think it is a step in the right direction, but it needs a lot of work. I think it has begun to make us think about discovery learning, but again, it needs to be better written." Another concluded, "Overall it was a good, positive experience, but there were bugs and if they are worked out . . . I liked the curriculum overall, I believe that it can work well for the students we have targeted for this course. My interest in the program has not changed, I am still very much behind the program . . . I think it is good for the general kid, it may open doors for some who want to take more science in the future."

It seems clear, at least for these teachers, that the SS&C project is in need of changes. These were mentioned often, however, despite the dissonance, frustrations and problems that were identified, the SS&C project was seen as a step in the right direction that will be enthusiastically implemented for their 10th-grade students during the 1996-97 school year.

Year One: Pre-SS&C

The teachers' were quite stable in their views and actions during the first year of the study. They went through no major changes within the setting, pedagogy or curriculum areas. Two of them were very content with their 9th grade science curriculum while the third teacher identified several areas of weakness in the curriculum she was using. All said that they could improve certain aspects of their courses. Their comments during the interviews were very professional and they seemed concerned with providing a quality educational experience for their students.

One teacher was uncomfortable with the physical state of her classroom and with the support provided by her administration. She said, "We do have a severe book shortage this year . . . In each class we have a classroom set of books. In my case, resources have been difficult to get a hold of, even though we have them." This teacher was teaching one period in a portable classroom that was a considerable distance from her home room. This exacerbated her resource problem. The other two teachers were comfortable with the resources available and the administrative support they received.

The teachers reported they were quite satisfied with the pedagogy they were using in their classes. When asked how much flexibility he had on what and how to teach, one teacher responded, "[We have a] great deal of freedom to teach the way we want, never had any interference from anyone." This teacher said that he was very satisfied with the way he taught. He described his sequence of instruction as, "a brief introduction activity to hype the students interest, discussion/lecture - presentation of material to get started, lab work, lecture/discussion, lab work, study guides, questions, test, and finally review the test."

These teachers considered themselves successful and placed high emphasis on their classes being relevant for their students. For example, Mr. D stated, "we stress current topics - genetics, reproduction and development, medical and health topics," while Mrs. M replied, "I think it should be interesting to the students so they can be intrinsically motivated." Despite this, all three teachers believed that the relevancy of their courses could be improved. When asked if her class was relevant, Mrs. M stated, "No, we did have a few things, but overall I don't think it was relevant." Mr. D replied to the same question by stating, "Yes, fairly relevant, not all parts, but some things they just ought to know."

They possessed different levels of knowledge concerning the project, but were enthusiastically anticipating its use the following year. Mr. D said, "I am looking forward to making changes on my part, and the entire staff is looking forward to getting this new program." Mrs. M said, "I am looking forward to implementing the SS&C program, as it seems a change for the better . . . We need this change and I am glad to be a part of it."

Although the teachers were looking forward to setting up the new SS&C project the following year, they did have some concerns. They were worried about the lack of direction heading into the summer workshop in Montana and hoped the SS&C activities would be ready to go when the school year began.

Year Two: SS&C Implementation

The teachers experienced some major changes in their beliefs and actions during the SS&C start-up year. The teachers were in a state of flux and this frequently produced frustration. Part of this was due to changes in their setting. For example, they were much busier doing the new program. Mr. D reported, "But this year is very different in the amount of work we are putting into this class, it is very busy." Ms. Y said, "It has been very difficult, to say the least . . . This is not only a new program but also I am new, so I have the new teachers' problems." Another said, "There are so many things to be changed, this or that just doesn't seem to be working . . . getting all the equipment lined up is a lot of work, but we are doing it as a team and this is working."

The teachers believed the students in the SS&C classes were different from previous 9th grade students. One teacher described the situation this way,

> They tried to do heterogeneous groupings, but my class has many more students who are not capable of doing the work. They seem scattered, unable to focus and they don't do their homework . . . I do have more non achieving students than last year, many low ability students.

The other two teachers did not see their students as academically different but they were behaviorally different. The 1995-96 9th graders had more behavioral problems and were less motivated than students from previous years. One teacher said,

> This year's 9th grade class may not have been representative as a norm. We were told by the junior high that this was a 'bad' class, behavior wise, and I definitely saw this, which most likely was an issue as far as their lack of motivation.

These perceptions of their students were mentioned throughout the year. It might be that concern about student misbehavior placed additional emphasis on classroom control rather than concentrating on using a new program.

There were some changes in the physical setting for the case study teachers. Mrs. M received a better teaching schedule and room assignment during the second year. The third teacher went through a complete change in physical setting because she was new; a replacement for the teacher who had retired. Mr. D, on the other hand, had no changes in his physical setting.

Only one teacher was comfortable with the resources available. Two had problems obtaining resources. This created difficulties and sometimes frustrating teaching situations. Mrs. Y had trouble finding the supplies needed to set up the activities while Mrs. M reported that money was tight and needed supplies were not available on time. However, both teachers saw improvement in the supply problem as the year progressed.

The teachers changed in their pedagogy as the year progressed. Mr. D doubted the SS&C method of teaching would work. He did not believe that giving the students the opportunity to do the activities before giving them instructions or content information would work very well. He was sure the students would not learn as much as under his previous method of lecture and discussion before doing an activity.

He was challenged throughout the year while he adapted to this change in teaching approach. However, after teaching the SS&C lessons during the year, he had tempered his beliefs.

> I think the activities allowed the students to be investigators to a greater degree than in my previous class, to do more work, to try to find the answers rather than to tell them . . . Less is more, maybe the pacing wasn't a problem after all, but it does take more time to do so many activities.

Each teacher struggled with starting students on the activities with limited instructions and without prior lecture and discussion. They felt that more training would have prepared them to deal better with the changes required in presenting the SS&C materials.

Concerns were voiced about the slow pace of the project at the beginning of the year. Part of the problem could be attributed to starting a new program and part was the lack of overall direction about the expected pace of carrying out the SS&C activities. Mr. D said, "it seemed at times that we lacked direction and feedback as to how and how fast to present the materials . . . We needed much more information and training about teaching these units."

By the end of the year the concerns about the pace of the class were being worked out. However, it was frustrating for the teachers to have to work the problem out by the trial and error rather than having some basic guidelines to help them plan the frequency and duration of the activities.

The teachers faced a challenge to their sense of academic freedom that affected their teaching throughout the year. At the beginning of the second year they were very comfortable with the freedom they had to teach what they believed was important and valuable to the students. However, several months into the second year, their judgment on what, when, and how to teach was being constrained by the SS&C units they were using.

> We did not know to what extent we were going to revisit the topics, so we couldn't and didn't plan accordingly. We needed more direction on the pacing, proper delivery styles, where we were going, should we spend a lot of time on each or which ones.

Another teacher said, "I do feel sort of tied to what they have sent us. There is a volume of material. Less is not more." The teachers felt unable to make clear, justified and informed decisions on which activities they were expected to choose from the variety and number of activities provided by SS&C developer.

It was clear the teachers were using many more hands-on activities than during the previous year. They enjoyed this aspect of the project and believed that the increased number of activities was a positive change for their students. However, with the increase in the number of activities was a significant increase in preparation time and time spent on each topic. One teacher described the situation this way:

> There were lots of problems setting up, lots of work, and very poor directions. It has just been a lot of prep work to get ready. We are really struggling with the prep, it feels like being a first year teacher.

The teachers were somewhat overwhelmed with the work required to start a new program that was philosophically different from what had been used. They sought help from many sources but were frustrated at the lack of clear directions available in the materials. In hindsight this is not too surprising given that their philosophy of teaching was, “tell me what to do first and then I will do it." They did not teach their classes using inquiry or problem solving methods and they were frustrated approaching the new program from an inquiry point of view.

Descriptions of the Teachers

Mr. D

Mr. D has been teaching science for 29 years and reports that he tries to create a classroom environment that helps students learn how to learn about science. His main goals are to make the science topics relevant and practical for his students and to make the class interesting.

He taught the 9th grade general biology class for many years and feels comfortable with the curriculum he developed. His assessment of the pre-SS&C year was, "This school year was average overall. Nothing stands out being unique. I had good students, some struggled, some were productive. I think the kids grew and learned biology and I think the course prepared them for other science courses."

Mr. D viewed his classroom as a place to do lab work that supported what he called his lecture/discussions. The bulletin boards were used to represent the content, for example, there was a display on animal kingdoms. Another illustrated career potential in science related fields. The laboratory portion of the room was well equipped and he felt the administration was very supportive with supplies and resources. He said, "As far as resources, both written and lab materials are plentiful and very acceptable. If we don't have it, the money is there to get it."

The general appearance and upkeep of the classroom and the school building was good. The facilities were kept neat and clean. The administration not only supported the science department with resources and supplies but also kept the buildings and grounds very well maintained.

Mr. D reported his biology courses were designed to develop higher order thinking skills, not just memorization. He used hands-on activities weekly followed by discussion. He did allow students occasionally to design their own experiments but most of his activities were primarily cookbook labs. When asked what he would change in his present course, he said he would change very little; he was quite satisfied with the biology course.

He saw himself as a traditional teacher who enjoyed talking and discussing science with his students besides providing information.

> I think a teacher who is interested in science, who really likes talking and discussing science, will kind of do things to make it interesting instead of dry. The kids know I like science, I relate my experiences and talk about the kind of experiences that they may have opportunities to have in the future, in science. I think it is more important to have someone who knows and likes science than a room full of equipment.

His classes generally started with a brief introduction activity to try to gain the interest of the students. He used lecture and discussion followed by lab work. The lab work was supplemented with study guides and questions and the unit ended with a test on the material.

Mr. D did not realize in 1994-95 that the SS&C project would be taught differently. The major change for him was students doing the activities before receiving definitions and background on the topics. He expected that the SS&C project would be a good fit for the average students, but not for the honor's students. He believed there would be many more hands-on activities and the way the topics would be introduced would be different from the way he presented topics in the past. These anticipated changes did not seem to pose any problems for Mr. D, however, he was concerned about the SS&C project being ready for the beginning of the fall quarter.

Although he said several times that discussions were a vital and necessary part of his classes, his observations on the discussion that took place were contradictory.

> Discussions (are) not a good method for this class. I tend to lean toward lecture, but then get away from it when it seems appropriate . . . I have become more verbal with age. Discussion is very important. It is interesting to me, with science there is so much to discuss. I try to pose questions that are challenging to the students during our discussions and our classes.

Mrs. M

Mrs. M taught science for 10 years, however, 1994-95 was the first time she had taught physical science in several years. She believed that science classes should increase the science literacy of the students. Her main focus was to make science topics interesting for students so they would be intrinsically motivated.

She was disappointed at the end of her first year, 1994-95. She did not think the year went very well partly due to a large class size and partly due to the scheduling of her class in a portable classroom. This made the task of setting up activities very difficult. She had this to say about her year,

> Overall, at times I'm amazed that the students learned anything at all. I feel guilty that I was not able to give my 100% mainly due to the many problems that I encountered this year . . . I know that some of the kids did well, I wish I could have spent more time with the other students.

Mrs. M viewed her classroom as a place overcrowded, badly needing repair and very inconvenient for doing any science activities. The room was not decorated with bulletin boards nor anything of interest. She said, "Some sort of coordinated effort [is needed] to get the school site looking good, desks are falling apart, it's depressing. If we order equipment, it gets wrecked easily. Physically, the site needs to be much better maintained."

The general appearance and upkeep of the classroom and the school buildings were poor. According to Mrs. M, the administration supported the science department verbally but resources and supplies were limited. The buildings and grounds were minimally maintained. Some teaching problems were directly connected to the lack of administrative support in building maintenance and to the scheduling and support of the teaching staff.

The students in Mrs. M's 9th grade physical science class were considered average as far as she could tell. However, she had not taught 9th grade students for several years so she had little current personal experience to make her judgment. She did categorize her class as quite average, however, she also commented that she had high absenteeism.

Mrs. M's physical science course was developed over the years by the 9th grade science team and included hands-on activities and lecture/demonstrations. Most often the topic was discussed and readings assigned to the students before doing the activities. She felt that the course was marginally relevant for her students. It needed improvement to be useful and interesting to her students. Most of her activities were cookbook labs that provided little latitude for the students. When asked what she would change in the course, she mentioned a smaller class size and improved physical condition of the building to make them more conducive for teaching and learning.

Mrs. M had clear ideas on what she thought would occur with the use of the SS&C project in 1995-96. She thought it would be more relevant with more hands-on material and more reading materials for the students. She also expected changes in the methods she would be asked to use to teach the course.

Mrs. M was concerned that science educators have forgotten the average students and that our science courses are designed primarily for college preparation. She believed that the SS&C project was designed to be for all students, especially for the non college bound student. She said, "Colleges are full of good scientists, it's time to get to the 80% that don't take science in college." After she taught SS&C, she did not believe the course worked as well for the non college bound students as she had hoped. She found her students could not complete the activities in the time available and she did not do as many activities as she thought she should be doing. Part of this was due to the low motivation level of the students that took the course. She summed up her reactions,

> Lots of problems setting up, lots of work, poor directions. Lack of motivation and relevancy. Poor readings, we didn't have time to look up our own readings that would be adequate, so we consequently did few readings. Better direction on where we are heading, a better outline needed for the teachers . . . Also, we need more training on how to teach the units effectively for all students, not just the college bound.

Mrs. M was disappointed and frustrated with the SS&C project. She said, “I really don't think my expectations were realized. I didn't see what I expected. I was fairly enthusiastic at first, but it quickly became drudgery . . . I don't know who decided the sequence and coordination, but I just never saw it.” However, despite the problems and frustrations that she experienced, she felt that the project was on the right track and stated that she was pleased with some aspects. She said, "Overall, I think it is a step in the right direction, but it needs a lot of work. I think it has begun to make us think about discovery learning, but again, it needs to be better written.”

Ms. Y

Ms. Y replaced the teacher that retired after the 1994-95 school year. She has had more than 20 years of teaching experience and said she was very student-centered. She emphasized that a successful classroom must be comfortable and allow the students to have a sense of well being. She was very concerned about having the science course meet the cultural needs of the students.

Ms. Y viewed her classroom as an important place for her students to feel comfortable. She was satisfied with the physical aspects of her classroom. However, it was difficult during the first part of the year because she was new and it took time to learn such things as how to obtain needed supplies and gain the support of the school administration.

Administration support the science department was limited, especially during the early part of the year. She described the situation, "The supplies here are very limited. Process of getting supplies very cumbersome. We have gained a little money to obtain supplies . . . We just didn't have the equipment or supplies needed this year.” She stated several times during her interviews that part of the supply and equipment problems were because she was a new teacher. The previous 9th grade science teacher had retired and was not available to help in the transition. However, she felt the situation improved as the year progressed.

The general appearance and upkeep of the classroom and school building were above average. Improvements were being made during the year including the addition of wall murals depicting ethnic scenes.

The students in Ms. Y's SS&C class were considered average academically. She believed they were academically normal for 9th graders but she saw many social and behavioral problems that concerned her. "I have been told that this class is the worst of any in recent history as far as behavior is concerned . . . More discipline, talking back and general rowdiness."

Overall, Ms. Y had a frustrating year. However, despite the problems, when asked to describe the benefits and drawbacks of the SS&C project for the teacher, she said,

> I do like the overall concept of the integration of the different sciences and next year should go much better for me. Again, a lot of my frustration was probably caused by me being new to the school and new to the curriculum . . . Time, without a doubt time is a definite drawback to the teacher. I simply had a very difficult time finding time to plan, gather and assemble the materials for the number of activities I was suppose to do.... I also think that by having all of the activities at the beginning of the year would help me plan and make it easier to teach.