DOCUMENT RESUME

ED 472 914 SE 067 305

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TITLE	The Relationship between Attitude toward Science with Enrollment in a 4x4 Block Schedule.
PUB DATE	2001-06-00
NOTE	30p.; In: Proceedings of the Annual Meeting of the Association for the Education of Teachers in Science (Costa Mesa, CA, January 18-21, 2001). For full proceedings, see ED 453 083.
PUB TYPE	Reports - Research (143)
EDRS PRICE	EDRS Price MF01/PC02 Plus Postage.
DESCRIPTORS	*Block Scheduling; *Science Education; Secondary Education; *Student Attitudes; Student Interests

ABSTRACT

This study examines the relationships between classroom environment and affective learning outcomes over time. Focus is placed on the investigation of the correlation between environmental variables and attitude toward science, and the change in attitude toward science and other classroom environment attitudes by students enrolled in block scheduled science courses. A group of rural high school students participated in this investigation that used an instrument developed by Simpson and Troost to measure attitudes toward science and other variables associated with school science by middle and high school students. Differences between grade levels and gender were found in this study. (KHR)

The Relationship between Attitude toward Science with Enrollment in a 4X4 Block Schedule

[James E. Spellman
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THE RELATIONSHIP BETWEEN ATTITUDE TOWARD SCIENCE WITH ENROLLMENT IN A 4x4 BLOCK SCHEDULE

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The focus of this study was to examine a group of rural high school students' attitude toward science at the beginning and end of a 90-day semester. With the growing use of one-semester courses in many schools, it is worth exploring the effects of this alternative schedule on students enrolled in these courses.

<u>Research about Attitude Toward Science</u>

Research into various aspects of attitudes toward science, which has been defined as a general and enduring positive or negative feeling about science (Koballa & Crawley, 1985), has contributed a significant amount of literature throughout the past several decades. A great deal of this research stemmed from the large amounts of data taken from the 1976-77 NAEP survey of nine, thirteen, and seventeen-year-olds, and from the 1982 study of approximately 4500 North Carolina students by Simpson and Troost. These and other studies of attitudes have led researchers in science education to the understanding that there are many variables that correlate with attitudes about science such as achievement (Schibeci, 1984), behavior (Shrigley, 1990), and grade level (Simpson & Oliver, 1985). Still, another goal for some science educators has been to find ways to foster positive attitudes toward science as an attempt to create a more scientifically literate populace (Simpson, Koballa, Oliver, & Crawley, 1994; Hufstedler & Lungenberg, 1980).

One major branch of research into student attitudes toward science has been to document a relevant correlation between these attitudes and student achievement. The common-sense argument leads us to believe that students who have a positive feeling toward science would engage in behavior that leads to higher achievement. However, there has been very little evidence to show that this relationship exists, at least not to a large degree (Steinkamp & Maehr, 1983; Talton & Simpson, 1987). Although correlations have been found, they tend to be extremely weak, accounting for approximately 10-18 percent of the variance in achievement. More problematic in this attempt to discover if affective means lead to achievement ends is the work of Rennie and Punch (1991), which showed that a student's attitude toward science is more strongly tied to previous achievement than that in the future. In other words, students enjoy science because they do well in the subject. Success leads to positive feelings more often than the reverse.

These findings do not bode well for establishing a linear path for greater achievement through increasing positive student attitudes. However, should that be the only reason that attitudes are of importance? Those interested solely in demonstrating that students are learning by pointing to higher test scores would most likely affirm. But what makes an individual want to continue with their involvement in science? Simpson et al. (1994) continues these pertinent questions, "What is it about our educational experience that significantly changes a young person? Why do some graduates become intelligent consumers of science and some do not? Why do some people immerse themselves in science while others shun the scientific enterprise? Why do some students seem to click into place while others wander outside the mainstream of science?" (p. 211). From a teacher's perspective, helping students to develop positive attitudes about science is, in and of itself, a worthwhile goal of science education. With that idea in mind, what aspects of a science education have been shown to demonstrate some relationship with a student's attitude toward science?

One of the first goals of the 1982 Simpson and Troost study was to develop a deeper understanding of the factors that lead to higher levels of commitment to science among adolescent students, with an ultimate goal of learning how to increase this commitment. Several researchers were able to specifically identify what some of these factors were and determined to what extent they were responsible for causing variations in students' attitudes toward science. Various published studies grew out of the data collected from the work of Simpson and Troost. Of the various factors under study, classroom factors were responsible for between 46-73 percent of the variance in these attitudes (Simpson & Oliver, 1990; Talton & Simpson, 1986; Talton & Simpson, 1987). Data from the same study also showed that student attitudes dropped as they aged, (Simpson & Oliver, 1990) along with their motivation to achieve. Particular aspects of a student's overall attitude, such as attitudes toward curriculum, the science teacher, and the physical environment, were found to significantly drop over time as a student progresses through school. Other factors, such as the classroom emotional climate and science self-attitude, were found to be somewhat more stable. Gender differences were also identified, regardless of grade level (Simpson & Oliver, 1990). For instance, males were found to differ significantly from females in terms of anxiety (less) during science class, science self concept, and in their general attitude toward science. Female students were found to have higher scores in their attitude of the physical environment of the science class. These gender differences were still significant when the different ability levels of the students were taken into account (Simpson & Oliver, 1985). It was also found that a student's attitude toward science declines throughout the course of the school year (Cannon & Simpson, 1985).

Among the more important findings of these studies was the ability to predict with high accuracy the likelihood of a student discontinuing his or her attempts to pursue science at a level beyond what was required in the high school curriculum (Simpson & Oliver, 1990). The scores of three affective subscales were 90 % accurate in predicting science enrollment during the last two years in high school in one group of students. Providing learning environments conducive to the development of positive attitudes seems to be critical in keeping pupils in the sciences. The structure of the school day is one aspect of the learning environment that has been modified for a variety of reasons.

Research on Block Scheduling

One of the most recent trends in secondary schools during the last decade has been the transition from a traditional six or seven period day to some form of an extended-time block schedule. One of the popular forms of the block schedule has been the 4x4 block, in which students attend four 90-minute classes each day that meet for one semester only (Hurley, 1997). Students are able to take eight different courses over the school year under this plan. Marshak (1997) states that one of the reasons for this change is to "escape from 'the box' and to create structures for high school based on some very different understandings of human development, learning and teaching, the nature and structure of knowledge, and the cultural and social realities of the present, as well as the future, as well as expectations for the future, than were commonly held in 1920 or 1970" (p. xiv).

Others have provided more pragmatic reasons for the switch to the block schedule. The school operating under this format will benefit from decreased movement of students between classes throughout the day, fewer administrative tasks faced by teachers, better student-teacher ratios, more planning time, promotion of hands-on and cooperative learning, and increased use of a variety of teaching strategies (Queen & Isenhour, 1999). The prevailing wisdom is that teachers will be unable to teach through lecture or other teacher-centered methods for the entirety of the 90-minute block without the use of a variety of exercises and experiences throughout the duration of each class. Students should become more active participants in their education as classrooms become more centered on the student and less so on the teacher. Action researchers concluded in one study of students on the block schedule that the key to student enjoyment of their classes was activity (Marshak, 1997).

Studies focusing on the effects of the implementation of this new form of scheduling have supported the ideas that teachers would use a greater array of techniques and that students would become more active in learning. After the implementation of the block schedule at a school in Southeastern Ohio, 97 % of teachers and 77 % of students stated that teachers supervised a greater variety of projects than under the traditional schedule (Eineder & Bishop, 1997). The same Ohio school reported that 91 percent of teachers and 77 % of students felt cooperative learning was more common during the longer class periods. Students from another pair of Ohio schools were commonly found reporting that extended classes were more interesting and enjoyable (Wronkovich, Hess, & Robinson, 1997). Hurley (1997) reported student support for the block schedule due to increased lab activities and group work. Much, although not all, of the research provides evidence that teachers become more student-centered in their methodologies while teaching in the 4x4 block schedule.

After changing from the traditional schedule, the emotional climate of the classroom has seemed to improve, both for students and teachers. The increased contact time each day has resulted in an increased number of students having more positive attitudes about their relationships with teachers (Eineder & Bishop, 1997) and with teachers feeling more positive about their relationship with students (Mistretta & Polansky, 1997). With the classroom more focused on the activity of the student, the teacher is better able to help those students who need it the most. Hurley (1997) reported in his qualitative study that students perceived more one-on-one time available with their teachers during class. With all of the positive changes in the atmosphere of the classroom, the overall atmosphere of the school experiences a subtle change for the better. Teachers in a California study concur with these findings that both teachers and students seem more relaxed under the block schedule because of fewer classes each day (Staunton & Adams, 1997). In addition, the school as a whole becomes less hectic due to the classroom climate becoming much more relaxed.

Up to this point, almost all research concerning the block schedule has been either open-ended, qualitative surveys and questionnaires, or focused on the correlational relationship between the block schedule and achievement. With these preliminary studies on the effects of the block schedule reporting many positive results, especially in terms of how students feel about the classroom environment, it is worth questioning how the block schedule may affect the attitude toward science that a student may hold. Attempts to establish the relationship between a student's attitude toward the classroom environment and attitude toward science have been supported by Talton and Simpson (1987) who found that student attitudes toward the classroom environment predicted between 56 to 61 percent of the variance in a student's attitude toward science. Talton and Simpson highlighted the significance of their data:

> The importance of classroom environment in relation to student attitudes toward science has been underscored in this study. This is itself is significant. If science curricula and activities are developed that enhance student interest in science, and if classrooms are made stimulating, supportive environments in which students may question and develop their interests in science, an important educational goal will have been achieved. Student commitment to and interest in science will help facilitate these students, as adults, to make enlightened decisions on science-related governmental policies and social issues. (p. 524)

The importance of the classroom environment on the student's attitude toward science is very evident.

With these relationships established, this investigation was designed to describe the relationship of enrollment in a block schedule with a student's attitude toward science and to determine whether or not these attitudes change throughout the course of the semester, as was previously found with students enrolled in a traditional school schedule. Few studies have inquired into this relationship, although Bateson (1990) concluded that there was no significant difference in affective scores of students in British Columbia using data from the Third Provincial Assessment of Science. This study only used data from the end of the course, so there was no investigation as to how affective domains changed. As more is understood about how this type of scheduling affects a student's attitudes about science, better decisions can be made in determining whether a switch to this format of scheduling is worthwhile.

Research Questions

The following research questions were developed to examine the relationships between classroom environment and affective learning outcomes over time:

1. Is there a correlation between classroom environment variables and attitude toward science?
2. Is there a change in attitude toward science and other classroom environment attitudes by students enrolled in semesterized block schedule science courses?

Method

Sample

This investigation was designed as a pilot study to determine changes in attitude toward science and attitude toward other classroom environment variables by science students at the beginning and end of a course operating under the 4x4 block schedule. Students (n = 121) from a small high school in eastern Georgia volunteered to participate in the study. The high school is the only public school in the county, has an enrollment between 700 and 800 students, and serves an adolescent population that is approximately 79% African-American and 19% White. Economically, over 80% of the students in the high school are eligible for either federally subsidized free or reduced lunches. This study included three different classrooms and represented ten different classes (including Physical Science, Biology, Chemistry, and Applied Biology and Chemistry) that were taught during the spring semester of 2000. Each of these classrooms also used student teachers during the year, which increased the number of instructors involved in this study to six.

Of the 121 students who participated in the study, six did not identify their gender during the first administration of the questionnaire. Of the remaining 115 students, 77 were female (67 percent) and 38 were male (33 percent). Eight students did not identify their grade level. Of the 113 remaining, 53 were in the 9th grade (47 percent), 30 were in the 10th grade (26.5 percent), and 30 were in the 11th/12th grade (26.5 percent). During the second administration, 110 students participated, with a loss of 11 students from the first administration. Several students neglected to identify gender and/or grade level, but the percentages of the subgroups during the second administration were essentially the same as in the first.

Instrument

The instrument used in the study was developed by Simpson and Troost (1982) to measure attitudes toward science and other variables associated with school science by middle and high school students. The instrument was designed with short and direct statements (Table 1) with a five-response Likert-type scale.

Table 1.

Items Comprising Instrument Subscales

Attitude toward Science	1. Science is fun. 5. I have good feelings toward science. 8. I enjoy science courses. 15. I really like science. 18. I would enjoy being a scientist. 21. I think scientists are neat people. 24. Everyone should learn about science.
Emotional climate of the science classroom	2. I feel nervous in science class. 9. I usually look forward to my science class. 19. This class is a good place.
Science curriculum	3. We do a lot of fun activities in science class. 10. We learn about important things in science class. 17. We cover interesting topics in science class. 23. I like our science textbook.
Science teacher	4. My science teacher encourages me to learn more science. 11. I enjoy talking to my science teacher after class. 14. My science teacher makes good plans for us. 20. Sometimes my science teacher makes me feel dumb. 22. My science teacher expects me to make good grades.
Anxiety	6. Science makes me feel as though I am lost in a jungle. 12. My mind goes blank when I am doing science. 16. Science tests make me nervous. 25. I would probably not do well in science in college.
Science self-concept	7. I consider myself a good science student. 13. I think I am capable of becoming a doctor or an engineer.

Note: Numbers preceding items indicate position of item in the instrument.

A response of five indicated strong agreement, and a response of one indicated strong disagreement. The original instrument contained 15 subscales that were used to examine attitudes toward science, classroom, school environment, home environment, and "self". For this study only six of the above subscales were selected for examination. The subscales that most directly related to the students' learning environment and science as a subject were chosen for this study. Subscales relating to family interest in science, friends' interest in science, and attitude toward school were not used as a part of this study. There was one attitude toward science scale, three classroom environment subscales, and two "self" subscales. The classroom environment scales examined attitudes about the emotional climate of the science classroom, the science curriculum, and the science teacher. The "self" subscales examined attitudes about science self-concept, and anxiety.

Data Collection Procedures

The attitude instrument was given during the spring semester of the 1999-2000 school year at the beginning and end of the course. During the first administration 121 students responded to the questionnaire. This number dropped to 110 for the second administration due to student loss over time from transfer, absenteeism, or other various reasons. Informal communication with and observation of the teachers in this study were conducted for the purpose of verifying the use of a variety of techniques in the classroom.

Data Analysis

The data were analyzed using SPSS 10.0 software (1999). All statements that were worded negatively were changed during the input of data. For example, "1" was changed to "5", and "2" was changed to "4". Descriptive statistics, such as mean and standard deviation, were then compiled. Data sets were grouped into several categories in order to make comparisons between gender and grade. For each student, the various statements from the questionnaire were summed in each subscale. Since there were seven statements in the Attitude Toward Science subscale, students could score a minimum of seven and a maximum of 35. Other subscales had different maximum/minimum values depending upon the number of items in the scale. Questionnaires with incomplete responses in any items in a subscale were not used in the data analysis. From these descriptives, it was concluded that parametric tests could be used for comparison of groups.

To compare each subscale, Pearson correlation coefficients were calculated using the total data collected. For group comparison, t tests were used to compare individual items and individual subscales at both times for total population, both genders, and each grade level. T-tests were also used to compare each grade and gender group to one another after each administration. Alpha reliability was calculated for each subscale.

Results

Reliability

Of the six subscales used in the study, acceptable alpha reliability was found in all but one (Table 2).

Table 2.

Reliability of Subscales

	Number of Items On Subscale	Alpha Reliability
Attitude Toward Science	7	.8730
Emotional Climate of The Classroom	3	.5280
Attitude Toward the Science Curriculum	4	.7579
Attitude Toward the Science Teacher	5	.6763
Science Anxiety	4	.1601
Science Self-Concept	2	.4251
Emotion Scale with Item 2 Omitted	2	.7070
Anxiety Scale with Item 25 Omitted	3	.6624

The Attitude Toward Science subscale, consisting of the largest number of items, had the highest reliability (0.8730), while the 4-item Science Anxiety subscale had the lowest alpha (0.1601). However, one item of the anxiety subscale was most responsible for this low value. The item, "I probably would not do well if I took science in college" was significantly lower than the other three items in the subscale. With the removal of this item from the group, the alpha value increased to 0.6624 with the other three items. The subscale for Emotional Climate of the Classroom was also lower than the others (0.5280), although there were only three items in the group. Again, one item, "I feel nervous in science class", was significantly higher (more positive) than the others. The removal of this item from the scale increased reliability to 0.7070.

Correlations

Each of the six subscales correlated significantly ($p<.01$) with each of the other groups (Table 3).

Table 3.

Correlation Coefficients (Pearson) for Subscales

	Curriculum	Emotion	Teacher	Self-Concept	Anxiety
Attitude Toward Science	.655	.675	.500	.585	.424
Attitude Toward The Science Curriculum	---	.572	.634	.477	.319
Emotional Climate of The Science Classroom	---	---	.517	.675	.367
Attitude Toward the Teacher	---	---	---	.353	.306
Science Self-Concept	---	---	---	---	.543

Note. All values are significant at $p<.01$

Of these, three had a Pearson coefficient greater than 0.65: Attitude Toward Science – Science Curriculum (0.655), Attitude Toward Science – Emotional Climate of the Classroom (0.675), and Emotional Climate of the Classroom – Science Self-Concept (0.675). The lowest Pearson coefficients were found between Attitude Toward the Teacher – Science Anxiety (0.306) and Attitude Toward Curriculum – Science Anxiety (0.319). The Attitude Toward Science was found to have the highest correlations of all groups, with the least significant relationship found with Science Anxiety, although the Pearson value for this was still significant (0.424).

Grade Levels

Students in the ninth grade reported the most positive overall scores during the first administration of the instrument (Table 4).

Table 4.

Time 1 Mean Scores (Standard Deviation)

	Total	Males	Females	9th	10th	11th /12th
Attitude toward science						
1.	3.04(1.27)	3.13(1.07)	3.00(1.19)	3.07(1.11)	2.90(1.14)	3.03(1.25)
5.	3.03(1.22)	3.05(1.35)	2.97(1.15)	3.02(1.31)	2.90(1.22)	3.10(1.13)
8.	3.02(1.25)	3.03(1.20)	2.90(1.32)	2.98(1.23)	3.00(1.29)	3.10(1.21)
15.	2.74(1.28)	3.43(1.29)	3.20(1.26)	2.67(1.23)	2.61(1.36)	2.73(1.28)
18.	2.07(1.22)	2.14(1.16)	1.96(1.27)	2.06(1.14)	1.90(1.17)	2.10(1.37)
21.	3.20(1.24)	3.10(1.15)	3.20(1.29)	3.05a(1.25)	3.00x (1.31)	3.66(1.14)
24.	3.71(1.15)	3.80(0.99)	3.67(1.24)	3.64(1.22)	3.41x (1.18)	4.14(0.95)
Emotional climate						
2.	4.36(0.88)	4.55(0.64)	4.26(0.98)	4.46A(0.75)	4.03(1.13)	4.52(0.98)
9.	2.96(1.27)	3.03(1.20)	2.90(1.32)	3.19A(1.18)	2.58(1.33)	2.83(1.32)
19.	3.15(1.30)	3.37(1.26)	3.05(1.32)	3.35C(1.29)	2.48x(1.15)	3.30(1.32)
Science curriculum						
3.	3.27(1.19)	3.58(1.22)	3.14(1.18)	3.63C(1.14)	2.61x(1.17)	3.20(1.06)
10..	3.81(1.21)	4.08*(0.88)	3.65(1.35)	4.20C(0.79)	3.16(1.46)	3.70(1.34)
17.	3.28(1.26)	3.43(1.26)	3.20(1.30)	3.52A(1.21)	2.79(1.45)	3.28(1.16)
23.	2.61(1.20)	2.33(1.12)	2.69(1.23)	2.56(1.30)	2.48(1.27)	2.79(1.05)
Science teacher						
4.	3.59(1.21)	3.89*(1.09)	3.44(1.25)	3.85C(1.07)	3.10(1.40)	3.43(1.14)
11.	2.43(1.10)	2.46(1.04)	2.39(1.05)	2.46(1.13)	2.14(1.13)	2.55(1.05)
14.	3.58(1.03)	3.74(0.72)	3.53(1.17)	3.81C(0.87)	3.07(1.20)	3.53(1.01)
20.	3.99(1.23)	3.83(1.23)	4.00(1.25)	4.12(1.14)	3.69(1.44)	4.03(1.18)
22.	4.18(0.89)	4.13(0.82)	4.24(0.91)	4.26(0.73)	4.07(1.13)	4.21(0.86)
Anxiety						
6.	3.66(1.39)	3.87(1.23)	3.53(1.44)	3.80(1.16)	3.58(1.52)	3.70(1.58)
12.	3.56(1.32)	3.37(1.42)	3.64(1.25)	3.70(1.33)	3.23(1.43)	3.67(1.21)
16.	3.03(1.44)	2.71(1.35)	3.13(1.46)	2.98(1.46)	2.94(1.41)	3.37(1.40)
25.	2.82(1.43)	3.13(1.33)	2.71(1.45)	3.19a(1.40)	2.72(1.28)	2.41(1.55)
Science self concept						
7.	3.50(1.26)	3.32(1.40)	3.56(1.19)	3.33a(1.33)	3.50(1.20)	3.87(1.14)
13.	2.98(1.24)	2.84(1.15)	3.06(1.29)	2.74(1.25)	3.19(1.31)	3.10(1.14)

Notes.

- * Mean is significantly different from females at the 5% level
- (A) Mean is significantly different from 10th grade at the 5% level
- (B) Mean is significantly different from 10th grade at the 2% level
- (C) Mean is significantly different from 10th grade at the 1% level
- (a) Mean is significantly different from 11th / 12th grade at the 5% level
- (b) Mean is significantly different from 11th / 12th grade at the 2% level
- (c) Mean is significantly different from 11th / 12th grade at the 1% level
- (x) Mean is significantly different from 11th / 12th grade at the 5% level
- (y) Mean is significantly different from 11th / 12th grade at the 2% level
- (z) Mean is significantly different from 11th / 12th grade at the 1% level

Numbers in the left margin correspond with statements on Table 1.

In particular, they gave the most positive responses to the Emotion, Curriculum, Teacher, and Anxiety scales, although they had the least positive beginning score in the Self-concept scale. Of note was the decline in all scales over the course of the semester, with the exception of the Attitude Toward Science scale, which rose minimally (Figure 1).

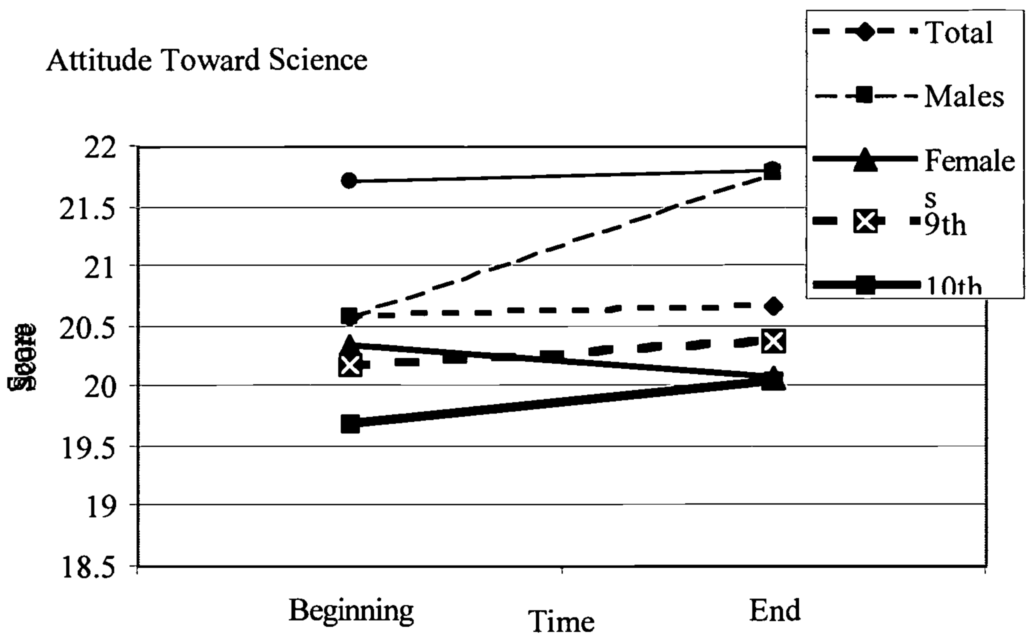

Figure 1. Change in attitude toward science by group over time. The maximum score was 35 and the minimum was 7.

The only significant change that was found was in the decrease reported on the Emotional Climate of the Classroom (Figure 2) scale ($p<.001$).

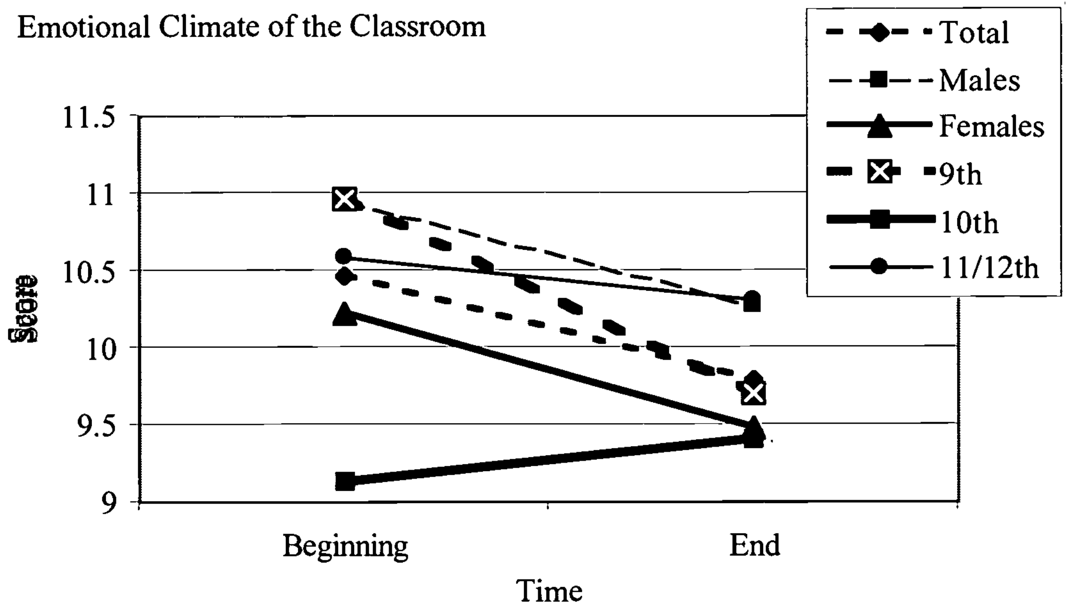

Figure 2. Change in the emotional climate of the classroom by group over time. The maximum score was 21 and the minimum was 3.

Also, students in Grade 9 had significant ($p<.05$) decreases in four items (#2, 9, 19, & 20) over the course of the semester (see Table 1 for these items). Three of these four were found in the Emotional Climate of the Classroom subscale.

Grade ten students reported the lowest overall scores at both the beginning and end of the semester. Scores for these students remained fairly constant throughout the school year, although four of the six scales (attitude toward science, emotion, curriculum, and teacher) became more positive, while the other two (anxiety and self-concept) decreased. None of the changes were significant. One item, "Science makes me feel as if I were lost in a jungle" was the only item with a significant ($p<.025$) decrease.

Students in grades eleven and twelve were pooled together during data collection because each group was fairly small, and they tended to be enrolled in classes together.

For example, Grade 9 students were mostly enrolled in physical science, while Grade 10 students in the study were enrolled in biology. Students in the highest two grades made up the enrollment in three other science classes. In other words, there were no courses taught that were either purely Grade 11 or Grade 12.

These students reported the highest ending scores of all groups (Table 5).

Table 5.

Time 2 Mean Scores (Standard Deviation)

	Total	Males	Females	9th	10th	11th /12th
Attitude toward science						
1.	2.97(1.20)	2.95(1.29)	2.99(1.16)	2.92(1.21)	2.68x(1.28)	3.31(1.07)
5.	2.86(1.21)	3.16(1.21)	2.70(1.18)	2.85(1.15)	2.68(1.28)	3.03(1.27)
8.	2.87(1.24)	2.97(1.14)	2.81(1.28)	2.89(1.25)	2.68(1.16)	3.03(1.30)
15.	2.68(1.35)	2.81(1.39)	2.59(1.36)	2.64(1.33)	2.50(1.43)	2.93(1.33)
18.	2.15(1.30)	2.56*(1.50)	1.93(1.14)	2.12(1.22)	2.26(1.43)	2.10(1.37)
21.	3.37(1.28)	3.47(1.16)	3.32(1.34)	3.37(1.32)	3.30(1.41)	3.46(1.10)
24.	3.64(1.33)	3.67(1.35)	3.61(1.35)	3.52(1.41)	3.61(1.52)	3.89(0.95)
Emotional climate						
2.	3.96(1.17)	3.95(1.20)	3.94(1.18)	4.00(1.21)	3.93(1.27)	3.93(1.03)
9.	2.73(1.29)	2.92(1.40)	2.64(1.24)	2.67(1.25)	2.68(1.36)	2.86(1.33)
19.	3.08(1.31)	3.41*(1.40)	2.87(1.22)	2.98(1.37)	2.82x(1.31)	3.52(1.12)
Science curriculum						
3.	3.20(1.22)	3.17(1.22)	3.23(1.21)	3.30(1.20)	3.07(1.39)	3.14(1.09)
10.	3.35(1.10)	3.43(1.22)	3.30(1.00)	3.33(1.11)	3.36(1.26)	3.38(0.88)
17.	3.35(1.19)	3.43(1.17)	3.30(1.18)	3.33(1.23)	3.36(1.28)	3.38(1.05)
23.	2.68(1.21)	2.86(1.24)	2.59(1.19)	2.54(1.24)	2.57(1.26)	3.04(1.03)
Science teacher						
4.	3.63(1.23)	3.86(1.20)	3.49(1.24)	3.60(1.21)	3.43(1.40)	3.89(1.07)
11.	2.35(1.21)	2.59(1.30)	2.24(1.16)	2.25(1.23)	2.32(1.16)	2.54(1.26)
14.	3.31(1.18)	3.41(1.09)	3.30(1.22)	3.42(1.20)	3.21(1.23)	3.21(1.11)
20.	3.42(1.61)	3.53(1.57)	3.41(1.65)	3.52(1.58)	3.14(1.71)	3.50(1.62)
22.	4.29(0.93)	4.31(0.89)	4.29(0.95)	4.21(1.01)	4.32(1.02)	4.39(0.63)
Anxiety						
6.	3.29(1.47)	3.76**(1.34)	3.04(1.49)	3.55B(1.35)	2.68(1.49)	3.38(1.57)
12.	3.30(1.46)	3.92***(1.30)	3.01(1.45)	3.45(1.54)	3.18(1.39)	3.14(1.41)
16.	3.03(1.47)	3.24(1.30)	2.84(1.53)	2.92(1.40)	2.68x(1.52)	3.55(1.45)
25.	2.87(1.55)	2.83(1.63)	2.86(1.53)	2.67(1.50)	3.36(1.73)	2.75(1.38)
Science self concept						
7.	3.48(1.30)	3.43(1.35)	3.46(1.28)	3.35(1.52)	3.43(1.10)	3.76(1.02)
13.	2.62(1.48)	2.62(1.46)	2.56(1.47)	2.77(1.53)	2.61(1.42)	2.34(1.47)

Notes.

* Mean is significantly different from females at the 5% level

** Mean is significantly different from females at the 2% level

*** Mean is significantly different from females at the 1% level

(B) Mean is significantly different from 10th grade at the 2% level

(x) Mean is significantly different from 11th / 12th grade at the 5% level

Like Grade 10 students, there was no change found from the beginning to the end of the semester. Of the six subscales, four declined, but only minimally. The exception to this was in the Science self-concept (Figure 3) which, although not significant (p<.143) was more substantial than the others.

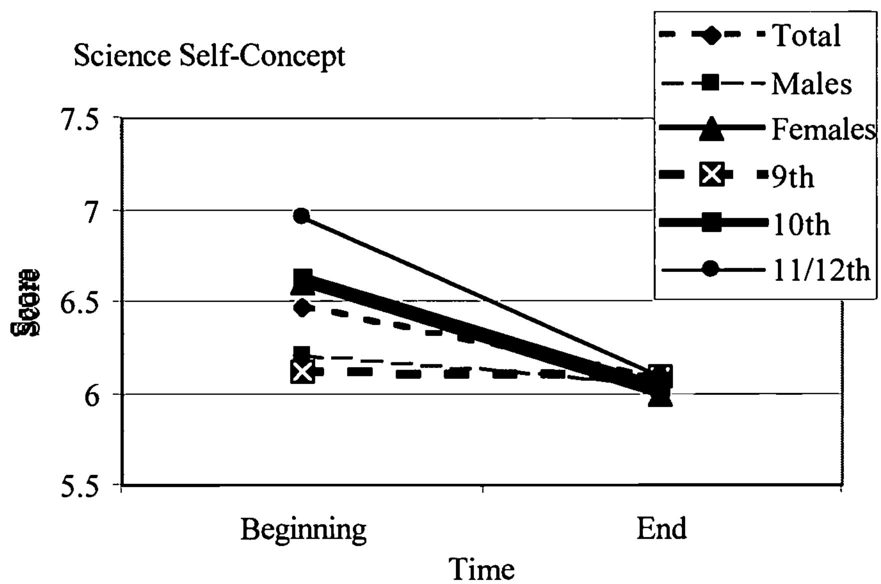

Figure 3. Change in students' science self-concept by group over time. The maximum score was 10 and the minimum was 2.

Scores for the Attitude Toward Science and Emotional Climate of the Classroom increased, but neither was significant. Only one item, "I feel nervous in science class" was found to have a significant decrease (p<.05).

In comparing each grade level to one another, several significant differences were found at the beginning of the semester, although none were found at the end. Grade 9 students were more positive than Grade 10 students in the Emotional Climate of the Classroom, Science Curriculum, and the Science Teacher. Students in grades eleven and twelve were more positive than Grade 10 students, as well, in the Emotional Climate of the Classroom.

Gender

Male students reported the most positive scores on four of the subscales at the beginning of the semester and on all scales at the end of the semester in comparison with females. There were no significant changes found between the ends of the semester in any of the subscales. Three scales (attitude toward science, curriculum, and anxiety) became more positive while the other three (emotion, teacher, and self-concept) each became more negative.

Female students reported higher values on Science Anxiety (meaning they actually had less anxiety) and in Science Self-Concept when the semester began. All scores dropped during the course of the semester, although only the anxiety subscale (Figure 4) was found to have a significant decrease.

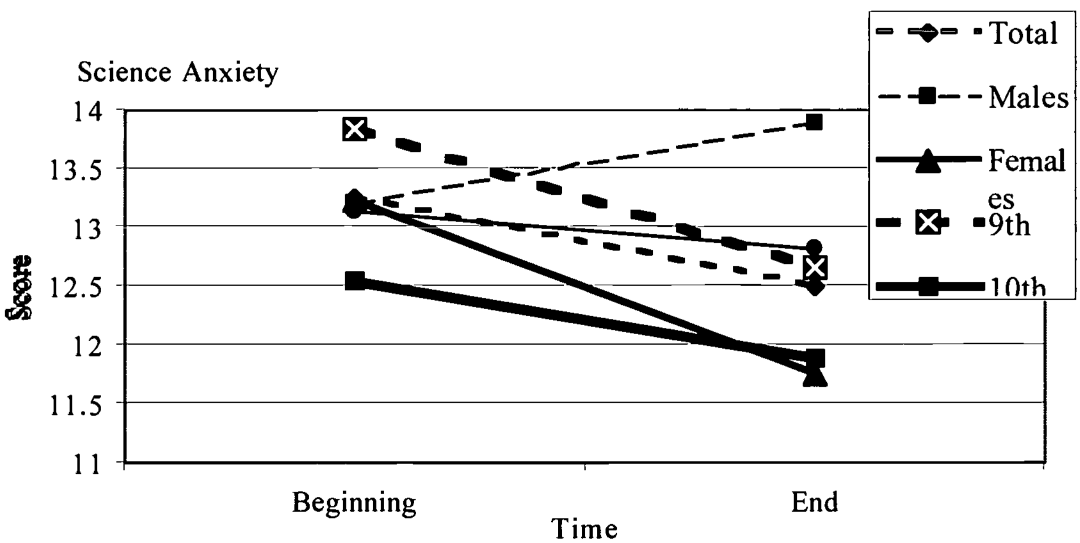

Figure 4. Change in levels of student anxiety toward science by group over time. The maximum score was 20 and the minimum was 4.

No significant differences were found when comparing the gender groups at either time of the administration, except at the end when females had a significantly lower score in Science Anxiety ($p<.011$), meaning that females had more anxiety.

Conclusion

The results from several parts of this instrument replicate findings from its first usage 20 years ago. First, the reliability values found indicate that the Simpson-Troost instrument is still useful in providing a glimpse into students' collective views on several important variables of interest to researchers in the school experience. Although two items used on the instrument decreased the reliability of subscales, the use of this instrument to investigate the principle subscale (Attitude Toward Science) demonstrated reliability. Almost all alpha values reported in this administration were similar to those found by Talton and Simpson (1986) in their analysis from data twenty years previous. The two items on the instrument that decreased the reliability in their respective subscales may need to be examined in future uses where these subscales are a primary part of the investigation.

With the reliability of the instrument supported, the research questions posed become important. Previous research showed significant relationships between students' attitude toward science and other classroom environmental variables. This study used subscales of Emotional Climate of the Classroom, Attitude Toward the Science Teacher, and Attitude Toward the Science Curriculum to investigate these previous claims. The Pearson correlation coefficients that were found from this population further support the relationship between classroom variables and a student's attitude toward science. The coefficients found with this group show either moderate or modest positive relationships between all subscales. This lends support to the idea of this study that changing the structure of the classroom may have some effect on improving attitudes toward science in the classroom. Although this is far from being the only factor influencing these attitudes, the research shows support that the environment plays an important role in how students feel about science.

Differences between grade levels and gender were also found in this study. One of the most glaring differences found in the data are the large declines in Grade 9 on most subscales. Although the only significant change (p<.05) was in the Emotional Climate of the Classroom, two other variables dropped quite dramatically, and with a larger sample size, may have showed significance. Science Anxiety (Figure 4) and Attitude Toward the Science Teacher (Figure 5) each dropped with a significance of approximately 0.10.

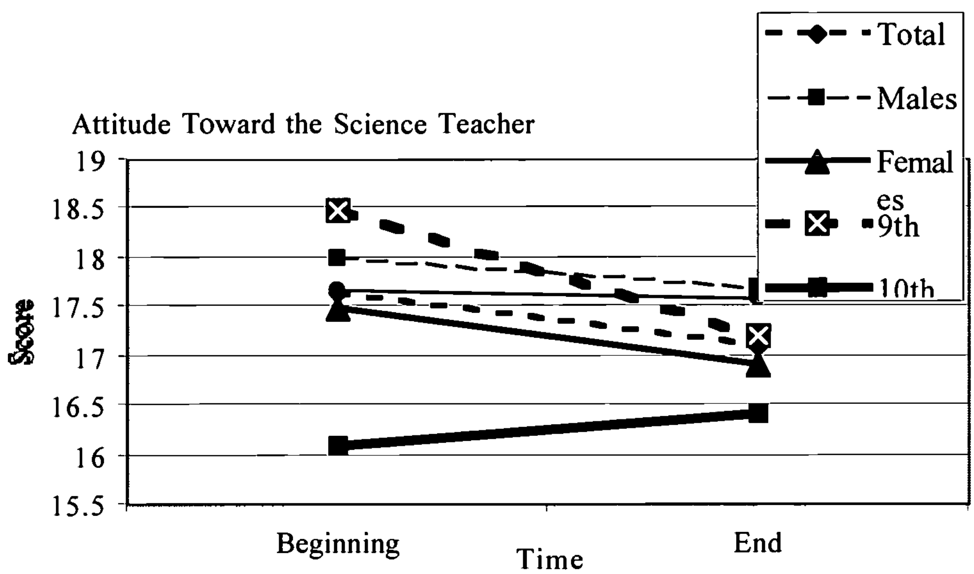

Figure 5. Change in levels of students' attitude toward the science teacher. The maximum score was 25 and the minimum was 5.

More puzzling was that, although many of these subscales dropped quite a bit, the Grade 9 students' Attitude Toward Science actually increased. The t-value that was associated most closely with this subscale was in the students' Science Self-Concept.

Some of these finding have been reported in previous research. For instance, Simpson and Oliver (1985) presented data that showed Grade 9 students reported higher attitudes toward science than Grade 10 students. Possible explanations for this may be found in the novelty and excitement of being in a new school after leaving the middle school years. However, students may quickly come to dislike their science classes, and other classes, as well, because of the high academic demands that are placed upon them as they enter high school. With state mandated achievement tests influencing the amount of fact acquisition by students in this study, it is not surprising to find that they come to dislike certain aspects of school as the year passes.

Another interesting observation of the data was the increase found in Grade 10 students on four of the six subscales. These students also began the year with lower scores on all scales. This is a phenomenon that seems anomalous when comparing the data to previous research. One possibility is that many of these students developed negative feelings about high school during their first year and became more acclimated as their second year continued. Students in Grades 11 and 12 showed the most stable results of all grade levels, suggesting the possibility that attitudes in the science courses may become more difficult to change as the students continue through their school experience.

There was little significance found in comparing males and females, but the fact that males reported more positive scores than females on all subscales is worth noting. With the widespread research into gender differences in science and in science careers, this study gives further evidence to these differences. Even though the females' score on Attitude Toward Science decreased, it was not significant. The only subscale in which female scores did not decrease was in the Attitude Toward Curriculum. This is the subscale that most directly relates to what is occurring in the science classroom. Although the classroom experiences of females in this study led them to report decreases in all other scales, an increase was found in how they felt about the science class itself. Perhaps the extended block of time is more in line with how females like to learn in the science class, with the very small decrease in Attitude Toward Science lending support to this.

Limitations and Implications

This study does not allow for generalizability to all other school groups. The population used for this study is very different from those found in many parts of the United States. However, there are many schools in the rural Southeastern United States that have characteristics very similar to this one. The low scores reported at the beginning of the semester by these students in comparison with the data reported from the early 1980's is of particular concern. Although there was little change in students' attitude toward science throughout the semester, the fact that these poor, rural students of color (80%) were much more negative toward science may suggest a future of science that continues to lack members from such a background. Research into the learning experiences of these students in their early years could help discern reasons behind this.

The influence of high stakes testing is also of concern in this study. Although not mentioned before, this school had scored in the lowest 25% of all high schools in several sections of the state mandated high school graduation exam, which must be passed in order for students to earn a diploma. Because of this, quite a bit of classroom time is dedicated to reviewing topics that are a part of these tests. Although such tests are well-intentioned in their goals of producing more knowledgeable students, they may do so at the expense of student attitudes toward science and learning. These tests may have an influence in the large decline in Science Self-Concept found in this sample of students.

One of the main limitations of this study was in the lack of data supporting how the classroom environment actually changes when a block schedule is implemented. Although there is support that teachers working during a 90 minute block of time make the classroom more centered on the student, empirical evidence for this is minimal at best. Future studies comparing teaching methods and planning by teachers using the block schedule with those on a traditional schedule would help in identifying whether or not these are advantages that are actually occurring in the classroom. Although I feel confident, through colleague conversations and informal classroom observation, that the classrooms used in this study were student-centered, hard evidence would better support the idea that the 90 minute block schedule creates a learning environment that is more conducive to positive student attitudes.

Even though the scores reported by these students in their attitude toward science were lower than data previously found, the fact that there was little decline during the course of the year is an important finding in support of implementing the 90-minute block schedule. For whatever reason, though not pinpointed in this study, student attitudes were only minimally lower at the end (and higher in some groups) than at the beginning.

Also important to note was the increase by all groups in their Attitude Toward the Science Curriculum (Figure 6).

Figure 6. Change in the students' attitude toward the science curriculum. The maximum score was 20 and the minimum was 4.

In particular, female students reported the most positive changes in this category, providing support that this type of scheduling is consistent with their learning styles and preferences. Further research into this may prove fruitful.

Although attitudes toward science are not an area of bountiful research in recent years, these topics are still important to look at when large-scale changes are made at the school level. If we can implement changes into the science classroom that have a positive effect on affective dimensions of learning, this may be as important a transformation in students as in their cognitive gains. The continued concerns of future pursuit of science as a career is connected, as shown above, with how students feel about science. Providing an environment that can foster these feelings without sacrificing achievement should be a goal of the science education community, especially if minority growth in the sciences is of concern.

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