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The effect of an activity based integrated science curriculum on secondary student attitudes

Norma M. Clauson

THE EFFECT OF AN ACTIVITY BASED INTEGRATED SCIENCE CURRICULUM ON SECONDARY STUDENT ATTITUDES

A Project

Presented to the

Faculty of

California State University,

San Bernardino

In Partial Fulfillment

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Master of Arts

in

Education: Secondary

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ABSTRACT

The State of California has responded to the national reform movement in science education by publishing a new science curriculum framework. This framework suggests that at least twenty-five percent of class time should be devoted to inquiry based hands on activities. The framework also recommends the implementation of an integrated science curriculum for kindergarten through tenth grade students. Since positive student attitudes toward science have been found to affect the pathways that students choose in post-secondary education, a study was conducted to evaluate the impact of a newly developed integrated curriculum on the attitudes of secondary science students. Using an attitude assessment survey, a comparison of student attitudes was made between ninth grade biology students and ninth grade integrated science students. 442 grade nine students from Cajon High School in the San Bernardino City Unified School District participated in the study. The results of the study found that a greater percentage of biology students had more positive attitudes toward their science class than did integrated science students. Factors that were identified as possibly contributing to the difference in positive attitudes were student experience with inquiry learning, teacher enthusiasm, and a reduction in textbook directed learning.

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INTRODUCTION

Pre-college science education in the United States is currently undergoing one of the biggest reform movements since the post Sputnik era (1993, Beardsley). Spurred by reports that the performance of U.S. science students falls far below the performance of students from other nations with comparable standards of living, the reform movement has attempted to redefine the goals of science education for the twenty-first century (1992, Commission on Teacher Credentialing - State of California). Traditionally, the role of science education in secondary school curriculum has been to prepare students for further education at the college or university level (1986, Mayer). The current reform movement, however has changed the goal of science education. The American Association for the Advancement of Science has defined science education's new goal to be the development of a "higher level of scientific literacy" in all Americans (1992, Commission on Teacher Credentialing).

The State of California responded to the national science education reform movement by publishing a new science framework in 1990. This new framework stressed the importance of experimentation and discovery in the teaching of science, and suggested that at least twenty-five percent of class time should be devoted to "hands-on" activities that stressed inquiry learning (1990, Science Framework for California Schools). The requirement to use more inquiry

learning in the science classroom was intended to provide students with an opportunity to experience the process of science. The authors of the framework hoped these experiences would help students develop an understanding of the process of science and that students would come to appreciate science as a tool for solving problems (1990, Science Framework for California Schools).

Another major change outlined by California's 1990 Science Framework was the transition from the traditional sequential curriculum approach to the development of an integrated science curriculum for kindergarten through tenth grade students. Integrated science instructs students in all areas of science simultaneously, by using a unifying topic. It is believed that an integrated approach will increase student enjoyment and performance, because it allows students to link ideas from one lesson to the next and demonstrates the inter-relatedness of science concepts (Science Framework for California Schools, 1990).

As the new changes proposed by California's 1990 Science Framework are implemented, an important consideration that must be remembered is that "to be effective, science education should be enjoyable" (1990, Science Framework for California Schools, p. 1). Current educational research suggests that attention must be given to student attitudes because student attitudes greatly affect the pathways that students choose for post secondary

education (1994, Simpson). California's 1990 Framework describes one of the responsibilities of educators is to ensure that historically underrepresented students have an equal opportunity to succeed in science related endeavors. The research on student attitudes toward science suggests that if students from underrepresented groups are going to choose pathways that will lead to science related careers, then these students must enjoy their experiences in the science classroom (1994, Simpson).

The purpose of this study was to evaluate the impact of the newly developed integrated science curriculum on the attitudes of secondary science students. Prior to completing the study it was believed that the use of an integrated science curriculum would not affect student attitudes toward their science class but that the increased use of inquiry based activities would result in more positive student attitudes.

The students that were evaluated in this study were ninth grade science students enrolled at Cajon High School located in San Bernardino, California. Cajon High School is part of the San Bernardino City Unified School District which has a total of fifty-seven schools and a student population of over 45,000. Cajon High School is one of four comprehensive high schools in the district and has a student population of just over 2200. The ethnic make up of Cajon High School is 38% White- not of Hispanic origin, 37%

Hispanic, 17% Black- not of Hispanic origin, and 8% other (1994, Cajon High School Self Study Report).

The students who participated in this study were enrolled in either a biology program or an integrated science I program. The Integrated Science I course is designed to integrate concepts from biology, earth science and biochemistry and is more similar to a life science program than a physical science program. The characteristics of the student population in each course was dependent upon the nature of each student's course of study. Students that are considered to be honor students in science are enrolled in the ninth grade honors course designated as Pre International Baccalaureate Biology (PIB Biology). Placement into the honors course is generally determined by past school performance, teacher recommendation, and parent request. Students that are not enrolled in the honors science program are either placed in college preparatory biology (Biology C), non college preparatory biology (Biology A) or the newly formed integrated science course (Integrated Science I). Placement into the integrated science program is done randomly by computer with no attention being given to the academic skill level of the student. Integrated science classes are, therefore, considered to be composed of a heterogeneous student population. The number of students enrolled in the integrated science program is limited by the number of

teachers participating in the pilot program (3 teachers). Students not placed in PIB Biology or Integrated Science I are placed into either a college preparatory biology class (Biology C) or a non-college preparatory class (Biology A). The student's past academic record is used to determine in which level of biology the student is placed.

Students from the classes of several different teachers were used in this study. The following is a brief description of each teacher's qualifications for teaching secondary science. Teacher A teaches integrated science and currently holds Single Subject Credentials in Chemistry, Life Science, Geology, and Physical Science from the State of California. Teacher A received a B.S. in Biology and a Master of Arts Degree in Education, and has been teaching at this school site for six years. Teacher B teaches integrated science and holds a California State Single Subject Credential in Life Science and a supplemental credential in Earth Science. Teacher B received a B.S. in Resource Science and has been teaching at this school site for two years. Teacher D teaches college preparatory biology and has a California State Standard Secondary Life Science credential. Teacher D received a B.S. in Biology and a Master of Arts degree in Botany, and has been teaching at this school site for twenty years. Teacher E teaches college preparatory biology and has a California State Emergency Credential in Life Science. Teacher E received a

B.A. in Physical Education and has been teaching biology at this school site for two years. Teacher F teaches non-college preparatory biology and has a California State Single Subject Credential in Life Science. Teacher F received a B.A. in Physical Education and a Master of Arts degree in Education. Teacher F has been teaching at this school site for four years. Teacher H teaches Pre International Baccalaureate Biology and holds a California State Single Subject Credential in Life Science. Teacher H received a B.S. in Wildlife Biology and has been teaching at this school site for seven years. One teacher teaches both integrated science and Pre International Baccalaureate Biology. This teacher was designated as Teacher C when teaching integrated science, and as Teacher G when teaching Pre International Baccalaureate Biology. Teacher C/G holds a California State Single Subject Credential in Life Science and a supplemental K-9 General Science credential. Teacher C/G received a B.S. in Biology and has been teaching at this school site for five years.

PROCEDURE

A preliminary survey was administered to 187 first year science students at Cajon High School to establish if a difference in student attitudes existed between students enrolled in the ninth grade biology program and students enrolled in the ninth grade integrated science program.

This preliminary survey consisted of thirty Lickert scale questions obtained from the Iowa Assessment Package for Evaluation in Five Domains of Science Education (1989, McComas). The questions that were selected for this survey were designed to evaluate student attitudes toward their current science class curriculum, the instructional strategies employed by the teacher, how often students performed activities and laboratories, and how students felt about science in general (Appendix A). Teachers were also asked to complete a questionnaire for each class that participated in the survey. Teacher information included class size, the predominate grade level of students, the percent of time students were required to perform hands on activities and the percent of time students were required to perform experiments (Appendix A).

After collecting data from the preliminary survey, the criteria were established of what was considered to reflect a positive attitude. "Yes" responses to the questions "Is your science class fun?", "Is your science class interesting?", and "Do you look forward to going to your science class?" were considered to reflect a positive attitude. Also considered to be a positive response was the choice of science as the student's favorite subject. After the criteria for measuring positive student attitudes were defined, a comparison of student attitudes was made between

the integrated science program and the biology A, biology C, and PIB biology programs.

Previous studies on the use of a new curriculum indicate that the type of curriculum employed has little effect on student attitudes (1994, Simpson). Information from the preliminary survey in this study revealed that a difference in student attitudes toward the biology program and the integrated science program did exist. A major difference that was observed between the two programs was student perception of time spent performing activities or laboratories. This finding resulted in the formation of two hypotheses: 1). More positive student attitudes would be obtained from students who performed experimentally oriented activities more frequently than other students, and 2). The type of curriculum used to instruct students would not affect the frequency of positive student attitudes. To specifically address these hypotheses, the questions on the survey were changed to evaluate only two areas, student attitudes and time spent performing activities that are associated with experimentation. The first eight questions of the second version of the survey were taken directly from the preliminary survey. The remaining seven questions on the survey were newly constructed and asked students to estimate how frequently they were required to perform different steps of the experimental processes (Appendix A).

The preliminary teacher questionnaire also had to be modified before administering the second student survey. The information provided by some teachers was not congruent with respect to the time students were reportedly performing hands on activities and experimental laboratories. The teacher estimates of hands on activity time and experiment time appeared to be exaggerated when compared to the student data. Teachers also expressed difficulty in distinguishing between hands on activities and laboratories that were experimental. The questions that were used on the teacher survey to estimate the frequency that students performed specific activities were therefore, the same seven as those used on the student survey. Questions which were designed to evaluate teacher attitude toward the curriculum were also included, as well as questions that asked teachers to list factors that limited them from including more experimental activities in their program (Appendix A).

The second survey was administered to 366 ninth grade biology students and 176 ninth grade Integrated Science I students. The administration of the student survey was done by the seven participating classroom teachers after the first twenty weeks of school had been completed. Teachers were asked to complete one questionnaire for each subject taught. Once all student survey answer sheets were collected, the results were tallied and analyzed for each teacher and for each program. The results of the survey

collected from the three levels of biology classes were tallied separately from each other so that comparisons between students of different skill levels could be made. Data from the Biology C and Biology A programs was also grouped so that comparisons could be made between groups of students that had similar skill levels. A decision to not pair-match student data was made due to time constraints.

REPORT OF SURVEY RESULTS

A comparison of Biology A student data to Biology C student data reflected that Biology A students have a more positive attitude toward their science class than Biology C students (Table 1 and 2: Question 1, 2, 3, and 5). Biology A students also appear to perform activities less frequently, use a text book less frequently, and enjoy problem solving less than Biology C students (Table 1 and 2: Question 9, 10, and 15). When a comparison of student attitudes was made between the integrated science course and the Biology A course, it was found to exhibit the same relationship that was seen when a comparison of student attitudes was made between the integrated science course and the Biology C course. The same relationship between the two biology courses and integrated science also existed when time spent performing specific activities was compared. A decision was made, therefore, to group Biology A and Biology C data together so that when comparisons were made between

the two student populations they were being made between populations that had students with similar skill levels.

A comparison of student attitudes between integrated science and Biology A and C students revealed that overall, biology students (students enrolled in Biology A and Biology C) enjoy their science course more than integrated science students (Graph 1). Table 3 reflects that 53% of the biology students surveyed felt that their science class was fun (Question 2) and 64% felt that their class was interesting (Question 3). Of the integrated science students that were surveyed, however, only 22% felt their class was fun (Table 4: Question 2) and only 40% of the students thought the class was interesting (Table 4: Question 3). Another indication that biology students enjoy their science course more than integrated science students is the fact that 16% of biology students stated that their science course is their favorite subject in school (Table 3: Question 1), and 49% of them look forward to going to their science class (Table 3: Question 5). Only 5% of integrated science students stated that their science course is their favorite subject (Table 4: Question 1) and only 21% of them look forward to going to their science class (Table 4: Question 5).

Originally, it was hypothesized that positive student attitudes would be linked to increased activity time. When a statistical comparison of student enjoyment and time spent

performing hands on activities was done using a standard Chi-Square test, the results indicated that although the two factors were found to be significantly related at the .001 level, the correlation coefficient, phi, was calculated to be only .254. This low correlation coefficient indicates that although student enjoyment and activity time were found to b statistically related, they do not have a strong correlation. The weak correlation between increased activity time and positive student attitudes can be evidenced by viewing individual teacher data. Graph 2 shows that a low percentage of Teacher D's biology students (26%) reported that they perform activities frequently or sometimes, and yet 65% of Teacher D's students report that this class is fun and 61% state that they look forward to going to class. Eighty-six percent of Teacher A's integrated science students state that they perform activities frequently or sometimes and yet only 22% of Teacher A's students think the class is fun and 16% of them look forward to going to this class (Graph 1).

Although the newly implemented integrated science program was designed to have more hands on activity time than the traditional biology program, the data indicates that this is not necessarily the case. A comparison of the frequency of performing activities and experiments between integrated science and biology revealed that overall, the two programs are not very different (Graph 3). Sixty-eight

percent of the integrated science students indicated that they performed activities frequently or sometimes (Table 4: Question 9). Sixty-one percent of biology students responded in the same manner (Table 3: Question 9).

A large difference in the types of activities performed was found between the two courses (Graph 3). Responses to question 11 indicate that 46% of integrated students felt they were required to make a hypothesis either frequently or sometimes (Table 4), whereas only 27% of biology students felt they were required to form a hypothesis frequently or sometimes (Table 3). The dramatic difference between the two courses with respect to hypothesizing may indicate that the integrated science program asks students to use problem solving and experimentation skills more often than the biology program.

Although there is a fairly large difference between the two programs with respect to student perception of time spent hypothesizing, there is little difference between the two courses with respect to time spent collecting data (Graph 3). Table 3 indicates that 69% of biology students felt that they were required to collect data either frequently or sometimes (Question 12), while 64% of integrated science students felt they were required to collect data either frequently or sometimes (Table 2: Question 12). The discrepancy between time spent hypothesizing and time spent collecting data in the biology

program suggests that biology students may be performing activities that are more observational than experimental in nature.

Another major difference between the two programs with respect to the type of work performed was found by comparing the amount of time students spend using a textbook (Graph 3). The data reflects that biology classes use the textbook much more frequently than the integrated science classes. Ninety-one percent of the surveyed biology students stated that they used a textbook either frequently or sometimes to complete their work (Table 3: Question 10). Only 66% of the integrated science students stated that they used a textbook frequently or sometimes (Table 4: Question 10). A comparison of the percentage of students who responded that they use their textbook frequently to complete their work was even more revealing. Seventy-four percent of biology students stated they use a textbook frequently to complete assigned work (Table 3: Question 10) whereas 35% of the integrated science students stated they used a textbook frequently (Table 4: Question 10).

In comparison to integrated science students, biology students seem to feel that their science course is more relevant to their lives. Fifty percent of the biology students surveyed indicated that their study of science will be useful to them (Table 3: Question 7) and 34% stated that they use the information learned in class outside of school

(Table 3: Question 6). Only 39% of integrated science students, however, felt their study of science would be useful to them (Table 4: Question 7), and 30% of them stated they used the information they learned in class outside of school (Table 4: Question 6). These differences could be due to a preference for life science over physical science, although this does not seem very likely since the curriculum of Integrated Science I revolves around biological concepts.

Although biology students appear to have a more positive attitude toward their science course, this did not seem to affect student attitude toward choosing a profession in the field of science. In both programs, only 16% of the students felt they would like to have a profession in the field of science (Table 3 and 4: Question 8).

A comparison of the results from the honors biology course (PIB Biology) with those of other science courses reflects that PIB Biology students responded with the highest frequency of positive student attitudes towards their science course (Graph 1). Sixty percent of PIB biology students state their class is fun and 72% of these students state their course is interesting (Table 5: Question 2 and 3). Twenty-five percent of PIB Biology students also stated that they would like a profession in the field of science (Table 5: Question 8).

PIB biology students also seem to be required to perform activities more frequently than the students in

other science courses (Graph 3). Sixty-six percent of PIB biology students state that they perform activities or laboratories frequently, and 99% of these students state they perform activities frequently or sometimes (Table 5: Question 9). Not surprising then is the fact that the PIB Biology program uses the textbook less often than the other science programs. Only 18% of the surveyed PIB Biology students responded that they use their textbook frequently (Table 5: Question 10).

The type of activities that PIB Biology students are required to do appears to be more experimental in nature than the work other science students are required to perform. Seventy-one percent of the PIB Biology students stated that they are required to make a hypothesis frequently, and 27% stated they must make a hypothesis sometimes (Table 5: Question 11).

PIB biology students enjoy problem solving much more than other science students. Fifty-nine percent of PIB Biology students state that they like doing work that requires them to solve a problem (Table 5: Question 15), but only 31% of integrated science and Biology A and C students stated that they enjoyed doing work that required them to solve a problem (Table 1 and 2: Question 15). A comparison between the students of different levels of biology indicates that enjoyment of problem solving may be linked with skill level. Fifty-nine percent of PIB Biology

students stated they enjoyed doing work that required them to solve a problem, while 35% of Biology C students and 22% of Biology A students responded in the same manner.

A comparison was made between teacher responses and the majority of student responses. The two areas that were looked at were frequency of performing activities and frequency of hypothesizing. All three of the integrated science teachers responded with higher frequency estimates in both areas than did their students (Table 6). Only one biology teacher responded with a higher estimation for time spent hypothesizing, when compared to the majority response of their students (Table 6). These results suggest that student perception of time spent performing specific activities is probably a conservative estimate of the time the integrated science and biology programs devote to activities. The PIB biology teachers and the majority of the PIB Biology students made the same frequency estimations for time spent performing activities and time spent hypothesizing. The estimates made by the PIB Biology students are probably fairly accurate estimations.

Reasons listed on the teacher survey for not including more inquiry based activities were lack of planning time, inadequate facilities, too large of a class size, and poor student attitudes (Table 6).

ANALYSIS OF RESULTS

The purpose of this study was to determine if the attitudes of ninth grade science students would be affected by the use of an integrated science curriculum versus a traditional biology curriculum. The study was also intended to determine if the attitudes of ninth grade science students were affected by the amount of time students spent performing inquiry-based activities. It was hypothesized that curriculum type would not affect positive student attitudes, but that the increased frequency of performing experimentally-oriented activities would generate more positive student attitudes. The data from this student survey does not support this hypothesis. Although positive student attitudes were found to be correlated with increased activity time, the correlation between these two factors was not found to be strong enough to be significant. A factor that was found to be influential over student attitudes was the type of curriculum being used. The data clearly supports that biology students have more positive student attitudes toward their science class than do integrated science students. Current research, however, indicates that curriculum changes do not tend to affect student attitudes (1994, Simpson). Factors other than a difference in curriculum were, therefore, looked at to determine if they might be influencing student attitudes.

One factor that could be influencing student attitudes could be the skill level of the student and the type of work expected from the student. Integrated science classes are composed of heterogeneous student populations with student skill levels ranging from much below grade level to above grade level. The data suggests that the integrated program requires students to use scientific thinking skills, such as hypothesizing, more often than the regular biology program (Graph 3). This is in spite of the fact that integrated classes often have students with limited experience in problem solving. Negative attitudes could, therefore be generated as a result of many students being uncomfortable with this type of work and finding it frustrating. When integrated science teachers were interviewed it was found many of their students have difficulty following the activities and are not able to draw conclusions from the activities. This suggests that a preference for the biology program may not be a result of curriculum content, but could be due to using methods with which students are unfamiliar.

The data from the PIB classes supports the hypothesis that student skill level and the type of work required could be influencing student attitudes. PIB Biology students responded with the most positive student attitudes of any group tested. This occurred even though the data suggests that these students are required to perform activities that require scientific thinking skills more often than other

science students (Graph 3). A reason for PIB Biology students responding with more positive attitudes despite performing tasks that are considered to be more difficult could be a result of PIB Biology students being more comfortable and familiar with problem solving activities. The higher comfort level of PIB Biology students could be due to the fact that many of the students enrolled in this course have been previously identified as gifted and talented and have participated in GATE (Gifted and Talented Education) programs at the elementary or middle school level. GATE programs tend to stress the importance of developing problem solving skills through the use of experimentation and open-ended activities. PIB Biology students, therefore, should be more familiar with an activity based program and a program that requires skills beyond the basic knowledge level. This familiarity could be causing these students to enjoy problem solving activities more than other science students. Supporting this idea is the fact that the percentage of biology students stating that they enjoy problem solving increased as the academic level of the biology student increased (Table 1, 2, and 3: Question 15).

If the hypothesis that familiarity and experience with problem solving activities affects positive student attitudes, then it could be expected that over time positive student attitudes will increase in the integrated science

students. Interviews with integrated science teachers suggest that this might already be happening. These teachers stated that their students are becoming more receptive to open-ended activities and are also becoming more proficient at work that requires more than just knowledge level learning. In order to confirm if attitudes will improve as students gain more experience in problem solving, the survey should be administered at the beginning and end of the course and the results should be compared. Additionally, the same students could be used in a two year longitudinal study to determine if increased problem solving experience affects the frequency of positive student attitudes.

Another indication that the type of work required of integrated students might be affecting student attitudes is the fact that the integrated program is less dependent on the use of a textbook. The traditional biology program has the benefit of using a well-developed textbook that is designed to address the content. Teachers, therefore, have a resource that they are comfortable with and can rely on to help disseminate information. The integrated program not only depends less on the use of a textbook, but does not have a single textbook that addresses the curriculum in a format that is comfortable for teachers. As a result, integrated science students are required to listen, summarize, and learn information through their own

experiences more often than most biology students. These students often find the work more difficult and frustrating. Interviews, with integrated science teachers predicted that the students probably would not like their class because it requires "too much work" and the students feel the work is "too hard" because it makes them "think too much." As integrated students become more comfortable with this new method of acquiring information their attitude toward their science class may improve.

Anoher factor that could be causing a less positive attitude from integrated science students could be teacher attitude. Teacher A had the highest percentage of students responding "NO" to the question "Do you think your science class is fun" (Graph 2). Teacher A was also the only teacher who responded "NO" to the question "Do you enjoy teaching the curriculum content of the course" (Table 4). Follow-up interviews with other integrated science teachers suggest that teacher attitude could indeed be influencing student attitudes. The other two integrated science teachers, for example, stated that although they did not dislike the integrated curriculum, they did prefer teaching the biology curriculum. Since teacher enthusiasm can easily be perceived by students, integrated science students may have a less positive attitude toward their class because their instructors are still not comfortable with the program. The teachers in this study commented that they are

still struggling with the appropriate sequencing of topics and the pace of the course. As with most science courses, the teachers still feel that there is too much material to cover in too little time. Over time, it is expected that teacher attitudes will improve as they become more accustomed to integrating concepts using an activity-based program. Consequently, students attitudes should also improve.

Conclusions drawn from this study are limited by the weaknesses of the survey instrument and by not pair matching students for control. One weakness in the survey instrument was the accurate estimation of activity time. Although a standard Chi-Square test indicated that the correlation between time spent performing activities and student enjoyment was weak, it is possible that this is not an accurate comparison of these two factors. The terms frequently, sometimes, and rarely do not have universal definitions and are too broad to accurately estimate time spent performing activities. Consequently, if the responses to these questions used actual time units such as day or hours, then a more accurate measurement of the relationship between activity time and student enjoyment could be established.

Another weakness of the survey was that it did not ask students to reflect on how difficult they felt the class was, if they felt they were learning, or if they were

required to work in class each day. It is possible that positive attitudes were not a result of students liking the learning of science, but occurred because students found the class to be an enjoyable social setting. The addition of questions addressing these areas might allow some distinction between classes that are attempting to teach science and those that function merely as holding tanks for students.

The lack of pair matching was also a weakness in this study. By not pair matching, the skills and attitudes of students in both curricula comparisons could have introduced variables that affected the results significantly.

CONCLUSION

The decision of students to continue in science education after high school has been associated with a positive student attitude toward science (1994, Simpson). The evaluation of how a science program affects student attitudes is, therefore, very important if the number of students entering science related fields is going to increase. The purpose of this study was to evaluate the impact of an integrated science curriculum on the attitudes of secondary science students. The integrated science curriculum reviewed in this study was a district level interpretation of the 1990 California Science Framework. Prior to completing the survey, it was believed that the use

of an integrated science curriculum would not affect student attitudes toward their science class but that the increased use of inquiry-based activities would result in more positive student attitudes.

The results of this study indicated that a greater percentage of students enrolled in the biology program at Cajon High School have more positive attitudes toward their science class than do students enrolled in the integrated science program. However, the data also seemed to reflect that course content was not the factor influencing student attitudes. Student inexperience with inquiry learning, teacher enthusiasm, and a reduction in textbook learning seemed to be factors that could have influenced positive student attitudes. The results of this study also seem to suggest that as students and teachers become more familiar with the inquiry learning method, student attitudes will probably improve. The program at this high school has only been implemented for two years and is still in the developmental stages. Student and teacher attitudes must be monitored over a period of time to determine if the program is assisting in the development of positive student attitudes.

A review of this study's teacher data reflects that many of the same problems that hindered science educators before the reform movement still exist today. The teachers in this study listed lack of preparation time, inadequate

facilities, and overcrowding of classes as reasons for not including more inquiry-based activities in their program (Table 7). Discussions with individual teachers also suggested that the lack of adequate teacher training might be hindering the use of inquiry learning. Most of the teachers did not understand the difference between a hands on activity and an experimental activity, nor did they understand how to shift from the use of recipe-type laboratories and experiments to student-designed and implemented experiments.

The data from this study suggests that student attitudes at this school site are being negatively influenced by the use of an activity-based integrated science curriculum. It is not clear, however, if these changes in attitudes are temporary or long term. It is important, therefore, that student attitudes be consistently monitored throughout the transition from the traditional sequential science program to the integrated science program. If student attitudes continue to be negatively affected, then it will be important to look closely at factors such as teacher attitude and instructional methods to determine if these factors are contributing to negative student attitudes.

APPENDIX A

EXAMPLES OF TEACHER AND STUDENT SURVEYS

PRELIMINARY STUDENT ATTITUDE ASSESSMENT
FOR A SECONDARY SCIENCE PROGRAM

1. What is your favorite subject in school?
   A. language arts (english) B. social studies
   C. mathematics D. science
   E. physical education F. foreign language

2. What is your next (second) favorite subject?
   A. language arts (english) B. social studies
   C. mathematics D. science
   E. physical education

3. What is your least favorite subject in school?
   A. language arts (english) B. social studies
   C. mathematics D. science
   E. physical education

4. Do you use information you learn in science in situations outside of school?
   A. yes B. no
   C. I don't know

5. Do you feel that your science study will help you in your future study?
   A. yes B. no
   C. I don't know

6. Do you feel that your study of science is useful in helping you to make choices?
   A. yes B. no
   C. I don't know

7. Is your science class fun?
   A. yes B. no
   C. I don't know

8. Is your science class interesting?
   A. yes B. no
   C. I don't know

9. Is your science class boring?
   A. yes B. no
   C. I don't know

10. Is science class difficult for you?
    A. yes B. no
    C. I don't know

11. Does your science teacher ask you many questions about science?
A. yes B. no
C. I don't know

12. Does your science teacher encourage you to state your own opinion?
A. yes B. no
C. I don't know

13. Does your science teacher like for you to ask questions about science?
A. yes B. no
C. I don't know

14. Do you think that being a scientist would be fun?
A. yes B. no
C. I don't know

15. Do you think that being a scientist would make you rich?
A. yes B. no
C. I don't know

16. Do you think that being a scientist would be a lot of work?
A. yes B. no
C. I don't know

17. Do you think that being a scientist would be boring for you?
A. yes B. no
C. I don't know

18. Do you think that being a scientist would make you feel important?
A. yes B. no
C. I don't know

19. Do you have fun trying to solve problems included in your science class?
A. yes B. no
C. I don't know

20. Do your parents ask you questions about what you do in science class?
A. yes B. no
C. I don't know

21. Do you feel that the science you are studying is generally useful to you?
A. yes B. no
C. I don't know

22. Do you wish you had more time for science classes in school?
A. yes B. no
C. I don't know

23. Do you wish you had more kinds of science courses to take?
A. yes B. no
C. I don't know

24. Do you think it is important to plan experiments to test your own ideas to see if they are right or wrong?
A. yes B. no
C. I don't know

25. Which "kind" of science do you like best?
A. science that is about living things
B. science that emphasizes the physical world
C. science that stresses the earth and the universe
D. I like them all equally

26. What do you think is the most important part of science?
A. knowing about your world
B. thinking through problems
C. being curious and exploring
D. explaining things you see
E. testing your ideas

27. How often does your science teacher encourage you to express your own opinion?
A. always B. sometimes
C. never

28. How often does your science teacher encourage you to think for yourself?
A. always B. sometimes
C. never

29. What is your sex?
A. female B. male

30. How often do you perform activities or laboratories?
A. most of the time B. sometimes
C. never

PRELIMINARY TEACHER QUESTIONNAIRE ASSOCIATED WITH THE ADMINISTRATION OF A STUDENT ATTITUDE ASSESSMENT

Dear Classroom Teacher,

Your class has been chosen to participate in a survey that will assess student attitude toward science education. Information gained from this survey will be used to write a Masters in Education Thesis concerning the impact of integrated science and hands on activities on student attitudes. The survey should take only 15 minutes of your class time. Student responses should be recorded on the provided machine grading forms. Please do not have students write their name on their answer sheet. When addressing the students, please inform them that this survey will not affect their grade, but they should be honest and choose their answers carefully.

While students are completing the survey, please complete the following information concerning each class that participates in the survey.

Teacher Name _____ .

Course Title _____ .

Number of Students Enrolled in the Class ____ .

Predominate Grade Level of Students _____ .

Percent of time students spend performing experiments _____.

Percent of time students spend performing hands on activities other than experiments _____ .

Percent of time students spend watching demonstrations ____.

STUDENT ATTITUDE ASSESSMENT FOR A
SECONDARY SCIENCE PROGRAM - VERSION II

Instructions: Read each question carefully. Choose the letter that most closely reflects your opinion to the question, and write the letter on the provided answer sheet. Do not write on this survey. Before turning in your answer sheet, please write your teacher's name, the name of the course you are taking, and your class period at the top of your answer sheet.

1. What is your favorite subject in school?
   A. English
   B. History or Social Studies
   C. Mathematics
   D. Science
   E. Other subject

2. Is your science class fun?
   A. yes B. no C. I don't know

3. Is your science class interesting?
   A. yes B. no C. I don't know

4. Is your science class boring?
   A. yes B. no C. I don't know

5. Do you look forward to going to your science class?
   A. yes B. no C. I don't know

6. Do you use information you learn in science in situations outside of school?
   A. yes B. no C. I don't know

7. Do you feel that your study of science is or will be useful to you?
   A. yes B. no C. I don't know

8. Do you think you would like to have a profession in the field of science?
   A. yes B. no C. I don't know

9. During your science class, how often do you perform activities or laboratories?
   A. most of the time or frequently

B. sometimes
C. rarely
D. never

10. During your science class, how often do you perform work that requires you to read and answer from a textbook?
A. most of the time or frequently
B. sometimes
C. rarely
D. never

11. During your science class, how often do the activities you preform require you to make an hypothesis?
A. frequently
B. sometimes
C. rarely
D. never
E. I don't know what a hypothesis is.

12. During your science class, how often are you required to collect data?
A. frequently
B. sometimes
C. rarely
D. never

13. During your science class, how often are you expected to design or create a project?
A. frequently
B. sometimes
C. rarely
D. never

14. In your science class, how often do you perform activities that require you to plan and perform an experiment that tests your own ideas?
A. frequently
B. sometimes
C. rarely
D. never

15. Do you enjoy doing work that requires you to solve a problem?
A. yes B. no C. I don't know

TEACHER QUESTIONNAIRE ASSOCIATED WITH THE ADMINISTRATION OF A STUDENT ATTITUDE ASSESSMENT - VERSION II

Dear Classroom Teacher,

Your class has been chosen to participate in a survey that will assess student attitude toward science education. Information gained from this survey will be used to write a Masters in Education Thesis concerning the impact of integrated science and hands on activities on student attitudes. The survey should take only 15 minutes of your class time. Student responses should be recorded on the provided paper. Please do not have students write their name on their answer sheet. When addressing the students, please inform them that this survey will not affect their grade, but they should be honest and choose their answers carefully.

While students are completing the survey, please complete the following information concerning each class that participates in the survey. Please try and answer each question honestly, all results will be kept confidential.

Teacher Name _____ .

Course Title _____ .

Number of Students Enrolled in the Class _____ .

Predominate Grade Level of Students _____ .

1. In your science course, how often do students perform activities or laboratories?
   A. frequently
   B. sometimes
   C. rarely
   D. never

2. In your science course, how often do students perform classwork that requires them to read and answer questions from a textbook or other source?
   A. frequently
   B. sometimes
   C. rarely
   D. never

3. How often do you require your students to form an hypothesis?
   A. frequently
   B. sometimes
   C. rarely
   D. never

4. How often do you require students to collect data?
   A. frequently
   B. sometimes
   C. rarely
   D. never

5. How often do you require students to plan and test their own experiments?
   A. frequently
   B. sometimes
   C. rarely
   D. never

6. How often do you require students to design or create a project?
   A. frequently
   B. sometimes
   C. rarely
   D. never

7. Do you enjoy teaching the curriculum content of this course?
   A. yes, generally B. no, not usually C. I don't know

8. Do you feel comfortable teaching this course with respect to your own knowledge of the subject matter?
   A. yes, generally B. no, not usually C. I don't know

9. Do you feel comfortable teaching this course with respect to the curriculum content of the course?
   A. yes, generally B. no, not usually C. I don't know

10. What are the largest factors that you feel prohibit you from including more hands on activity time for your students?

11. What are the two factors that you feel prohibit you from including more experimental activity time for your students?

APPENDIX B

RESPONSE TOTALS FOR STUDENT AND TEACHER SURVEYS

TABLE 1: SURVEY RESPONSE TOTALS FOR BIOLOGY A STUDENTS (N=77)

Question #	Percent Response	Percent Response	Percent Response	Percent Response	Percent Response
1	14	9	14	21	42
2	65	23	12	NA	NA
3	62	26	12	NA	NA
4	19	72	9	NA	NA
5	61	16	23	NA	NA
6	35	41	24	NA	NA
7	49	28	23	NA	NA
8	10	66	25	NA	NA
9	7	20	25	48	NA
10	51	30	16	3	NA
11	6	21	40	24	9
12	37	37	16	10	NA
13	22	27	20	31	NA
14	12	26	26	36	NA
15	22	58	17	3	NA

TABLE 2: SURVEY RESPONSE TOTALS FOR BIOLOGY C STUDENTS (N=153)

Question #	Percent Response	Percent Response	Percent Response	Percent Response	Percent Response
1	18	13	20	12	37
2	47	24	29	NA	NA
3	65	21	14	NA	NA
4	31	46	22	NA	NA
5	43	30	26	NA	NA
6	34	49	17	NA	NA
7	50	23	26	NA	NA
8	17	58	25	NA	NA
9	22	58	20	0	NA
10	85	10	3	2	NA
11	5	22	58	10	5
12	24	43	28	5	NA
13	4	40	47	8	NA
14	7	27	48	18	NA
15	35	45	19	NA	NA

TABLE 3: SURVEY RESPONSE TOTALS FOR BIOLOGY A AND BIOLOGY C STUDENTS (N=296)

Question #	Percent Response	Percent Response	Percent Response	Percent Response	Percent Response
1	18	13	11	16	42
2	53	24	23	NA	NA
3	64	23	13	NA	NA
4	27	55	18	NA	NA
5	49	25	25	NA	NA
6	34	46	19	NA	NA
7	50	25	25	NA	NA
8	16	65	19	NA	NA
9	17	44	22	17	NA
10	74	17	7	2	NA
11	5	22	52	15	NA
12	28	41	24	7	NA
13	10	36	38	16	NA
14	8	26	42	24	NA
15	31	50	19	NA	NA

TABLE 4: SURVEY RESPONSE TOTALS FOR INTEGRATED SCIENCE STUDENTS (N=176)

Question #	Percent Response	Percent Response	Percent Response	Percent Response	Percent Response
1	19	9	22	5	45
2	22	60	18	NA	NA
3	40	48	12	NA	NA
4	59	29	12	NA	NA
5	21	65	14	NA	NA
6	29	58	13	NA	NA
7	39	39	22	NA	NA
8	16	67	17	NA	NA
9	16	52	28	4	NA
10	35	31	18	16	NA
11	15	31	39	9	6
12	29	35	32	4	NA
13	6	32	37	25	NA
14	5	30	35	30	NA
15	31	52	17	NA	NA

TABLE 5: SURVEY RESPONSE TOTALS FOR PIB BIOLOGY STUDENTS (N=136)

Question #	Percent Response	Percent Response	Percent Response	Percent Response	Percent Response
1	22	18	30	16	14
2	59	35	6	NA	NA
3	72	21	7	NA	NA
4	31	51	18	NA	NA
5	36	38	26	NA	NA
6	38	45	17	NA	NA
7	72	16	13	NA	NA
8	25	48	26	NA	NA
9	66	33	1	NA	NA
10	18	48	31	3	NA
11	72	27	1	1	NA
12	81	18	1	NA	NA
13	6	32	56	6	NA
14	17	42	33	8	NA
15	58	22	19	NA	NA

TABLE 6: COMPARISON OF INDIVIDUAL TEACHER RESPONSES TO THE MAJORITY OF STUDENT RESPONSES

	Estimate of Activity Time Frequency		Estimate of Hypothesizing Frequency	
Teacher	Majority of Student Response	Teacher Response	Majority of Student Response	Teacher Response
A	sometimes	frequently	rarely	sometimes
B	sometimes	frequently	rarely	frequently
C	sometimes	frequently	rarely	sometimes
D	sometimes	sometimes	rarely	sometimes
E	frequently	sometimes	rarely	sometimes
F	never	rarely	rarely	sometimes
G	frequently	frequently	frequently	frequently
H	frequently	frequently	frequently	frequently

TABLE 7: SUMMARY OF TEACHER SURVEY RESPONSES (N=8)

Question	Teacher							
	A	B	C	D	E	F	G	H
1	yes	no	yes	yes	yes	yes	yes	yes
2	yes	yes	yes	yes	yes	yes	yes	yes
3	yes	no	yes	yes	yes	yes	yes	yes
4	freq	freq	freq	some	some	rare	freq	freq
5	some	rare	some	freq	freq	freq	some	rare
6	some	freq	some	some	some	some	freq	freq
7	freq	some	freq	rare	freq	rare	freq	freq
8	M	M, O	P	A	P, F	T, F	T	T

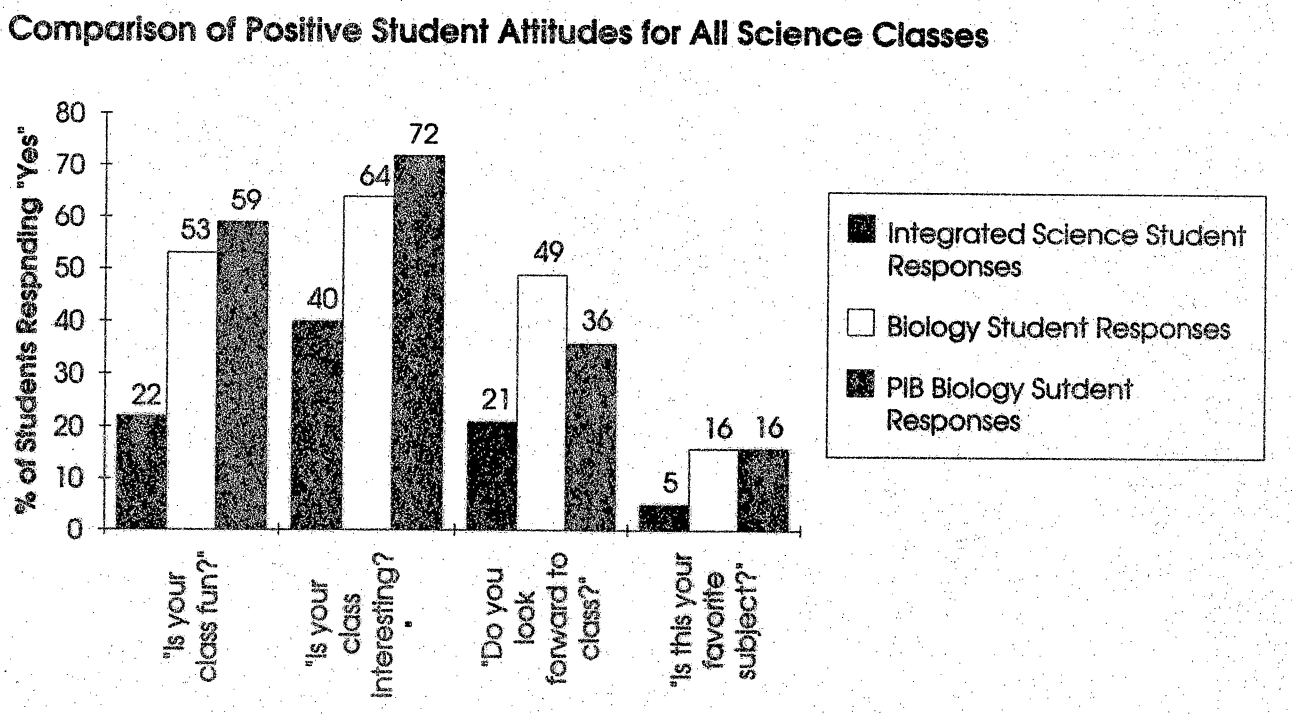
Question #'s
1 - Do you enjoy teaching the curriculum?
2 - Are you comfortable with your knowledge of curriculum?
3 - Are you comfortable with the curriculum content?
4 - How often are students required to perform activities?
5 - How often do students use a textbook?
6 - How often do students hypothesize?
7 - How often do students collect data?
8 - What is the main reason for not doing more laboratory activities?

Reasons
A - poor student activities
F - inadequate facilities
M - lack of materials
O - overcrowded classes
P - lack of planning time
T - lack of time

APPENDIX C

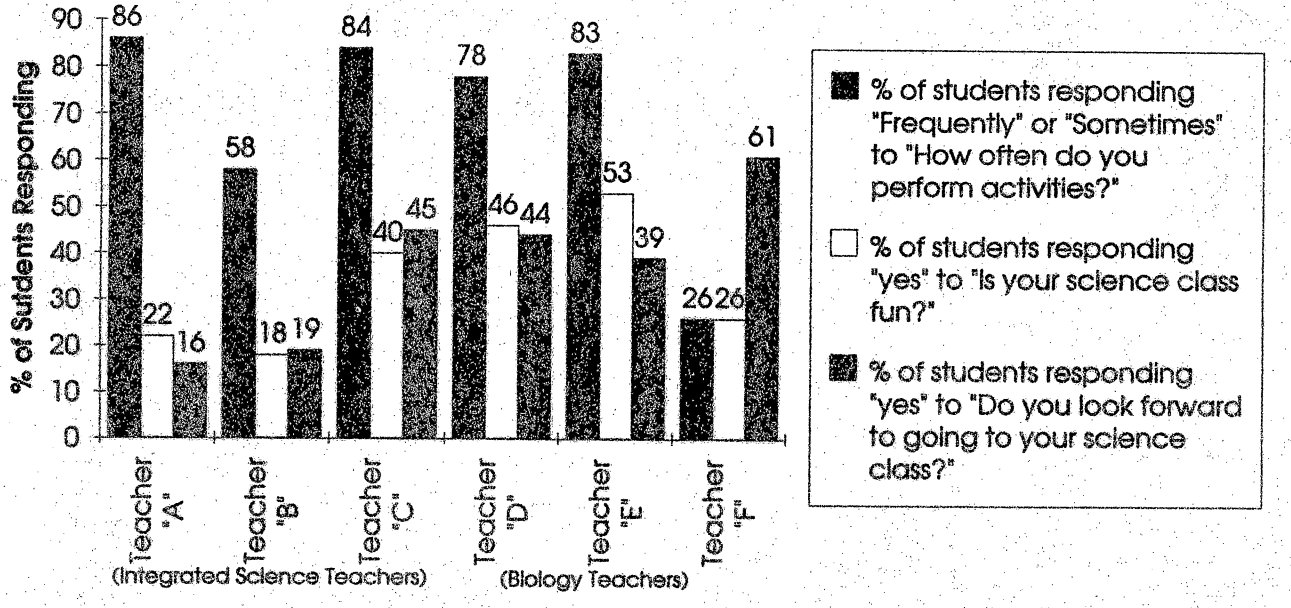
GRAPHIC COMPARISONS OF STUDENT RESPONSES FOR ALL SCIENCE COURSES

Graph 1

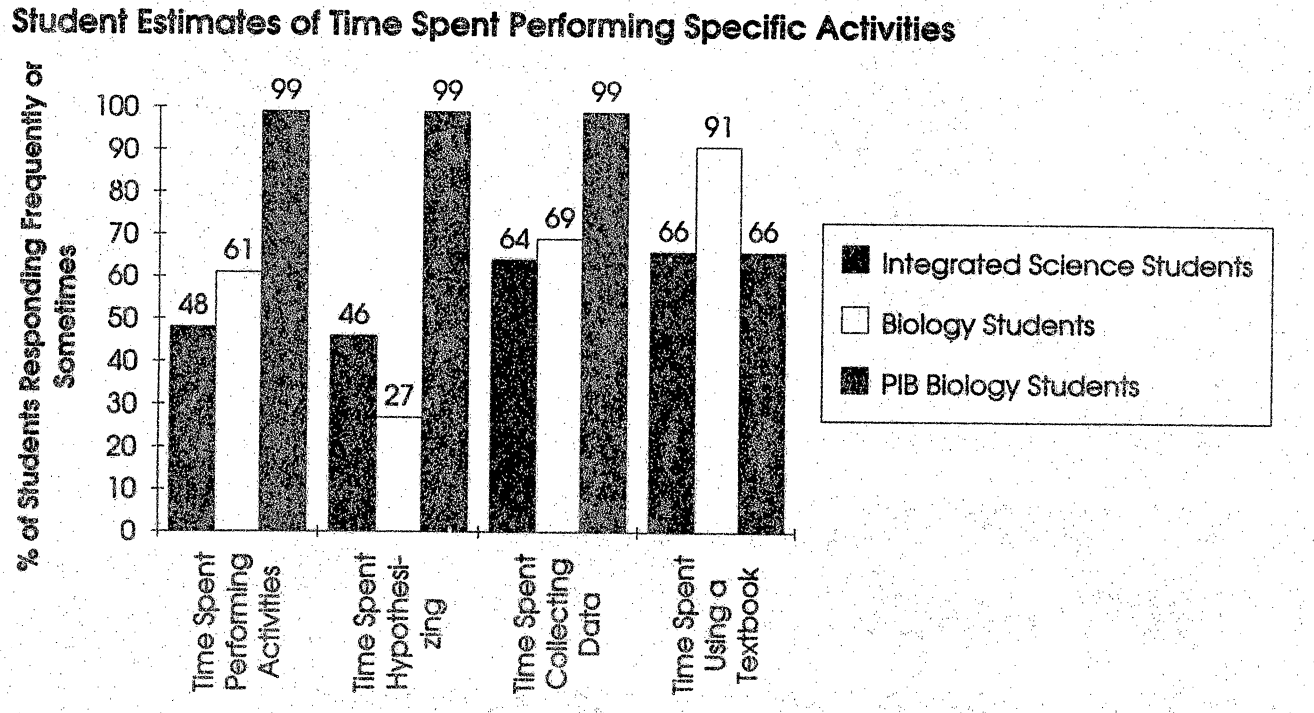

Comparison of Positive Student Attitudes for All Science Classes
% of Students Responding "Yes"
80
70
60
50
40
30
20
10
0
22
53
59
40
64
72
21
49
36
5
16
16
"Is your class fun?"
"Is your class interesting?"
"Do you look forward to class?"
"Is this your favorite subject?"
Integrated Science Student Responses
Biology Student Responses
PIB Biology Sutdent Responses

Graph 2:

Individual Class Comparison of Positive Student Attitudes to Time Spent Performing Activities



Graph 3:


Student Estimates of Time Spent Performing Specific Activities
% of Students Responding Frequently or Sometimes
100
90
80
70
60
50
40
30
20
10
0
48
61
99
46
27
99
64
69
99
66
91
66
Time Spent Performing Activities
Time Spent Hypothesi-zing
Time Spent Collecting Data
Time Spent Using a Textbook
Integrated Science Students
Biology Students
PIB Biology Students

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