AN EVALUATION OF THE ADVANCED PLACEMENT PROGRAM IN ENVIRONMENTAL SCIENCE

By

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I dedicate this dissertation to my late father, Harold Russell Penwell, Jr., who I never had the chance to know, and my late grandfather, Edward Kolaczynski, who was always there to make me laugh and brighten up my life. I also dedicate this dissertation to my mother Karen Penwell, who showed me that life is not always the way we perceive it, that we have the chance to make it better, and to learn to understand each other. I also dedicate this work to my grandmother, Anna Kolaczynski, who gave me so much love and support and made sure that I always had good food to eat, and to my little sister, Maria Friday, who was always there to remind me that I should finish school because I was getting old.

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Stakeholders' perceptions of the Advanced Placement Program in Environmental Science (APES) in California, Florida, and New York were evaluated. Research questions focused on teacher and student profiles, attitudes toward APES, the effect of gender and ethnicity on attitudes, differences in self-report data by teachers and students, strengths and weaknesses of APES and a match between implementation and College Board guidelines. Twelve teachers and 355 students completed attitude surveys, and 10 students and one teacher were interviewed.

The results indicated that APES students spend few hours per week studying and doing homework. Most APES students are White 12th grade females with high grade point averages who have taken more than three high school science classes. APES students do not completed many other Advanced Placement classes. Further results indicated that APES teachers spend more hours preparing to teach than students spend studying. They also spend more time grading assignments than students spend doing

homework. APES teachers were mostly White females who live in suburban areas.   On average, students and teachers reported overall positive attitudes toward APES. Gender and ethnicity do not significantly influence students' attitudes toward APES. The student interview data corroborated the student survey data. Students reported spending less than one hour per week on labs, fieldwork, independent research, presentations, and identifying, analyzing, solving, assessing and working on solutions to environmental problems.

Teachers and students identified fieldwork and class discussions as important strengths of APES classes while spending an insufficient amount of time on field and lab work were identified as the most significant weakness. Teachers reportedly did not follow many of the APES guidelines identified by the College Board, including offering one lab a week and spending a significant amount of time doing fieldwork and working on environmental problems. Recommendations for improvement of the APES Program include increasing the amount of time spent on lab activities and fieldwork and time spent working on solutions to environmental problems and hands-on activities. Additionally, schools need funding to purchase lab equipment and high schools should adopt block scheduling to allow APES classes more time for lab and fieldwork.

CHAPTER 1
INTRODUCTION

History of the Advanced Placement Environmental Science Program

As national interest in environmental issues increased in the 1990's, the Advanced Placement Environmental Science (APES) Program was created. It is the most recent of the Advanced Placement (AP) Science Programs and was approved for adoption in May of 1998. In 1993, the Geraldine R. Dodge Foundation for the College Board recognized the need for an AP ecology course and funded research to determine its feasibility. The resulting study suggested that a course in AP environmental science be offered instead of AP ecology because the goal of environmental science courses is to create citizens who can make intelligent, informed decisions concerning environmental issues (College Board, 1997).

In a follow-up study, faculty in more than 300 college biology, environmental science, and interdepartmental programs were surveyed to determine their attitudes concerning the offering of an AP Environmental Science Program (College Board, 1997). The results indicated that most colleges and universities already offered an introductory-level environmental science course and could support an AP Environmental Science Program. High schools that already had AP Programs in place were also surveyed to determine their attitudes regarding an AP Environmental Science Program. The respondents stated that their schools already had some type of environmental science course in place or would be interested in offering a course in environmental science, indicating that secondary schools were also willing to support the offering of an AP environmental science class. Additionally, the survey revealed that high school students were interested in participating in an AP environmental science course (College Board, 1997).

The goals of APES focus on processes and systems and include student experiences such as

- Evaluating information
- Applying concepts to new information
- Understanding natural systems
- Asking questions
- Recognizing how humans have impacted the environment
- Understanding the limits of science and
- Devising solutions to environmental problems (College Board, 1997).

Importance of the Study

This study is based on a modification of a previous study evaluating the Advanced Placement Biology Program (APBP) (Lucky, 1972). Lucky (1972) investigated the attitudes of students, teachers, and principals involved in the APBP in high schools in Memphis, Tennessee, during the 1970-71 academic year. The current study evaluated the Advanced Placement Environmental Science Program (APESP) in four high schools in California, Florida, and New York. It investigated the types of students and teachers involved in the APESP and their attitudes towards the program. It is important to determine students' attitudes toward APES because students' attitudes toward science affect their science achievement and knowledge (Cannon & Simpson, 1985; Schibeci & Riley, 1986; & Weinburgh, 1995). The current study also highlighted the program's strengths and weaknesses and provided recommendations for program improvement.

The current study was needed because the Advanced Placement Environmental Science Program has not been evaluated since its 1998 inception. Education programs should be evaluated using quantitative and qualitative methods because without such evaluation it cannot be determined if programs are achieving their goals (O'Hearn, 1982). In the case of the APES Program, it is important to determine whether it is being implemented according to the guidelines developed by the College Examination Board. Currently, there is no evidence to support whether or not the APES Program is achieving its goals, or if the design of the program is functioning to benefit the stakeholders (students and teachers involved in APES).

One previous study has been conducted to determine the demographics of students who take AP exams (College Entrance Examination Board, 2000), but there have been no studies specifically investigating the demographics of students and teachers of APES classes. The current study provides a baseline for studies of other AP programs. It is important to determine the types of students and teachers involved in the Advanced Placement Environmental Science Program especially because the College Examination Board is seeking new ways to increase the enrollment of poor (low-income) and minority (Hispanic and African American) students in AP classes (College Entrance Examination Board, 2000).

The data from the current study also provided information regarding the strengths and weaknesses of the program as perceived by teachers and students. These findings were used to develop recommendations for program improvement, and to highlight areas of the program that teachers and students viewed differently. The data were also used to provide explanations of why teachers do or do not follow the guidelines for APES set forth by the College Examination Board.

Purpose of the Study

The purpose of this study was to evaluate stakeholders' perceptions of the Advanced Placement Environmental Science Programs in 12 high schools in California, Florida, and New York. Specifically this study gathered data pertaining to the following six categories:

- General characteristics of students and teachers participating in the Advanced Placement Environmental Science Program.
- Attitudes of students and teachers toward the APES Program.
- Gender and ethnic differences in student attitudes toward the APES Program.
- Perceived strengths and weaknesses of the program identified by teachers and students.
- Match between stated APES goals/guidelines and actual implementation.
- Recommendations for improvement of the program.

The above six categories were used to develop 10 research questions, which are listed in the section below.

Research Questions

1. What is the profile of students who enroll in APES?
2. What is the profile of teachers who teach APES?
3. What are the attitudes of students toward APES?
4. What are the attitudes of teachers toward APES?
5. Do the attitudes of students toward APES differ by gender or ethnicity?
6. Are there differences in the amount of time spent on APES and other class activities reported by students and teachers?
7. What do students feel are the strengths/weaknesses of APES?
8. What do teachers feel are the strengths/weaknesses of APES?

9. How closely does the actual implementation of APES match the goals/guidelines stated by the College Board?

10. What recommendations can be made to improve APES?

Description of the Study

This was an exploratory study designed to describe and evaluate the Advanced Placement Environmental Science Program in 12 high schools in California, Florida, and New York.

Theoretical Framework

Attitude Model

The theoretical framework used to measure the construct of students' and teachers' attitudes toward Advanced Placement Environmental Science is based on the model developed by Haladyna, Olsen, and Shaughnessy (1982, 1983). This model suggests that student, teacher, and learning environment variables affect students' attitudes toward science and arise from factors that cannot be controlled (age of the teacher, gender of the student, or condition of the classroom) and from factors that can be controlled (teacher praise and student reinforcement, the relationship students have with each other, and the tone of the classroom). Haladyna et al. (1983) identified three variables that affect students' attitudes toward science:

- Self-confidence
- Fatalism
- Feelings of the importance of science.

They suggested that either students enjoy science because they feel that it is important, or they feel that science is important because they enjoy it. Students with high academic self-confidence who believe they control their academic fate have more positive attitudes toward science. Most importantly, Haladyna et al. (1982, 1983) posited that the following four factors are the most significant factors predicting students' attitudes toward science:

- Teacher enthusiasm
- Respect for teacher knowledge
- Teacher support for students
- Praise and commitment to learning fairness.

The learning environment variables shown to affect students' positive attitudes toward science were

- Overall satisfaction
- Enjoyment of classmates
- Positive class environment
- Organized instruction
- Attentiveness (Haladyna et al, 1982).

This current study was designed to determine stakeholders' perceptions of the APES Program by focusing on the three facets of student variables, teacher variables, and learning environment variables that function together to explain the construct of student attitude toward science. A construct is a complex, inferred concept (Dooley, 2001), which can be made up of parts or facets. Student and teacher attitude surveys were developed specifically for this study and included items pertaining to students' and teachers' attitudes toward student variables, teacher variables, and learning environment variables in an attempt to determine students' and teachers' attitudes toward Advanced Placement Environmental Science.

Evaluation Model

The evaluation of an educational program is important because it establishes the worth or value of that program (O'Hearn, 1982). Evaluation and communication of results to stakeholders are keys to the success of any program (Bennett, 1982). Currently, two basic types of educational evaluation paradigms exist. One is descriptive or empirical and explains events or phenomena and is often referred to as educational evaluation analysis. The other type of evaluation theory is normative and defines the applicability of educational activities and the techniques that should be used to perform them. Normative evaluation approaches are used to make value judgments regarding activities or programs (Ellett, 1979). In this study, an evaluation of the Advanced Placement Environmental Science Program was conducted using a combination of empirical and normative approaches.

Of particular interest to this study is the Bennett model (1988-1989), which outlines four steps for evaluating environmental education programs. The first step is to set expectations for the evaluation. In this step, the evaluator asks, "What is the goal of the evaluation?" Step two involves planning of the evaluation. The evaluator needs to determine how to design the evaluation, what kind of data he/she will collect, how and when he/she will collect the data, and how the data will be recorded. The third step is determining the results of the evaluation. Did the evaluator achieve the objective of the evaluation; were there any unexpected outcomes; and were there any problems with the evaluation? The final step involves using the results of the evaluation. The evaluator needs to decide who should see the results, how will they be used, and how to improve the program (Bennett 1988-1989).

Stake's (1967) Countenance Model provided the basis for the APES evaluation design because it focuses on describing and making judgments about a program. Stake (1967) provided a framework for evaluators to collect, organize, and interpret both qualitative and quantitative data. His model separates descriptive from judgmental activities and determines whether they occur as antecedents (are prior evaluation conditions), transactions (occur during the implementation of the educational program), or outcomes (the results of the program). In Stake's (1967) model, descriptive activities are subdivided into intended and observed. Judgmental activities are subdivided into standards used to make judgments and the actual judgments about the educational program being evaluated. Stake (1971) recommended that evaluators study the relationships among program antecedents, transactions, and outcomes. His model is extremely useful for educational program evaluation. It provides broad insights regarding the successes and shortcomings of programs because it investigates links among all aspects of a program (Wood, 2001). The Stake model also helps researchers determine whether teaching and learning processes are followed as prescribed by guidelines or other standards (Guba & Lincoln, 1982).

The framework for this current evaluation of the APES program followed the four steps of the Bennett model. In step one, the research questions were developed. Step two involved determining the types of data, data sources, and data collection methods needed to answer the research questions. The third step involved analysis of the data and identification of key results, and the fourth step focused on making suggestions for improvement of the APES Program.

Throughout all four steps of the Bennett evaluation model, antecedent, transaction and outcome components of the Stake model (1967) were incorporated. Antecedents investigated included the demographic characteristics of students and teachers involved in the Advanced Placement Environmental Science Program in selected schools in California, Florida, and New York. The transactions investigated focused on student and teacher reports regarding implementation of the program. Specific transactions studied included the types of and amount of time spent on various classroom activities such as lab activities, fieldwork, lecture, cooperative group work, student independent research, class discussions, and identifying, analyzing, solving, assessing, and preventing environmental problems was also collected. These transactions were also compared to standards and guidelines prescribed by the College Board. The outcomes investigated in this study focused on the affective domain, specifically, attitudes of teachers and students toward APES.

All 10 of the research questions investigated in this study required the collection and analysis of quantitative data. To provide further insight into the APES Program, qualitative data were also gathered via classroom observations and interviews of a teacher and 10 students in one Advanced Placement Environmental Science class at a high school in Gainesville, Florida. Qualitative data from this case study supplemented the quantitative data and helped answer research questions 6-10. Figure 1-1 contains a flow chart illustrating the evaluation design used in this study.

Definition of Terms

Specialized terms used in this study are discussed below.

Advanced Placement Program. A program designed by the College Board to give high school students the opportunity to take college-level courses while still in high school.

Advanced Placement Environmental Science Program. An Advanced Placement Program course in environmental science.

APESP. An abbreviation for Advanced Placement Environmental Science Program.

APES. An abbreviation for Advanced Placement Environmental Science.

> **Environmental Science**. The study of the natural sciences in an interdisciplinary context that always includes consideration of people and how they have influenced the systems under examination. It includes many aspects of biology, earth and atmospheric sciences, fundamental principles of chemistry and physics, human population dynamics, and appreciation for biological and natural resources. (College Board, 1997, p, 1)

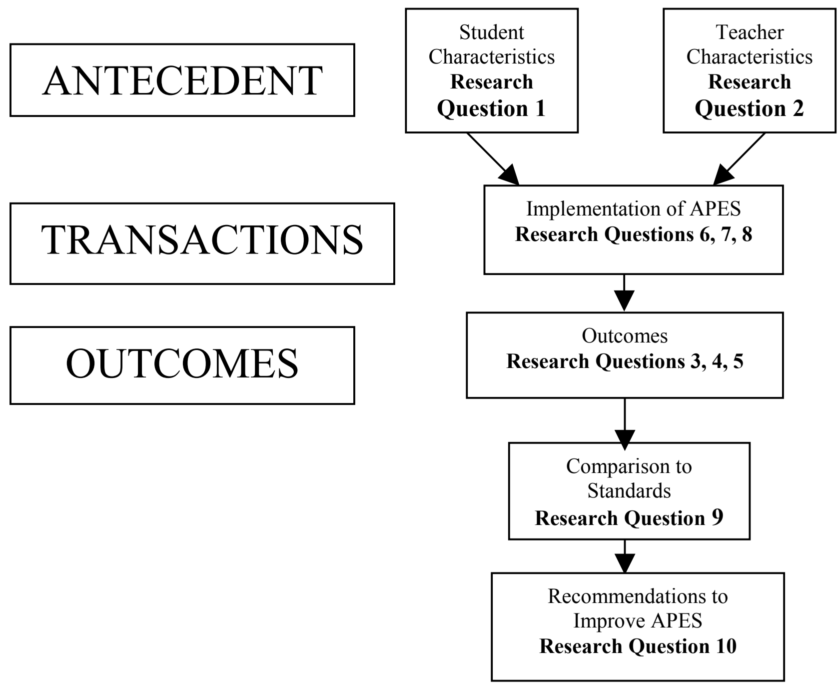


Figure 1-1. Flow Chart of Evaluation Procedure.

Methods

Survey Study Sample

California, Florida, and New York were selected for this study because they are the three states with the highest numbers of schools having at least 10 students who took the Advanced Placement Environmental Science exam in 2000. A letter explaining the study and asking for participation was sent to 50 APES teachers from 50 randomly selected schools in each of the three states. Follow-up postcards were sent one month later to those teachers who had not responded to encourage more participation. The 15 teachers from five schools in each state who agreed to participate were then sent teacher and student surveys. The final sample consisted of four schools in each state: California, Florida and New York and included a total of 12 teachers and 355 students who filled out and returned the surveys. The student sample was 61% female, and 56% White, 17% Hispanic, 16% Asian, 8% Black, and 4% other ethnic groups. The majority of the students were in 12th grade (52%), followed by 46% in 11th grade, 2% in 10th grade, and 1% in 9th grade. The teachers were 100% White and 60% female.

Observation/Interview Study Sample

The case study sample was included to collect qualitative data and to add to the richness of the survey data, to provide insights into the interpretation of the survey data, and for triangulation. The case study site was chosen because it was one of two high school AP Environmental Science class sites in Gainesville, Florida, that had a teacher willing to participate and was the most convenient location for the researcher to visit.

The class was taught by a White male teacher and contained 30 students in the class (19 females and 11 males). All of the students were White except for one Asian female and two Black females. The majority of the students were 9th graders (12) with ten 10th, four 11th, and four 12th graders. Ten of these students were chosen to be interviewed based on gender, ethnicity, grade level, APES class grade, and overall grade point average to make the sample as heterogeneous as possible.

Data Collection and Analysis

Surveys were completed by teachers of four Advanced Placement Environmental Science courses in each state. The teachers filled out a teacher survey and a data sheet providing information specific to their Advanced Placement Environmental Science classes (Appendix B). The teachers then administered a student survey to all students in each section of their Advanced Placement Environmental Science classes (Appendix C).

Additional data were collected through 10 class observations and teacher and student interviews at the case study APES class site. Table 1-1 summarizes the data collection and analysis techniques used to investigate each research question. Questions 1-5 utilized quantitative data from the survey study sample while questions 6-10 were investigated using a combination of quantitative survey data and qualitative survey and case study data.

Research questions 1 and 2 were analyzed by calculating the frequency of responses for each survey item. Research question 3 was analyzed by computing an average attitude scale score for each student and by computing descriptive statistics (means, standard deviations) and a 95% confidence interval for individual attitude items. Descriptive statistics, such as means and standard deviations, for the overall attitude scale as well as individual attitude items were also computed to answer research question 4. A two-way ANOVA was conducted to investigate research question 5. The remaining five research questions were investigated using both quantitative and qualitative data sources. The quantitative data were analyzed by calculating the frequency of responses for relevant survey or interview items and the case study observation field notes were analyzed using the constant comparison method.

The two assumptions used to interpret the results of this study were:

- Teachers and students have particular attitudes toward APES
- Teachers and students properly followed the directions on the surveys.

Table 1-1. Research Questions and Data Collection and Analysis Tools.

Research Question	Types of Data	Study Subjects	Data Collection Tools	Data Analysis
1. What is the profile of students enrolled in APES?	Demographic	Students	Survey	Frequency distributions
2. What is the profile of teachers who teach APES?	Demographic	Teachers	Survey	Frequency distributions
3. What are the attitudes of students toward APES?	Attitude	Students	Survey	Attitude scale scores Descriptive statistics 95% Confidence interval
4. What are the attitudes of teachers toward APES?	Attitude	Teachers	Survey	Descriptive statistics
5. Do the attitudes of students toward APES differ by gender or ethnicity?	Attitude Demographic	Students	Survey	Two-way ANOVA
6. Are there differences in the amount of time spent on APES and other class activities reported by students and teachers?	Time spent on class activities	Students Teachers	Survey Interviews	Frequency Distribution Case study-constant comparison
7. What do students feel are the strengths/weaknesses of APES?	Free response	Students	Survey Interviews	Frequency distributions Case study-constant comparison
8. What do teachers feel are the strengths/weaknesses of APES?	Free response	Teachers	Survey Interviews	Frequency distributions Case study-constant comparison
9. How closely does the actual implementation of APES match the goals/guidelines stated by the College Board?	Time spent on class activities	Students Teachers	Survey Observations Interviews	Frequency distributions Case study-constant comparison
10. What recommendations can be made to improve APES?	Free response	Students Teachers	Survey Interviews	Categorizing survey data responses Categorizing case study data

Limitations of the Study

The following areas limit the generalizability of this study:

- The sample size for the attitude survey was small (355 students and 12 teachers).
- The students who completed the survey only consisted of those who returned to school after the taking APES exam.
- The teachers and students who completed the attitude surveys were only from three states (Florida, California, and New York).
- The student survey sample consisted of mostly juniors and seniors while students who were observed and interviewed were mostly freshman.
- Teacher and student observations and interviews were only completed for one APES class at one local high school.

Delimitations of the Study

The scope of the current study is limited to the following:

- The 355 students and 12 teachers from the 12 high school APES classes in Florida, California, and New York.
- The 30 students who were observed and the one teacher and 10 students who were interviewed were in one APES class at one local high school.

Summary of Chapters

This chapter provided an overview of the entire study, while Chapter 2 outlines related literature. The data sample, data collection, data analysis and methodology are described in Chapter 3. The results of the quantitative research questions are discussed in Chapter 4. Chapter 5 presents a case study of one APES class. Chapter 6 presents the results of the mixed-method research questions as well as the conclusions and implications of the study.

CHAPTER 2
LITERATURE REVIEW

Introduction

This chapter contains a review of related literature. The purpose of the literature review is to set the context for this study. This review of the literature was conducted on each of the following topics:

- Status of environmental knowledge
- High school accelerated programs
- Advanced science courses
- Environmental science courses
- Students' attitudes toward science
- High school environmental science courses
- History of the Advanced Placement Environmental Science Program.

Status of Environmental Knowledge

Since the first Earth Day on April 22, 1970, environmental issues have been highly publicized due to the efforts of environmentalists and scientists seeking to increase the awareness and knowledge of the public about environmental problems caused by human impact. Methods used to increase public knowledge include books and periodicals as well as presentations and rallies by environmental groups (Arcury & Johnson, 1987). The news media have supported this effort through reports of environmental problems and crises that have occurred over the years (Arcury & Johnson, 1987). Therefore, the act of publicizing environmental issues has created an emotionally charged and environmentally aware citizenry, but unfortunately has not increased their environmental knowledge (Gambro & Switzky, 1996).

The status of environmental knowledge in the United States is rather grim and is further compounded by the lack of literature on the topic (Gambro & Switzky, 1996). Environmental knowledge describes the factual information that one has about the environment and the impact that humans have on it (Arcury & Johnson, 1987). A study showed that most students and adults have very little knowledge of the environment and environmental issues, and therefore, are unable to make educated decisions regarding the environment (Gambro & Switzky, 1996).

Most high school students have low levels of environmental knowledge; they are able to remember basic facts about environmental problems, but they are unable to apply this knowledge to understand the consequences of solutions to environmental problems and thus will not be able to make intelligent decisions concerning environmental problems and solutions in the future (Gambro & Switzky, 1996). This is tragic considering how rapidly environmental problems and issues are becoming a part of our everyday lives (Gambro & Switzky, 1996). Therefore, educators need to find ways to increase the environmental knowledge of students. The next generation must be equipped with environmental knowledge and skills now, so that when the time comes, they will be able to make informed decisions concerning environmental problems and solutions (Gambro & Switzky, 1996). Research has shown the most important factors affecting students' environmental knowledge are the level of their parents' education or socioeconomic status, the number of high school science classes they have taken, and gender (males have more environmental knowledge than females) (Gambro & Switzky, 1999).

This finding could be due to gender biases in school (Gambro & Switzky, 1999). For example, teachers pay more attention to male students, ask them more questions and give them higher quality feedback than they do female students (Gambro & Switzky, 1999). Also, particularly in science classes, it is the males who control lab equipment, which deprives females of the laboratory educational experience (Gambro & Switzky, 1999). Therefore, the effects of teachers paying more attention to males, lack of laboratory education experiences for females, and the fact that females take fewer science classes than males can all have a profound effect on females' environmental knowledge (Gambro & Switzky, 1999).

A study of 429 ninth-grade students by Barrow and Morrisey (1988-1989) revealed that males demonstrated a higher degree of knowledge concerning energy than did females. The study also indicated that the energy literacy of these students was very low. Blum (1987) also found low levels of environmental knowledge among 9th and 10th graders. He found that the students received most of their knowledge and beliefs about the environment from the media and not from school. This may explain why their environmental beliefs were stronger than their factual and conceptual environmental knowledge. The portrayal of terrible environmental events in the world is downplaying local issues causing students to think that local issues are not important (Blum, 1987). The media is less apt to present all the facts about a situation, let alone educate students in how to analyze a problem, clarify values, and suggest viable solutions to environmental problems (Blum, 1987). A study of 175 students in 4th, 8th, and 11th grades revealed that their level of knowledge about acidic deposition and related concepts did not increase from 4th through 11th grade (Brody, Chipman, & Marion, 1988-1989).

The environmental knowledge of students in the United States is low and does not seem to be improving as they move from elementary, through middle, and then to high school (Brody et al., 1988-1989).

A study by Gambro and Switzky (1999) showed that high school seniors who took the highest number of laboratory science courses possessed the highest levels of environmental knowledge, but the majority of the students in the sample had only taken two science laboratory courses. Unfortunately, many high school students are not capitalizing on the opportunity to increase their environmental knowledge by taking more science courses (Gambro & Switzky, 1999). The results of this study suggest that high school students should be encouraged or even required to take more science classes, especially those incorporating laboratory exercises. It makes sense that students who have had more science classes will have a larger repertoire of knowledge to utilize in making complex decisions pertaining to environmental issues (Gambro & Switzky, 1999).

Arcury, Johnson, and Scollay, in a 1986 study of Kentucky residents, showed that increased general education is positively associated with positive environmental attitudes and a higher degree of environmental knowledge if the cognitive and affective aspects of the environment are taught. This study also found that the level of environmental knowledge one has is influenced by one's worldview of the place of humans in relation to the environment. It is the worldview of a person that determines how much and what is learned and understood about the environment.

High School Accelerated Programs

Many high schools in the United States offer accelerated programs for their students such as:

- Curriculum compacting
- Subject acceleration
- Mentorships
- Dual enrollment
- Early college admission.

These programs differ widely. Each will be discussed in detail.

Curriculum Compacting

Curriculum compacting is an idea that arose to prevent gifted or accelerated students from repeating information they have already mastered. Therefore, these students are permitted to skip parts of the curriculum. Textbook pre and posttests can be used to evaluate which part(s) of the curriculum these students have mastered and on which they need to concentrate (Starko, 1989). There are several benefits of curriculum compacting for gifted students such as:

- Allowing these students to spend more time on their personal areas of interest
- Reducing the chance that students will feel bored
- Ensuring that students are not repeating material
- Allowing students to progress at their own pace (Sisk, 1988).

Some of the disadvantages include:

- The students must be mature enough to learn on their own (Taylor, 1989)
- It takes much time for a teacher to plan a compact curriculum for different students (Starko, 1986)
- Each student needs an individualized curriculum to meet their particular needs (Sisk, 1988)
- The students need to feel support from their teachers and their parents (Starko, 1986).

Subject Acceleration

Subject acceleration is comprised of honors courses, the International Baccalaureate Program and the Advanced Placement Program. Each of these topics will be discussed in further detail under the appropriate heading.

Honors courses

Honors, Advanced Placement (AP), and International Baccalaureate (IB) programs are all designed to prepare students for college, but the AP and IB programs are much more rigorous courses of study than are honors classes. There is no documentation of when honors classes began (Herr, 1993). It is known that they pre-date AP classes, which began in the 1950's and were often replaced by AP classes (Herr, 1993).

There is not much literature outlining the history of honors classes in high schools (Herr, 1992a). A study by Herr in 1992b surveyed 361 high school administrators about their feelings toward AP and honors classes at their schools. The results indicate that administrators are more supportive of AP classes than honors classes. In 1992, Herr also performed a study that compared the influence of AP and honors classes on science instruction. The study involved 847 AP and honors high school science teachers from California and New York. Herr found that teachers use lecture more in AP classes than in honors classes due to the vast amount of material that must be covered in AP classes. In addition, AP classes cover science content in more breadth and depth, and the pace of AP classes is much faster than honors classes. Teachers have more curricular freedom in honors classes, and one third of the teachers stated they would rather teach honors classes if given the choice due to the pressure of preparing students for the AP exam (Herr, 1992a). Another study by Herr (1991) looked at the relationship between teachers of AP and honors classes and professional development. He interviewed 19 teachers from southern California and reported that teachers felt teaching AP classes was more effective in promoting professional development and communication and teaching AP classes was more intellectually stimulating.

International Baccalaureate Program

The IB program began in the 1970's as a way of devising a standardized international curriculum for students traveling throughout European countries and between the United States and European countries (Poelzer & Felhusen, 1996). The IB program, a two year program designed for highly gifted and highly motivated juniors and seniors provides an opportunity for students to begin specializing in an academic area of their choice while still in high school (Peterson, 1977).

Unlike the AP program, the IB program is based on a set of classes and is not offered as separate individual classes. The classes required for students to receive their IB diploma include: English, literature, foreign language, science, math, social studies, theory of knowledge, independent research, and 150 hours of social service or creative aesthetic activities (Peterson, 1983).

The IB program is similar to the AP program in that they both offer college-level work to students in high school, prepare students for college-level work, provide training for teachers, have externally developed, internationally standardized curricula, and externally evaluated exams. If the students do well on the exams, they may receive college credit. The IB and AP programs differ in that the IB exam is graded on a 1-7 point scale whereas the AP exam is graded on a 1-5 point scale. The IB exam is much more expensive than the AP exam, and the IB Office specifies which textbooks to use in the IB program while the College Examination Board does not dictate the textbooks for the AP program (College Entrance Examination Board, 2000).

Advanced Placement Program

In an attempt to spur higher academic achievement in high schools and to prevent curricular overlap between high schools and colleges and universities, the College Entrance Examination Board accepted the Advanced Placement (AP) Program in the United States in 1954 (Herr, 1993). The first AP exams were administered in the spring of 1956. Since then, the AP Program has grown to include 32 subjects in 18 disciplines (College Board, 1997).

Representatives of the College Board decide and enforce the polices of the AP Program. The representatives are made up of College Board member institutions and agencies, public and private high schools, and colleges and universities. The Educational Testing Service (ETS) is in charge of developing and scoring the exams (College Board, 1997).

The AP Program operates through cooperative efforts of secondary schools, colleges, and universities. It is based on the idea that college-level material can be successfully taught to high achieving, able high school students. The goal of the AP Program is to acknowledge students who succeed in AP courses while still in high school. Colleges and universities are encouraged to grant credit, advanced placement, or both in recognition of students' high scores on the AP exam (Curry, MacDonald, & Morgan, 1999).

Many secondary schools offer AP classes in a variety of subjects, and any high school that chooses to do so may participate in the AP Program. The AP curriculum includes:

- Art (art history, studio art - drawing portfolio, studio art - general portfolio)
- Biology

- Calculus (calculus AB, calculus BC)
- Chemistry
- Computer science (computer science A, computer science AB)
- Economics (macroeconomics, microeconomics)
- English (English language and composition, English literature and composition, international English language)
- Environmental science
- French (French language, French literature)
- German (German language)
- Government and politics (comparative, United States)
- History (European, United States, World)
- Latin (Latin literature, Vergil)
- Music (music theory)
- Physics (physics B, physics C-electricity and magnetisms, physics C-mechanics)
- Psychology
- Spanish (Spanish language, Spanish literature)
- Statistics (Curry et al., 1999).

Some schools choose to offer AP classes as an integral part of the curriculum, while others offer AP classes as electives (College Board, 1997).

Advanced Placement Programs can now be found all over the world and in all 50 states. They have become one of the top indicators used by educators to determine the status of education in the United States (Curry et al., 1999). In some states, about 80% of both public and private schools offer AP courses. Currently in the United States, about 77% of all AP students are from public schools, 60% are in 12th grade (40% in 11th grade), 55% are female (Curry et al., 1999), 31% are minorities (African American and

Hispanic), and 7.8% are from low-income families (College Entrance Examination Board, 2000). Overall, about 40% of the public high schools in the United States, most of which are in rural and inner city areas, do not offer AP classes (Oregon University, 1999).

Since the program's inception, the number of disadvantaged students (poor and minority) taking AP exams has increased (College Entrance Examination Board, 2000). In 1999, the U.S. Department of Education provided $4 million in grants to pay for the examination fees of disadvantaged students in AP classes as an incentive for high schools to offer more AP classes and raise their academic standards (Curry et al., 1999). Advanced Placement classes give such students an opportunity to excel in an atmosphere that has high academic standards (College Entrance Examination Board, 2000).

Every year more colleges and universities grant college credit to students who score a 3 or higher on the AP exam (College Board, 1997). The AP grade qualifications are as follows:

- Extremely well qualified = 5
- Well qualified = 4
- Qualified = 3
- Possibly qualified = 2
- No recommendation = 1 (Curry et al., 1999).

In the United States, about 3,500 four-year colleges/universities participate in the AP program (Curry et al., 1999). According to the College Board, about 63.8% of the students in AP courses take the AP exam (Oregon University 1999); though anyone who chooses can take the AP exam (College Board, 1997). In 1999, 64% of all AP exam grades were a 3 or higher (Curry et al., 1999).

There are several benefits of the AP Program for the students, teachers, and high schools involved. Students can receive college credit for AP classes they take while still in high school, which saves them the cost of college tuition. Advanced Placement classes also provide students with knowledge and skills that may help them to be successful in college. The benefits to teachers include opportunities to teach rigorous content and attend professional development workshops (College Entrance Examination Board, 2000). The benefits to high schools are that AP courses enrich the curriculum, motivate teachers and students, and set high academic standards (Curry et al., 1999).

A study by Troidl and DeGracie (1984) found that of 182 high school graduates who took AP classes in high school, over 80% of the students believed their AP classes prepared them for college-level work, provided valuable experiences, and were more interesting and challenging than any of their other classes. A study by Curry et al. (1999) analyzed 66,125 first and second year college students' academic performance in upper-level college classes by comparing students who received advanced placement into the upper-level college courses with those who took the prerequisite college courses first.

The results showed that the 27,268 students who received advanced placement credit earned higher grades in their upper-level college courses than the students who did not receive advanced placement but took the equivalent introductory level college courses first (Curry et al, 1999). As a result of this study, Curry et al (1999) concluded that students who take AP classes in high school are:

- Academically better prepared for college than those students who do not take AP classes
- Have a higher probability of majoring in more academically challenging fields
- Complete more college-level coursework

- Take more upper-level college courses in the area of their high school AP classes
- Have stronger leadership skills
- Have a greater probability of graduating with a double major
- Are two times as likely to continue their education in graduate or professional school.

The authors of the study have coined these attributes of AP students the "AP Effect" (Curry et al., 1999).

Mentorships

Another way to help gifted students learn is to provide them with a mentor. A mentor is an older student who acts as teacher and friend to the gifted student (Ellingson, Haeger, & Feldhuse, 1986). Mentorships provide a way for gifted students to learn content that is above and beyond their school curriculum. For example, gifted students can observe their mentor outside of class, perhaps at his/her place of work, where students can learn about careers or other interests (Reiss & Follo, 1993).

Dual Enrollment

Dual enrollment programs have been established as a way to challenge gifted students in their junior and senior years of high school (Andrews & Marshall, 1991). These students are enrolled in high school as well as college courses. The students may attain high school and college credit for their college courses. The students can either attend the college to take their classes or a college professor may teach a few college classes at local high schools (Reiss & Follo, 1993). Most states enable high school students to take college courses at no additional cost (Andrews & Marshall, 1991).

Early Admission to College

An Early Admission to College Program allowing students to attend college early came as an extension of AP and dual enrollment programs (Feldhusen, 1983). Transition Programs have been established to help high school students with the transition from high school to college. Such programs provide orientation sessions, college student mentors, and separate living quarters for the high school students during their first year of college (Reiss & Follo, 1993).

Advanced Science Courses

Currently, there is no one report that can provide complete information pertaining to the number of students enrolled in advanced science classes (Doran, 1991). This is due in part to the wide variety of titles for these classes, the methods used to collect such data (teachers are asked to use surveys to report the number of students at their school enrolled in a list of pre-existing science courses), and the fact that students take these classes in 10^{th}, 11^{th}, or 12^{th} grade. In the United States it is estimated that between 1.4 and 1.7% (28,000) of high school students complete advanced physics courses, between 3.9 and 4.5% (107,000) complete advanced chemistry courses, and about 15.6% (341,000) complete advanced biology courses (Doran, 1991).

A study by Campbell and Connolly in 1984 that involved surveys of 287 students from advanced science and math classes found that females enroll in fewer advanced science and math classes than males. This was thought to occur because females tend to have lower self-esteem and because males portray negative attitudes towards females in advanced classes. Through their research of 720 females enrolled in advanced science and math classes, Campbell and Evans (1993) concluded that females who enroll in advanced science and math classes tend to have high self-esteem and an internal locus of control.

Thomas (1986) found that few Black students enroll in advanced science classes in high school (as cited in Pearson & Betchel, 1989). A 1993 study by Malcom reported that few Blacks and Hispanics take advanced science classes as a result of years of teachers and school counselors discouraging minority students from enrolling in such classes (as cited in Pearson & Betchel, 1989; Chenoweth, 1999). Several other reasons have been given as to why females and minorities avoid advanced science classes:

- They do not feel these classes are necessary for their future career plans
- They perceive these classes as difficult and requiring too much effort to do well in them
- They have had unsuccessful experiences in previous science classes
- They have had negative student/teacher interactions in previous science classes
- Females feel that these classes will destroy their friendships with males because science is masculine and not feminine (Clewell, Anderson, & Thorpe, 1992).

Environmental Science Courses

Courses in environmental science were created as a response to the interest in, and concern for, the environment that was piqued by the first Earth Day in 1970 (Howell & Warmbrod, 1974; Singletary, 1992; College Board, 1997). Since then, environmental science has grown in popularity and, as a result, today it is a definite field of science (College Board, 1997). It is taught in many colleges, universities, and high schools and is brought to our attention almost every day through news media such as newspapers and television. The following is the definition of environmental science as outlined by the College Examination Board:

> Environmental science is the study of the natural sciences in an interdisciplinary context that always includes consideration of the people and how they have influenced the systems under examination. It includes many aspects of biology, earth and atmospheric sciences, fundamental principles of chemistry and physics, human population dynamics, and an appreciation for biological and natural resources (College Board, 1997, p.1).

An environmental science course will focus on science concepts, but it may also briefly touch on some subjects such as: environmental economics, environmental policy, and sustainable futures (College Board, 1997).

A case study by Singletary (1992) of six secondary schools in Illinois found that the teachers of environmental science classes used individualized instruction and student projects in their classes, but class discussion was the teaching method most commonly used. Few laboratory exercises were performed. Nature films and videotapes were used quite often. The majority of the courses studied were initially designed as a way to offer an additional science course to students who were uninterested in, or lacked the prerequisite knowledge for, chemistry or physics. Therefore, the environmental science courses were seen as classes that were not academically challenging, thus allowing low ability students the chance to take more science courses (Singletary, 1992).

Additional sections of some of these courses were added later as more college-bound students became interested in such courses. Teachers who taught both the upper and lower level environmental science classes could not clearly articulate how these classes actually differed. The goals of these courses were to provide students with information about the environment and environmental issues and the skills to evaluate such information (Singletary, 1992).

None of the courses in Singletary's case study emphasized the affective domain of environmental science. The teachers explained this by saying they thought if they just increased the students' environmental knowledge it would be enough to encourage them to behave in a more environmentally responsible manner. But, without addressing the affective along with the cognitive domain and without providing students with the opportunity to practice behaviors that are more environmentally appropriate, it is doubtful that students will begin to behave in a more environmentally responsible manner (Singletary, 1992).

High school environmental science courses such as the ones described in the above case study have the opportunity to be the last valuable formal exposure to science for students not planning to attend college as well as for students who do not intend to major in science in college. These high school environmental science classes could also provide the framework from which all other formal environmental science courses extend (Singletary, 1992).

Science curriculum supervisors and 7^{th}-12^{th} grade science teachers in Texas were asked to identify their use of environmental science facilities, the environmental science teaching materials and techniques used, and what they needed to improve environmental science classes (Adams, Biddle, & Thomas, 1988). The participants stated they needed adequate training and environmental science facilities, curricula, and successful programs to model (Adams et al., 1988).

Goals of Environmental Science Courses

The goals of environmental science are:

- To provide knowledge and skills that will enable students to understand environmental issues (Singletary, 1992)
- To develop concern for the environment
- To create citizens who are motivated to work to solve problems concerning the environment (Howell & Warmbrod, 1974).

Originally, environmental science classes were created for students who were academically unprepared to take chemistry or physics, and higher levels were developed later as more college-bound students became interested. Due to the interdisciplinary nature of environmental science, it may attract college-bound students or those who are not interested in chemistry or physics (Singletary, 1992). Therefore, it may be a chance to get more students to take science classes in high school, which could lead to students having more environmental knowledge upon which to draw when making decisions concerning environmental issues (Gambro & Switzky, 1999).

Difficulties Inherent in Teaching Environmental Science

There are some inherent difficulties specific to implementing environmental science courses. Four aspects that make environmental science difficult to teach and understand are:

- It is interdisciplinary, thus, one needs to have knowledge of a variety of science concepts
- There is no agreement on the terminology used to define energy; energy is a unit of measure, but it is measured using different units such as: electricity (kilowatts), gasoline (gallons), and natural gas (cubic feet), which are all different from the calorie (used in science) and the kilocalorie (used in nutritional information)
- There are no absolutes (for example, how do you measure environmental quality?)
- There is no baseline or an untouched Earth to compare with today's Earth to know exactly what humans have done to the Earth, and what has been the result of natural processes (College Board, 1997).

Importance of Studying Students' Attitudes Toward Science

Research has shown that the cognitive domain should not be the only domain of learning addressed by teachers. Although the affective domain should not be addressed at the expense of the cognitive, it should have substantial curricular time. How students feel about, or their attitudes toward, school subjects should be considered an important goal of education. Therefore, it can be inferred that it is important to determine students' attitudes toward science as well as how and why such attitudes were formed. It should thus be an important objective of science education to promote positive attitudes toward science in schools. Once educators know what the attitudes of students are toward science and how and why they are formed, they can work towards improving these attitudes in their classrooms (Myers & Fouts, 1992).

Students' Attitudes Toward Science

Studies have suggested that teacher variables may be the most powerful predictors of students' attitudes toward science (Haladyna, Olsen, & Shaughnessy, 1982). It is also known that variables such as socioeconomic status, family background, and student aptitude for learning play a part in the initial development of attitudes toward science (Haladyna et al., 1982). A study by Haladyna, et al. (1982) of 315 students in 4th grade, 322 in 7th grade, and 365 in 9th grade found the student variables with the most consistent significant relationship to students' attitudes toward science were self-confidence in ability to learn science, fatalism (feeling that how they perform in science is predetermined), and feelings of the importance of science.

For teacher variables, overall quality of the teacher (teacher enthusiasm, respect for teacher's knowledge, teacher support for students, praise and commitment to learning and fairness) was the best predictor of students' attitudes toward science. The learning environment variables shown to affect students' positive attitudes toward science were overall satisfaction, enjoyment of classmates, positive class environment, organized instruction, and attentiveness (Haladyna et al., 1982). A study of 125 science students in 7th and 8th grade by Germann in 1988 also concluded that students' feelings about the importance of science strongly correlated to students' attitudes toward science.

A study by Cannon and Simpson (1985) which involved 821 7th grade life science students and 11 science teachers, a study involving 673 11th grade students by Schibeci and Riley (1986), and a study by Weinburgh (1995) presenting a meta-analysis of 6,753 students found that males have more positive attitudes toward science than females and that students' attitudes toward science affect their science achievement. However, a study of 5th, 7th, and 10th graders by Morrell and Lederman (1998) concluded that gender does not affect students' attitude toward science. Catsambis (1995) found that a gap in the attitudes of male and female students toward science exists even when females outperform males in science classes. Therefore, female students' negative attitudes toward science develop independent of their levels of science achievement (Catsambis, 1995).

Although Black students have historically been outperformed by their White counterparts, they have retained more positive attitudes toward science in high school (Pearson & Bechtel, 1989). Bachman and O'Malley (1984) reported that Black students may appear to have more positive attitudes toward science because they are more likely than White students to choose responses at the positive end of a Likert-type scale (as cited in Pearson & Bechtel, 1989).

Another study of 1,560 students in 6th through 10th grade and 23 10th grade teachers (Talton & Simpson, 1987) revealed that 56-61% of the variance in students' attitudes toward science could be explained by students' attitudes toward their classroom environment. The authors of this study suggest that when determining students' attitudes toward science it is important to consider how the students feel about the emotional and physical climate of their classroom, activities performed, and their interactions with their classmates and teachers.

The stronger the commitment to, and the higher the interest in science, the more able students will be to make intelligent decisions on political and social issues relating to science as adults. It is thought that a positive, supportive classroom environment incorporating laboratory instruction (Freedman, 1997) and more student involvement (Hender, Fisher & Fraser, 1998) will lead to both more positive attitudes toward science and greater science achievement for students (Talton & Simpson, 1987).

Students' attitudes toward science become more negative as students move from the beginning of the school year to the end (Cannon & Simpson, 1985), and as students pass through middle and junior high school (Haladyna & Shaughnessy, 1982; Morrell & Lederman, 1998). Advanced science students have the most positive attitudes toward science and basic science students have the least positive attitudes toward science (Cannon & Simpson, 1985).

A study involving 4,000 science students in grades 6-9 and 57 teachers by Simpson and Oliver (1985), found that as students progress through school, science becomes less fun, less interesting, and more boring. In light of the fact that students' attitudes toward science become more negative as students get older, it is important to consider that science achievement motivation and science self-concept are powerful predictors of achievement in science as demonstrated in a study by Oliver and Simpson (1988) in which they collected data on 5000 students in grades 6-10. This conclusion can be disheartening if viewed from the vantage point that students' attitudes toward science decrease with age. It can be enlightening if looked at from the view that there is hope if we can promote positive student attitudes toward science among students early in their schooling because then we can increase their science achievement in subsequent years.

The Advanced Placement Environmental Science Program

Faculty from colleges and high schools formed the AP Environmental Science Development Committee. They created the first edition of the Course Description for AP Environmental Science, also known as the acorn booklet, in 1997. This publication contained content outlines Appendix A), lab activity suggestions, as well as sample APES exam questions (College Board, 1997).

The goals of the APESP are:

> to provide students with the scientific principles, concepts, and methodologies needed to understand the interrelationships between people and their environment, to identify and analyze environmental problems both natural and human made, to assess the risks associated with these problems, and to identify solutions for resolving or preventing them, and to understand natural systems, be able to ask questions, recognize when and how human perturbations may become or have become problems, and understand the limits of what questions science can answer. (College Board, 1997, p. 1, 11)

The APES course is a yearlong course that meets for at least one period per day and has at least one lab period per week. Due to the interdisciplinary nature of environmental science, the course builds on students' prior knowledge of chemistry, physics and biology, and may function to attract students who would not normally be enrolled in an AP course. Therefore, as a prerequisite, students must have done well in, and completed, at least two years of science (one physical and one life science) and one year of algebra. Thus, students should take AP Environmental Science in either their junior or senior year (College Board, 1997).

Advanced Placement Environmental Science Guidelines

APES requires students to perform significant laboratory and fieldwork as an integral part of the course. Laboratory and fieldwork are a necessity if students are to gain an adequate understanding of how natural processes operate. It is through such laboratory and fieldwork that students receive hands-on experiences and are able to test the ideas they learn about in the classroom. This is their chance to do real science. It is recommended that students perform at least 12 labs throughout the course (College Board, 1997).

When establishing a new course, such as the AP Environmental Science Program, teacher selection and training is crucial if the course is to be successful. An enthusiastic, highly motivated, and dedicated teacher can make a course, while the opposite can break it. The following are suggested criteria for teacher selection:

- Enthusiastic about teaching
- Works well with others, which is particularly important due to the interdisciplinary nature of environmental science
- Strong knowledge base of environmental science, chemistry, physics, biology, and earth science
- Highly motivated to provide students with much laboratory and fieldwork (College Board, 1997).

Advanced Placement Environmental Science Teacher Training Workshops

The College Board offers workshops to help train teachers in the teaching of AP classes. The workshop sessions include training in instructional and laboratory methods, an explanation of the format of the AP exam, and strategies for preparing students for the AP exam. Several colleges and universities also offer their own training programs for teachers. Some high schools pay for these teacher-training sessions. Teachers can receive information about training sessions and gain valuable ideas and activities by attending conferences and searching the Internet (College Board, 1997).

The Advanced Placement Environmental Science Exam

The focus of the APES exam is to quantify how well students are able to express their knowledge and understanding of environmental science concepts. It is a three-hour exam that consists of multiple-choice and essay questions. Scores range from 1 to 5, with 3 as a minimum passing score (College Board, 1997).

The purpose of the APES exam is to evaluate a student's level of knowledge and understanding of environmental science. The College Board AP Environmental Science Development Committee devises the questions. The exam takes three hours to complete. Sixty percent of the exam grade is determined by the multiple-choice section, which evaluates the breadth of the student's knowledge (College Board, 1997).

The questions vary widely by topic and level of difficulty. The score on the multiple-choice section is calculated by adding the number of questions the student answered correctly and subtracting a quarter of the questions the student answered incorrectly. The free response section constitutes 40% of the AP exam grade and consists of four equally-weighted questions. These questions must be answered in the form of an essay. The free response questions fall into three categories:

- Data analysis (which presents the student with data to interpret)
- Document based (which presents the student with documents such as newspaper articles and asks students to apply knowledge)
- Synthesis and evaluation (which involves in-depth synthesis and evaluation of environmental science concepts).

Of the four free response questions, one is data based, one is document based, and two are synthesis and evaluation (College Board, 1997).

These questions are graded by only giving points to arguments that are supported by scientific facts. Each question is scored from 1-10 points. Samples of all question types are available for students in the Advanced Placement Environmental Science Course Description (College Board, 1997). Currently, no data are available regarding the number of AP environmental science classes offered each year or the number of students in these classes, but there is data on the number of students who take the APES exam. In 2000, 13,546 students took the APES exam in the United States (R. Morgan, personal communication, July 13, 2001).

This chapter discussed the relevant research that has been done in several areas related to the current study. The following topics were reviewed:

- Status of environmental knowledge
- High school accelerated programs
- Advanced science courses
- Environmental science courses
- Students' attitudes toward science
- High school environmental science courses
- History of the Advanced Placement Environmental Science Program

Chapter 3 discusses the study sample, data sources, data collection, and analysis techniques. Chapter 4 reports the results of the quantitative research questions. Chapter 5 describes the case study that was developed from the APES observations and interviews. Chapter 6 discusses the results of the quantitative/qualitative research questions as well as the conclusions drawn base and the overall implications of the results.

CHAPTER 3
METHODOLOGY

Introduction

This chapter gives a brief description of the study, explains the research questions and how they were developed, describes the study sample (comprised of a survey sample and a case study sample), and outlines the data sources, data collection, and data analysis techniques for each of the 10 research questions. Specifically, it summarizes the demographics of the survey study sample and the case study observation and interview study sample. This chapter also summarizes the processes used to develop and pilot test the teacher and student assessment instruments. The techniques used to validate and determine the reliability of the student attitude scale are explained and potential limitations to the validity and reliability of the student attitude scale are also discussed.

Description of the Study

This was an exploratory study designed to describe and evaluate the Advanced Placement Environmental Science Program in 12 high schools in California, Florida, and New York. Specifically this study gathered data pertaining to the following six categories:

- General characteristics of students and teachers participating in the Advanced Placement Environmental Science Program.
- Attitudes of students and teachers toward the APES Program.
- Gender and ethnic differences in student attitudes toward the APES Program.
- Perceived strengths and weaknesses of the program identified by teachers and students.

- Match between stated APES goals/guidelines and actual implementation.
- Recommendations for improvement of the program.

The following ten research questions were developed related to these six categories.

Research Questions

1. What is the profile of students who enroll in APES?
2. What is the profile of teachers who teach APES?
3. What are the attitudes of students toward APES?
4. What are the attitudes of teachers toward APES?
5. Do the attitudes of students toward APES differ by gender or ethnicity?
6. Are there differences in the amount of time spent on APES and other class activities reported by students and teachers?
7. What do students feel are the strengths/weaknesses of APES?
8. What do teachers feel are the strengths/weaknesses of APES?
9. How closely does the actual implementation of APES match the goals/guidelines stated by the College Board?
10. What recommendations can be made to improve APES?

To answer these research questions, data were collected from two different groups of APES teachers and students. These two groups consisted of one large survey study sample from three states and one intact AP Environmental Science class case study sample in Gainesville, Florida. The large survey study sample was used to gather quantitative data to be used in statistical analyses and the case study sample was included to collect qualitative data to supplement the survey data by adding richness to the data set, providing insights into the interpretation of the survey data, and for triangulation purposes.

Survey Study Sample

California, Florida, and New York were selected for this study because they are the three states with the highest numbers of schools having at least 10 students who took the Advanced Placement Environmental Science exam in 2000. A composite list of all schools in the United States currently offering APES was obtained from the College Board. A letter explaining the study and asking for participation was sent to 50 APES teachers from 50 different schools in each of the three states of interest.

The teachers were randomly selected from the total available population of APES teachers in each state using SPSS. Due to a poor response of only six volunteer teachers (two from each state), follow-up postcards were sent one month later to the 48 teachers in each state who had not responded. Five teachers from five schools in each state agreed to participate and all 15 of these sites received teacher and student surveys.

The final sample consisted of four schools in each state, which included a total of 12 teachers and 355 students. One teacher from each state did not return the surveys. The total student sample was 60% female, and 56% White, 17% Hispanic, 16% Asian, 8% Black, and 4% other ethnic groups. The majority of the students were in 12th grade (52%), followed by 46% in 11th grade, 2% in 10th grade, and 1% in 9th grade. The teachers were 100% White and 60% female.

The student sample was not random because the students who filled out the survey were those who returned to class after taking the APES exam. Due to the nature of APES and the pressure that teachers feel to cover material to prepare students for the APES exam, the teachers only agreed to administer the survey after the exam. The entire sample of students and teachers was collapsed across all states and no state-by-state comparisons were made.

Observation/Interview Study Sample

The case study sample was included to collect qualitative data and to add to the richness of the survey data, to provide insights into the interpretation of the survey data, and for triangulation. The case study site was chosen because it was one of two high school AP Environmental Science class sites in Gainesville, Florida that had a teacher willing to participate and was the most convenient location for the researcher to visit.

Mr. S. is the instructor of the Advanced Placement Environmental Science class at a large, high socioeconomic, suburban high school in Gainesville, Florida. He is a White male teacher who lives in a rural area, has a bachelor's degree in biology education, and has taught science for 11 years, and APES three and a half years. There were 30 students in the class, 19 females and 11 males.

All of the students were White except for one Asian female and two Black females. The majority of the students were 9^{th} graders (12) with ten 10^{th}, four 11^{th}, and four 12^{th} graders. Ten of these students were chosen to be interviewed based on gender, ethnicity, grade level, and APES class grade point average to make the sample as heterogeneous as possible. Each of the 10 students interviewed lived in the suburbs, their grade point averages ranged from 2.8 to 4.0, and their APES class grades ranged from an A to a C. There were six freshman, two juniors, and two seniors in the student interview sample. The highest academic degree of the students' mothers ranged from technical school certification to a master's degree, while the highest academic degree of their fathers ranged from a high school diploma to M.D. and Ph.D. degrees.

Data Sources/Data Collection

The data sources for this study consisted of two different groups of APES teachers and students. One of these groups consisted of a large sample of 12 teachers and 355 students from four APES classes in each of three states. Quantitative data from this study sample was used to answer the first five research questions. The other group was a smaller intact group of 30 students and a teacher from an APES class in Gainesville, Florida. Qualitative data was collected to develop a case study of an APES class and was combined with quantitative data to answer the last five research questions.

Teacher and Student Surveys

To collect information from the large survey study sample, mail-in paper and pencil surveys were used. Teacher and student surveys were mailed to teachers of five Advanced Placement Environmental Science courses in each state: California, Florida, and New York. The teachers were asked to complete the teacher survey (Appendix B), and to administer a student survey to all students in each section of their Advanced Placement Environmental Science classes (Appendix C). Both the teacher and student surveys were composed of four major sections: an attitude scale, self-report data on the amount of time spent on APES activities, demographic and personal profile information, and self-report data on the most important strengths and most significant weaknesses of APES. Each section of the surveys will be discussed in more detail under the research question to which it pertains.

APES Class Observations

To collect information from the case study sample, on-site class observations and oral teacher and student interviews were used. The APES class observations were conducted during a first period class at a local high school in Gainesville, Florida. They began in September 2002 and ended in December 2002. A total of 10 fifty-minute class periods were observed. The observations were made on five Mondays and five Fridays according to the availability of the researcher. The researcher was a non-participant observer, and thus did not interact with the students. The teacher was only communicated with either before or after each observed class. A diagram of the classroom is presented in Chapter 5 along with the case study developed as a result of the observations. Detailed field notes were collected during each observation day. The observations were analyzed using the constant comparison method (Meyers, 1981) in which all incidences were coded, and then compared to provide information regarding the following categories:

- Teacher instructional methodology
- Student/teacher interactions
- Student/student interactions
- Student level of involvement during instruction/class activities
- Use of classroom resources
- Student use of class time
- Type and frequency of different instructional activities (e.g. lecture, labs, fieldwork, discussions, student presentations, cooperative group work, student independent research, and working on solutions to environmental problems)
- Teacher use of real-world examples
- Teacher use of methods for a variety of learning styles
- Teacher questioning techniques.

APES Class Interviews

Teacher, parent, and student consent forms were distributed to the teacher and the 10 students to be interviewed. The interviews were only conducted once all of the consent forms were signed and returned to the researcher. Interviews were conducted on days convenient for the teacher and students. The students interviewed were chosen based on gender, ethnicity, grade level, and APES Grade Point Average to be as heterogeneous as possible.

The 10 students were randomly selected based upon the above criteria from a list of the students in the APES class being observed. A summary of characteristics of the students chosen for the interview is presented in Chapter 5. The 22-item teacher (Appendix D) and 20-item student (Appendix E) interview protocols were developed by the researcher and were based on observations and data collected during the previous 10 class observations and on the guidelines stated by the College Board regarding the amount of class time that should be spent on certain types of activities. The interviews were audiotaped and then transcribed.

The teacher and student interviews were conducted to enhance and clarify the interpretation of the field note observational data. The teacher and each student were only interviewed on one occasion. Each interview lasted approximately 20 minutes. The teacher and student interviews were used to develop a case study of one AP Environmental Science class that focused on:

- Demographic Information
- Curriculum
- Classroom Learning Environment
- Planning
- Instructional Methodology
- Classroom Management
- Assessment
- Match with APES Guidelines.

Observation/Interview Data Analysis

The field note and interview data were analyzed using the constant comparison method (Meyers, 1981). First, each incidence was coded and then all related incidences were placed into the same category. Then the incidences within a given category were compared to determine the properties of each category. Finally, a theory was developed to explain how the categories of data were related to each other, and thus attempted to explain the incidences that were observed (Meyers, 1981).

The teacher and student interview data were then compared to the field note data to see how well the teacher's and students' statements matched what was observed in the classroom. Both the field note data and the interview data were also compared to the data reported by the teachers and students on the teacher and student surveys. Using multiple methods to collect the same type of data is used as an effort to validate data (McFee, 1992). The observation and interview data were analyzed collectively and used to prepare a case study of one Advanced Placement Environmental Science class. For a detailed outline of the study design and timeline see Appendix F.

Survey Instrumentation/Data Analysis

Teacher and student assessment instruments (surveys) were designed to collect information in four distinct areas. How each instrument was developed, and the data analysis techniques used to analyze survey results are discussed under each research question.

1. What is the profile of students who enroll in APES? Two items on the student survey specifically focused on self-report profile data and nine items focused on demographic characteristics of students (see Table 3-1). All 11 items were combined to provide a profile of students enrolled in APES. The self-report and demographic data were analyzed by calculating the frequency of each response category for the entire student sample.

Table 3-1. Self-report and demographic items on the student survey.

Self-report Items
How many hours a week do you spend studying?
How many hours a week do you spend on homework?
Demographic Items
What is your gender?
In what type of area do you live?
What grade level are you in school?
What is your approximate grade point average?
What is your ethnic background?
Indicate the highest academic degree of your mother.
Indicate the highest academic degree of your father.
How many high school science courses have you completed?
How many other AP courses have you taken?

2. What is the profile of teachers who teach APES? Fifteen items on the teacher survey specifically focused on self-report profile data. Six pertained to instructional techniques, four contained information about his/her APES students, and five asked about assessment techniques.

Table 3-2. Self-report and demographic items on the teacher survey.

Self-report Items Instructional Techniques
How many hours a week do you spend preparing to teach?
How many hours a week do you spend grading?
How many hours a week do you spend preparing for lab activities?
How many hours a week do you spend preparing for fieldwork?
How many hours a month do you spend on professional development?
How many sections of AP Environmental Science do you teach?
Self-report Items APES Students
About how many students do you have in each section?
In what grade are the majority of your students?
What is the percent of students who take the AP Environmental Science Exam?
What is the percent of students who pass the AP Environmental Science Exam?
Demographic Items
Did you complete formal training for the AP Environmental Science course?
What is your gender?
In what type of area do you live?
What is your ethnic background?
Indicate your highest academic degree?
How many years of science teaching experience do you have including this year?
How many years have you been teaching AP classes?
Self-report Items Assessment Techniques
Indicate the percentage of your assessments that are matching.
Indicate the percentage of your assessments that are multiple-choice.
Indicate the percentage of your assessments that are true/false.
Indicate the percentage of your assessments that are essay.
How often do you assess your students?

The remaining seven items focused on demographic characteristics of teachers (see Table 3-2). All 22 items were combined to provide a profile of teachers who teach APES. The self-report and demographic data were analyzed by calculating the frequency of each response category for the entire teacher sample.

3. What are the attitudes of students toward APES? The majority of the student assessment instrument was developed to measure student attitudes toward APES using the model proposed by Haladyna, Olsen and Shaughnessy (1982). Their study of 315 students in 4th grade, 322 in 7th grade, and 365 in 9th grade found three main categories of variables that affect students' attitudes toward science. They include:

- Student variables (factors that are attributable only to the individual student)
- Teacher variables (factors that are unique to an individual teacher)
- Learning environment variables (factors that describe the context and setting in which learning takes place).

To assess student attitudes related to these three categories, a 42-item attitude scale was used. This attitude scale was designed around the subscales of student, teacher, and learning environment variables to explain the overall construct of student attitudes toward APES (see Table 3-3 for items included in each subscale). All items were original and developed by the researcher because of the outdated nature of the questions from the Haladyna et a. (1982) study. Lucky's study (1972) was used as a guide for the development of the teacher and student attitude scales because his study looked at the attitudes of teachers and students toward AP Biology in the Memphis City Schools. His study utilized a teacher and student attitude survey of 25 items each and a Likert scale ranging from strongly disagree to strongly agree with four response choices to measure attitudes.

Table 3-3. Original student attitude scale items

Attitude Toward The Class Subscale Items
The benefits of taking this class outweigh the amount of work I put into it.
This course has met my expectations of preparing me for college-level course work.
My decision to take this course was a good one.
I have learned a lot about environmental science in this class.
As a result of taking this class, I have learned a lot about how to take action to solve environmental problems.
As a result of taking this class, my attitude toward the environment has become more positive.
As a result of taking this class, my behavior towards the environment has become more positive.
I enjoy this class.
I took this class because I believe it is important to learn about the environment.
The workload for this class is too extensive.
Given the opportunity, I would take this class again.
The lab exercises in this course are excellent.
The fieldwork in this course is excellent.
It is necessary for a student to have at least two years of a high school Laboratory science to do well in this class.
I feel prepared to take the AP Environmental Science Exam.
I took the AP Environmental Science exam.
Attitude Toward The Teacher Subscale Items
My teacher is well qualified to teach this course.
My teacher does an excellent job teaching this course.
My teacher explains concepts well.
My teacher enjoys teaching this course.
My teacher is very knowledgeable about environmental science.
My teacher cares about his/her students.
My teacher listens to his/her students.
My teacher is available to provide extra help for his/her students.
My teacher tells his/her students when they have done a good job.
My teacher has high expectations for all students in this class.
My teacher is fair to all students.
My teacher believes it is important to learn about the environment.
My teacher believes it is important to learn how to solve environmental problems.
My teacher displays a positive attitude toward the environment.
My teacher encourages his/her students to take the AP Environmental Science Exam.
My teacher has made sure that his/her students are prepared to take the AP Environmental Science Exam.
My teacher's main mode of instruction for this course is lecture.
My teacher gives us too much work in this class.
My teacher uses outside readings to supplement the textbook in this class.
My teacher encourages independent research in this class.
My teacher encourages laboratory work in this class.
My teacher encourages cooperative group work in this class.
My teacher encourages fieldwork in this class.
My teacher emphasizes to his/her students the benefits of taking an AP course.
I respect my teacher.
I like my teacher.
My teacher is enthusiastic about environmental science.
Attitude Toward The Student Subscale Items
I do excellent work in this class.
It is important to me to get good grades.
Environmental Science is an important subject.
I enjoy learning environmental science.

This study used the same Likert scale to measure the attitudes of teachers and students toward APES. The response choices were coded as follows: Strongly Disagree=0, Disagree=1, Agree=2, and Strongly Agree= 3. Therefore, a response coding of 2 or 3 indicated an agree or strongly agree response and was considered a positive attitude, while codings of 0 or 1 indicated a negative attitude.

To determine student attitudes, a total scale score for each student for the attitude scale and each of the three attitude subscales was calculated. This was done by summing each student's coded response to all items. The total scale score was divided by the number of items to determine an average scale score for each student. The attitude toward APES of the entire student sample was determined by averaging the average scale score (overall average attitude scale score) of all students for the attitude scale and each of the subscales. Descriptive statistics (means and standard deviations) were computed to evaluate the students' attitudes regarding individual attitude items.

Pilot Testing

The student attitude scale was pilot tested by administering it to 50 students at two suburban high schools currently offering Advanced Placement Environmental Science courses in Gainesville, Florida. Data were analyzed using SPSS (10.0) to perform factor and item analyses. Based on the results of the data analyses, the surveys were revised before final distribution. These analyses are explained in more detail later in this chapter.

Reliability/Construct Validity

Reliability of the student attitude scale was determined by performing an item analysis on the pilot test results and using Cronbach's alpha as a measure of internal consistency of the entire set of items. Construct validity was determined by performing a factor analysis on the pilot test results for the student attitude scale.

Results of the first item analysis of all 47 items of the student attitude scale indicated that items 10 and 34 had negatively corrected item-total correlations and needed to be reverse coded (see Appendix G, Table F-1 for results of the first item analysis). The reliability of the 47-item student attitude scale as measured by Cronbach's alpha was 0.9289. Items 10 and 34 were reverse coded, and a second item analysis was performed (see Table 3-4).

Table 3-4. Items that were reverse coded after the first student attitude scale item analysis.

The workload for this class is too extensive.
My teacher gives us too much work in this class.

The second item analysis with items 10 and 34 reverse coded yielded item response means between 2.574 and 3.730, standard deviations between 0.530 and 0.892, and corrected item-total correlations between 0.050 and 0.707 (see Appendix G, Table F-2 for the results of the second item analysis). The reliability of the revised total attitude scale as measured by Cronbach's alpha was 0.938, an increase from 0.930 when items 10 and 34 were reverse coded. To be considered acceptable, target means and corrected item-total correlations for individual items were 3.0 and 0.3 or higher respectively, and an overall Cronbach's alpha reliability coefficient was 0.8 or higher was targeted for the entire attitude scale. Items 10, 14, 16, 33, and 34 had low corrected item-total correlations, indicating they needed to be either revised or removed.

The first factor analysis of all 47 student attitude items with items 10 and 34 reverse coded yielded 11 factors with loadings ranging from 0.244 to 0.770 and items displayed communalities between 0.208 and 0.779. Target loadings for individual items were $\geq$0.3 and target communalities were $\geq$0.5. Based on these criteria, items 14, 16, 26, 33, and 35 had low communalities (around 0.2), which provided evidence to remove them because they were not loading high on any factors (see Appendix H, Table G-1 for the results of the first factor analysis). All items had loadings above or near 0.3, therefore no changes were needed.

Based on the results of the initial item and factor analyses, items 10, 14, 16, 33, and 34 were removed from the survey (see Table 3-5).

Table 3-5. Items deleted from the student attitude scale.

10.	The workload for this class is too extensive.
14.	It is necessary for a student to have at least two years of a high school laboratory science to do well in this class.
16.	I took the AP Environmental Science exam.
33.	My teacher's main mode of instruction for this course is lecture.
34.	My teacher gives us too much work in this class.

Items 14, 16, and 33 were removed because they performed poorly on both the item and factor analyses. Items 10 and 34 were removed because they had low corrected item-total correlations on the item analysis. The fact that they had high loadings and communalities on an eighth factor did not support keeping them since their correlations with the other items of the student attitude scale were so low. Items 26 and 35 were not removed because although they had low communalities on the factor analysis, their corrected item-total correlations on the item analysis were acceptable.

A third item analysis for the 42-item student attitude scale was performed after items 10, 14, 16, 33, and 34 were deleted. The coded response means of the items were between 2.574 and 3.729. The standard deviations were between 0.525 and 0.892. The corrected item-total correlations increased and were between 0.336 and 0.703. Thus, the remaining items were found to be of good quality because they had good spread, meaning that individuals were responding in all four response categories, and each response category was providing information about students' attitudes toward APES (see Appendix

G, Table F-3 for the results of the third item analysis). The reliability of the revised student attitude scale as measured by Cronbach's alpha was 0.941, an increase from 0.932.

After items 10, 14, 16, 33, and 34 were removed, a second factor analysis yielded seven factors. The loadings ranged from 0.289 to 0.777, and communalities were between 0.229 and 0.774. The number of factors decreased from 11 for the first factor analysis to seven, and the loadings and communalities increased as items 10, 14, 16, 33, and 34 were removed (see Appendix H, Table G-2 for the results of the second factor analysis). Based on the results of the item and factor analyses, the number of student attitude items was decreased from 47 to 42 with items 10, 14, 16, 33, and 34 deleted. Descriptive statistics (means and standard deviations) were performed for the overall attitude scale and each of the subscales (see Table 3-6).

Table 3-6. Descriptive statistics for the revised student attitude scale and subscales with items 10, 14, 16, 33, and 34 deleted.

Scale	Mean Score	Standard Deviation	Number of Items	N
Student	3.256	0.564	4	50
Teacher	3.403	0.440	25	50
Class	3.403	0.455	13	50
Overall	3.291	0.392	42	50

For the most part, the items on the student attitude scale loaded on factors with items associated with each of the three subscales: attitude toward teacher, attitude toward student, and attitude toward classroom environment, with some overlap of the class and student and class and teacher subscales. This may have occurred because the students could not separate themselves or their teachers from a few of the classroom environment questions. An example of an item with overlap is "As a result of taking this class, I have learned a lot about how to take action to solve environmental problems, and given the opportunity, I would take this class again." When responding to this item, students could be focusing on the APES class, themselves as students, or having a good teacher.

In order to determine if the construct of students' attitudes toward science could be measured by a one-factor model, it was determined how well a one-factor model fit the pilot data. The resulting one-factor model consisted of items 22-25, 27, and 41-42, explained 31.15% of the variance of the items, had loadings >0.48, and adding additional factors did not contribute significantly to the amount of variance explained by the 1-factor model (see Table 3-7). Therefore, the student attitude scale overall was considered to measure the one factor of student's attitudes toward APES with the three subscales of students' attitudes toward their teacher, themselves as students, and their APES classroom environment.

Table 3-7. Items in the 1-factor model for the revised student attitude scale

Item	Subscale
My teacher tells his/her students when they have done a good job.	Teacher
My teacher has high expectations for all students in this class.	Teacher
My teacher is fair to all students.	Teacher
My teacher believes it is important to learn about the environment.	Teacher
My teacher displays a positive attitude toward the environment.	Teacher
Environmental Science is an important subject.	Student
I enjoy learning environmental science.	Student

Limitations to Reliability and Construct Validity

Several factors beyond the researcher's control may limit the reliability and construct validity of the student attitude scale. The students filled out the surveys by bubbling their responses on scantron sheets, which, due to human error in marking their responses to each question, could have had an undetermined effect. In addition, the teachers administered the student assessment instruments; therefore, students may not have been completely honest in their responses. Students may have felt that their teachers would not approve of their truthful answers especially if their answers differed from their teachers' expectations.

4. **What are the attitudes of teachers toward APES**? A 45-item attitude scale was developed to assess teacher attitudes toward APES overall, their attitudes toward their APES class, their attitude towards their students, and their attitudes toward themselves as APES teachers. Each of the subscales of attitudes toward class, students, and themselves as teachers functioned together to explain the overall construct of teacher attitudes toward APES (see Table 3-8 for items included in each subscale). Descriptive statistics (means and standard deviations) were computed to determine the teachers' attitudes toward individual attitude items.

The items included in the teacher attitude scale paralleled those of the student attitude scale. Due to the small pilot test teacher sample size (N=2), item and factor analyses could not be performed for the teacher attitude scale. The items in the teacher attitude scale that were similar to the items deleted in the student attitude scale after pilot testing and subsequent analyses were also deleted from the teacher attitude scale. Thus, it was assumed that if the student attitude scale was reliable and valid, the teacher attitude scale was also reliable and valid since the attitude questions on both instruments paralleled each other. Therefore, based on the results of the item and factor analyses for the student attitude scale, the teacher attitude scale was modified to include questions paralleling those in the final student survey.

Table 3-8. Attitude scale and subscale questions for the teacher assessment instrument.

Attitude Toward The Class Subscale Items
The benefits of teaching this class outweighs the costs of the time needed to prepare to teach it.
This course has met my expectations of having the opportunity to teach highly motivated students.
My decision to teach this course was a good one.
I have learned a lot about environmental science in preparing to teach this class.
In preparing to teach this class, I have learned a lot about how to take action to solve environmental problems.
As a result of teaching this class, my attitude toward the environment has become more positive.
As a result of teaching this class, my behavior toward the environment has become more positive.
I have enjoyed teaching this class.
I wanted to teach this class because I believe that it is important for students to learn about the environment.
I feel the lab exercises designed for this course are excellent.
I feel the fieldwork in this course is excellent.
I feel the textbook that is used for this class is helpful.
Attitude Toward The Student Subscale Items
I feel my students are prepared to take the AP Environmental Science Exam.
I think the majority of my students do excellent work in this class.
I think my students are the type to do well in science.
I think it is important to my students to get good grades.
I think environmental science is an important subject to my students.
I think my students work hard in this class.
I think my students appreciate the hard work they do in this class.
I think my students enjoy learning environmental science.
Attitude Toward The Teacher Subscale Items
I feel I am well qualified to teach this course.
I feel I do an excellent job teaching this course.
I feel I explain concepts well.
I am very knowledgeable about environmental science.
I care about my students.
I listen to my students.
I am available to provide extra help for my students when needed.
I tell my students when they have done a good job.
I have high expectations for all students in this class.
I am fair to all students.
I believe it is important for students to learn about the environment.
I believe it is important for students to learn how to solve environmental problems.
I display a positive attitude toward the environment.
I encourage my students to take the AP Environmental Science Exam.
I have made sure my students are prepared to take the AP Environmental Science Exam.
I give my students a lot of work in this class.
I use outside readings to supplement the textbook in this class.
I encourage independent research in this class.
I encourage laboratory work in this class.
I encourage cooperative group work in this class.
I encourage fieldwork in this class.
I emphasize to my students the benefits of taking an AP course.
I respect my students.
I like my students.
I am enthusiastic about environmental science.

5. Do the attitudes of students toward APES differ by gender or ethnicity?

Using students' average scale scores on the attitude scale (items 1-42) and each of the three attitude subscales, a two-way ANOVA was used to determine if the students' attitudes towards their APES class was dependent on gender or ethnicity. This was done by comparing the male students' average scale scores to the female students' average scale scores and by comparing the students' average scale scores for each ethnicity to all of the other ethnicities. The Type I error (α) used for both the *t*-test and the one-way ANOVA was 0.05.

6. Are there differences in the amount of time spent on APES and other class activities reported by students and teachers? The *Teacher's Guide AP Environmental Science* (College Board, 1997) was consulted to develop a set of items measuring teacher and student self-reports of the amount of time spent on APES class activities (items 45, 46, and 49-53 on the student survey; items 49, 51, and 57-61 on the teacher survey). The items were designed to reflect the types of activities that should occur in APES classes as recommended by the College Board. The researcher also included items pertaining to other class activities such as: amount of class time spent on lecture, cooperative group work, class discussions, student presentations, and independent research.

Table 3-9. Items assessing self-reports of the amount of time spent on APES and other class activities on the student survey.

Amount of Time Spent on APES Class Activities
How many hours a week do you spend on lab activities?
How many hours a week do you spend doing fieldwork?
How many hours a week do you spend identifying environmental problems?
How many hours a week do you spend analyzing environmental problems?
How many hours a week do you spend solving environmental problems?
How many hours a week do you spend assessing the risks associated with environmental problems?
How many hours a week do you spend working on solutions to prevent environmental problems?
Amount of Time Spent on Other Class Activities
How many hours a week does your teacher spend lecturing?
How many hours a week do you spend doing cooperative group work?
How many hours a week do you engage in class discussions with your teacher?
How many hours a week do students engage in presentations?
How many hours a week do you spend doing independent research?

The rationale for these items was based on the idea that critical thinking and knowledge application skills are important for students to be able to succeed in our democratic society (Ornstein, Behar-Horenstein, & Pajak, 2003). This set of items measured teacher and student self-reports of the amount of time spent on other class activities (items 47-48, and 54-56 on the student survey; items 52-56 on the teacher survey). Tables 3-9 and 3-10 list the items that were used to assess self-reports of the amount of time spent on APES and other class activities on the student and teacher surveys respectively.

Table 3-10. Items assessing self-reports of the amount of time spent on APES and other class activities on the teacher survey.

Amount of Time Spent on APES Class Activities
How many hours a week do you spend on lab activities?
How many hours a week do you spend doing fieldwork?
How many hours a week do you spend helping students identify environmental problems?
How many hours a week do you spend helping students analyze environmental problems?
How many hours a week do you spend helping students solve environmental problems?
How many hours a week do you spend helping students assess the risks associated with environmental problems?
How many hours a week do you spend helping students prevent environmental problems?
Amount of Time Spent on Other Class Activities
How many hours a week do you spend lecturing?
How many hours a week do your students spend doing cooperative group work?
How many hours a week do your students spend doing independent research?
How many hours a week do you engage in class discussions with your students?
How many hours a week do your students engage in presentations?

The frequency of each response category for the amount of time spent on APES and other class activities for the student sample and the teacher sample was tabulated and compared. The interview protocol administered to a teacher and 10 students in an AP Environmental Science class at a local high school in Gainesville, Florida also included self-report items focusing on the amount of time spent on the same APES and other class activities. The response frequencies for these teacher and student interview items were also tallied and compared with frequency results from the survey data.

7. What do students feel are the strengths/weaknesses of APES? Two self-report items on the student survey pertained to students' perceptions of the most important strengths and the most significant weaknesses of APES: "List the most important strengths of your AP Environmental Science class" (item 66) and "List the most significant weaknesses of your AP Environmental Science class" (item 67). The strengths/weaknesses the students expressed were categorized and the frequency of responses in each category was calculated. The interview protocol administered to 10 students in an AP Environmental Science class at a local high school in Gainesville, Florida also included self-report items focusing on the most important strengths and the most significant weaknesses of APES. The response frequencies for the student interview items were also tallied and compared with, frequency results from the student survey data.

8. What do teachers feel are the strengths/weaknesses of APES? Two self-report items on the teacher survey pertained to teachers' perceptions of the most important strengths and the most significant weaknesses of APES: "List the most important strengths of your AP Environmental Science class" (item 80) and "List the most significant weaknesses of your AP Environmental Science class" (item 81). The strengths/weaknesses the teachers expressed were categorized and the frequency of responses in each category was calculated. The interview protocol administered to a teacher in an AP Environmental Science class at a local high school in Gainesville, Florida also included self-report items focusing on the most important strengths and the most significant weaknesses of APES. The response frequencies for the teacher interview items were also tallied and compared with, frequency results from the teacher survey data.

9. How closely does the actual implementation of APES match the goals/guidelines stated by the College Board? The *Teacher's Guide AP Environmental Science* (1997) was used to develop a standard for comparison to answer the research question "How closely does the actual implementation of APES match the goals/guidelines stated by the College Board?" Self-report items 45-46, 49-53 on the student survey and self-report items 49, 51, 57-61 on the teacher survey specifically addressed this question (see Table 3-11 for the student survey items and Table 3-12 for the teacher survey items).

Table 3-11. Items assessing self-reports of the amount of time spent on APES class activities on the student survey.

How many hours a week do you spend on lab activities?
How many hours a week do you spend doing fieldwork?
How many hours a week do you spend identifying environmental problems?
How many hours a week do you spend analyzing environmental problems?
How many hours a week do you spend solving environmental problems?
How many hours a week do you spend assessing the risks associated with environmental problems?
How many hours a week do you spend working on solutions to prevent environmental problems?

Table 3-12. Items assessing self-reports of the amount of time spent on APES class activities on the teacher survey.

How many hours a week do you spend on lab activities?
How many hours a week do you spend doing fieldwork?
How many hours a week do you spend helping students identify environmental problems?
How many hours a week do you spend helping students analyze environmental problems?
How many hours a week do you spend helping students solve environmental problems?
How many hours a week do you spend helping students assess the risks associated with environmental problems?
How many hours a week do you spend helping students prevent environmental problems?

Frequency data for each response category were tabulated for the amount of time spent on APES class activities on the teacher and student surveys. The data were compared to a standard to look for a match (see Table 3-13). The College Board has designed the APES Program to include a significant amount of lab and fieldwork. The researcher interpreted "significant" to mean at least one lab or field activity per week. The College Board also states that one of the goals of APES is for students to be able to identify, analyze, solve, assess the risks of, and work on solutions to prevent environmental problems. The College Board suggests no specified amount of time for these activities. Thus, when developing a standard for comparison the researcher interpreted the amount of time that should be spent on these goals as more than half of one class period per week (approximately 3 hours/week).

Table 3-13. Standards set by the College Board for the amount of time that should be spent on APES class activities.

Time spent on lab activities/fieldwork	Significant = at least 1 lab or field activity/week
Time spent on identifying environmental problems	Goal = 3hours/week
Time spent on analyzing environmental problems	Goal = 3hours/week
Time spent solving environmental problems	Goal = 3hours/week
Time spent assessing the risks associated with environmental problems	Goal = 3hours/week
Time spent on working on solutions to prevent environmental problems	Goal = 3hours/week

In addition to analyzing survey item responses for this research question, the relative amount of time spent on different learning activities, labs, fieldwork, and identifying, analyzing, solving, assessing the risks of, and working on solutions to environmental problems during 10 case study observations of the high school APES class in Gainesville, Florida was also computed. The frequency of time spent on the same activities that was self-reported during the teacher and student interviews at the APES case study site in Gainesville was also tallied (see Table 3-14 for the teacher interview and Table 3-15 for the student interview items related to this research question).

Table 3-14. Teacher interview item.

How much time do you spend on lab activities, fieldwork, identifying environmental problems, analyzing environmental problems, assessing the risks associated with environmental problems, and working on solutions to environmental problems?

Table 3-15. Student interview item.

How much time do you spend on lab activities, fieldwork, identifying environmental problems, analyzing environmental problems, assessing the risks associated with environmental problems, and working on solutions to environmental problems?

The frequencies of responses to these interview items were compared to the same standard and to those reported in the teacher and student surveys. All of the data from the teacher and student surveys, case study observations, and the teacher and student interviews were combined to determine how well the actual implementation of APES matched the goals/guidelines stated by the College Board. Specifically, the data from all sources were used to compare the average amount of time teachers and students reported spending on lab activities, fieldwork, and identifying, analyzing, solving, assessing, and working on solutions to environmental problems to the standard amount of time recommendation by the College Board.

10. What recommendations can be made to improve APES? Recommendations for improvement of the Advanced Placement Environmental Science Program were made based on all data sources. The data sources included the teacher and student attitude scales, the amount of time devoted to APES class activities as reported by the teachers and students, and what the students and teachers felt were the most important strengths and the most significant weaknesses of APES as stated on the student and teacher survey. Data collected from the APES class observations, and the teacher and student interviews at a local high school in Gainesville, Florida were also used to supplement the survey data.

Face Validity

A panel of Four University experts that consisted of a science educator, two environmental educators, and an educational research methods specialist determined face validity of the entire teacher and student survey instrument. The research specialist provided comments on the structure, response choices, directions, and order of questions. The educators provided comments on the types of questions asked, wording, and content of the questions. As a result of their comments, the demographic information was placed at the end of the survey, the directions were made more clear, the structure of the survey was simplified, and the wording and content of some of the questions was changed.

This chapter outlined the research questions, study sample, data sources, data collection techniques, and procedures for data analysis for all research questions. Chapter 4 reports the results of research questions 1-5. Chapter 5 describes the APES observations and interviews for the case study sample. Chapter 6 discusses the results of research questions 6-10 as well as the conclusions and implications of the results on the Advanced Placement Environmental Science Program.

CHAPTER 4
QUANTITATIVE RESULTS

Introduction

This chapter revisits the data analysis procedures and reports results for the five quantitative research questions (1-5). The results will be discussed under the appropriate research question.

Research Questions

1. What is the profile of students who enroll in APES? The student survey sample consisted of 355 students. The frequency of responses to items 43- 44 (self-report) and items 57-65 (demographics) on the student survey were calculated to determine a profile of the types of students enrolled in APES (see Table 4-1). The majority of APES students in this study:

- Study for APES one to three hours a week
- Do less than one hour of APES homework a week
- Are female (61%)
- Live in the suburbs (52% suburban, 37% urban, and 9% rural)
- Are in 12th grade
- Have a 3.5-4.0 G.P.A.
- Are White (56% White, 17% Hispanic, 16% Asian, 8% Black, and 4% other ethnic groups)
- Have mothers with bachelor's degrees
- Have fathers with master's degrees
- Have taken four to five high school science classes

- Have taken one or no other AP classes.

Table 4-1. Student frequency of responses for self-report and demographic items.

Item	Abbreviation	Response	Valid Percent
43	Studying	1-3 (hrs./wk)	43.0
44	Homework	<1 (hrs./wk)	44.9
57	Gender	Female	60.6
58	Live	Suburban	51.7
59	Grade	12^{th}	51.7
60	G.P.A	3.5-4.0	53.7
61	Ethnic	White	55.7
62	Degree mom	Bachelors degree	35.9
63	Degree dad	Masters degree	35.3
64	H.S. science	4-5	62.4
65	AP classes	<1	37.0

2. What is the profile of teachers who teach APES? The teacher survey sample contained 12 teachers. The frequency of responses regarding self-report instructional techniques (items 46-48, 50, and 62-63), self-report information on APES students (items 64-67), self-report responses regarding assessment techniques (items 75-79), and demographics (items 68-74) on the teacher survey were calculated to determine the profile of teachers involved in APES (see Table 4-2). The majority of APES teachers spend three to five hours a week preparing to teach, one to three hours a week grading, one to three hours a week preparing for lab activities, and less than one hour per week preparing for fieldwork. They spend less than five hours a month on professional development and teach two sections of APES with 21-30 mostly 12^{th} grade students in each section. About 75-100% of their students take the APES exam and 75-100% of those students pass the exam. Most of the teachers have no formal AP training, a master's degree, over 12 years of science teaching experience, and three to five years of AP teaching experience. These teachers assess their students about once every two weeks and less than 10% of their assessments are matching, 31-59% are multiple-choice, less than 10% are true/false, and 31-59% are essay. All of the teachers are White, 60% are female, and 60% live in the suburbs (40% urban).

Table 4-2. Teacher frequency of responses for self-report and demographic items.

Item	Abbreviation	Response	Valid Percent
46	Preparing to teach	3.1-5 (hrs./wk)	40.0
47	Grading	1-3 (hrs./wk)	60.0
48	Preparing for lab activities	1-3 (hrs./wk)	80.0
50	Preparing for fieldwork	<1 (hrs./wk)	60.0
62	Professional development	>5 (hrs./month)	44.4
63	Sections APES	2	60.0
64	Students per section	21-30	70.0
65	Grade	12^{th}	66.7
66	% students taken AP exam	75-100	100.0
67	% students pass AP exam	75-100	60.0
68	AP training	No	60.0
69	Gender	Female	60.0
70	Live	Suburban	60.0
71	Ethnic	White	100.0
72	Degree	Masters degree	50.0
73	Science teaching	>12	40.0
74	AP teaching	3-5	60.0
75	% Matching	<10	100.0
76	% Multiple-choice	31-59	40.0
77	% True/false	<10	100.0
78	% Essay	31-59%	50.0
79	How often assess	1X2weeks	50.0

3. **What are the attitudes of students toward APES**? To determine the attitudes of the 355 students in this study, a total scale score for each student for the attitude scale and each of the subscales was calculated (items 1-42). This was done by summing each student's response to all items. The total scale score was divided by the number of items to get the average scale score for each student. The students' attitudes toward APES were

determined by averaging the average scale score (overall average scale score) of each student for the attitude scale and each of the subscales.

The overall average scores for all students on the attitude scale (items 1-42) and each of the subscales (class, teacher, and student) were all close to 2.0 (responses of 0=strongly disagree, 1=disagree, 2=agree, and 3=strongly agree), indicating that the students in this study have overall positive attitudes toward APES. Specifically, the average attitude score for the entire attitude scale was 1.99, the class subscale average score was 1.60, the teacher subscale average score was 2.20, and the student subscale average score was 2.24. Overall, the students in this study have the most positive attitudes toward themselves as students in APES, followed by attitudes toward their teachers, overall attitudes, and attitudes toward their APES classes (see Table 4-3).

Regarding individual items, mean responses were two or above for 34 of the items and less than two for eight of the items. The standard deviations of mean student attitude scores for the entire attitude scale ranged from 0.56 to 0.92, indicating a great deal of variability in the students' attitudes and thus, the data should be interpreted with caution.

Students have less than positive attitudes toward the following items:

Class subscale:

- This course has met my expectations of preparing me for college-level course work.
- I took this class because I believe it is important to learn about the environment.
- Given the opportunity, I would take this class again.
- The lab exercises in this course are excellent.
- The fieldwork in this course is excellent.
- I feel prepared to take the AP Environmental Science Exam.

Teacher subscale:

- My teacher encourages independent research in this class.

Student subscale:

- I do excellent work in this class.

Students had more positive attitudes toward the following items:

Class subscale (criteria = mean of 2.20 or higher):

- My decision to take this course was a good one.
- I have learned a lot about environmental science in this class.
- As a result of taking this class, my attitude toward the environment has become more positive.

Teacher subscale (criteria = mean of 2.50 or higher):

- My teacher is well qualified to teach this course.
- My teacher enjoys teaching this course.
- My teacher is very knowledgeable about environmental science.
- My teacher believes it is important to learn about the environment.
- My teacher believes it is important to learn how to solve environmental problems.
- My teacher displays a positive attitude toward the environment.
- My teacher encourages his/her students to take the AP Environmental Science Exam.
- I respect my teacher.
- My teacher is enthusiastic about environmental science.

Student subscale (criteria = mean of 2.20 or higher):

- It is important to me to get good grades.
- Environmental science is an important subject.
- I enjoy learning environmental science.

Table 4-3. Descriptive statistics for the student attitude scale.

Item	Question	N	Mean	Std. Dev.
	Class Subscale			
1	The benefits of taking this class outweigh the amount of work I put into it.	353	2.020	0.774
2	This course has met my expectations of preparing me for college-level course work.	349	1.765*	0.807
3	My decision to take this course was a good one.	354	2.325	0.763
4	I have learned a lot about environmental science in this class.	354	2.492	0.635
5	As a result of taking this class, I have learned a lot about how to take action to solve environmental problems.	355	2.080	0.751
6	As a result of taking this class, my attitude toward the environment has become more positive.	353	2.250	0.753
7	As a result of taking this class, my behavior towards the environment has become more positive.	353	2.108	0.769
8	I enjoy this class.	354	2.170	0.782
9	I took this class because I believe it is important to learn about the environment.	355	1.834*	0.916
10	Given the opportunity, I would take this class again.	353	1.867*	0.915
11	The lab exercises in this course are excellent.	354	1.542*	0.807
12	The fieldwork in this course is excellent.	333	1.670*	0.779
13	I feel prepared to take the AP Environmental Science Exam.	352	1.906*	0.851
	Teacher Subscale			
14	My teacher is well qualified to teach this course.	355	2.575	0.699
15	My teacher does an excellent job teaching this course.	354	2.350	0.812
16	My teacher explains concepts well.	354	2.370	0.703
17	My teacher enjoys teaching this course.	354	2.588	0.673
18	My teacher is very knowledgeable about Environmental science.	355	2.651	0.608
19	My teacher cares about his/her students.	355	2.482	0.694
20	My teacher listens to his/her students.	354	2.376	0.736
21	My teacher is available to provide extra help for his/her students when needed.	352	2.409	0.738
22	My teacher tells his/her students when they have done a good job.	354	2.297	0.782
23	My teacher has high expectations for all students in this class.	354	2.288	0.765
24	My teacher is fair to all students.	353	2.323	0.775
25	My teacher believes it is important to learn about the environment.	354	2.689	0.558
24	My teacher is fair to all students.	353	2.323	0.775
25	My teacher believes it is important to learn about the environment.	354	2.689	0.558
26	My teacher believes it is important to learn how to solve environmental problems.	355	2.578	0.630
27	My teacher displays a positive attitude toward the environment.	354	2.528	0.674

*= mean <2 (less than "agree")

Table 4-3 Continued..

28	My teacher encourages his/her students to take the AP Environmental Science Exam.	355	2.639	0.610
29	My teacher has made sure that his/her students are prepared to take the AP Environmental Science Exam.	355	2.344	0.778
30	My teacher uses outside readings to supplement the textbook in this class.	354	2.133	0.833
31	My teacher encourages independent research in this class.	351	1.940*	0.891
32	My teacher encourages laboratory work in this class.	354	2.093	0.722
33	My teacher encourages cooperative group work in this class.	353	2.275	0.747
34	My teacher encourages fieldwork in this class.	346	2.095	0.787
35	My teacher emphasizes to his/her students the benefits of taking an AP course.	354	2.065	0.820
36	I respect my teacher.	353	2.527	0.691
37	I like my teacher.	353	2.473	0.707
38	My teacher is enthusiastic about environmental science.	352	2.585	0.644
	Student Subscale			
39	I do excellent work in this class.	351	1.974*	0.801
40	It is important to me to get good grades.	352	2.460	0.707
41	Environmental science is an important subject.	351	2.345	0.743
42	I enjoy learning environmental science.	353	2.241	0.788

* = mean <2 (less than "agree")

Results of the attitude scale analyses indicate that overall, students enjoy their APES classes, but would not take them again. Students feel their APES classes are beneficial because their decision to take this course was a good one, they learn a lot about environmental science and how to take action to solve environmental problems, feel the class has made their attitudes and behaviors toward the environment more positive, consider environmental science to be an important subject, but did not take the class because they feel it is important to learn about the environment. Interestingly, the students do feel their teachers believe it is important to learn about the environment and how to solve environmental problems.

Students do not feel personally prepared to take the APES exam, nor do they feel this course has met their expectations of preparing them for college-level course work, but do feel the teachers make sure their students are prepared to take the APES exam.

They think they have well qualified, knowledgeable, excellent, and caring teachers who encourage lab work, fieldwork, and cooperative, not independent group work, but at the same time the students feel the quality of the lab and fieldwork in APES is poor. Finally, students like and respect their enthusiastic APES teachers who display positive attitudes toward the environment, and feel it is important to get good grades, but do not think they do excellent work in their APES classes.

Results indicate that APES is meeting some of the College Board's stated goals for the environmental science class such as: having students learn about the environment and especially how to take action to solve environmental problems, having knowledgeable teachers who feel it is important to learn about the environment, preparing students for the APES exam, and promoting lab and fieldwork. But, students do not feel that APES meets their expectations of preparing them for college-level work or to take the APES exam, nor do they consider the lab and fieldwork to be of high quality. These findings are important because the College Board believes APES should prepare students for college-level work and the APES exam and that APES should include excellent labs and fieldwork.

4. What are the attitudes of teachers toward APES? On average, the 12 teachers in this study have overall positive attitudes toward APES (responses of 0=strongly disagree, 1=disagree, 2=agree, and 3=strongly agree). The mean score for the total attitude scale was 2.27 (items 1-45). Mean subscale attitude scores were: 2.07 for the class subscale, 1.90 for the student subscale, and 2.40 for the attitude toward self as a teacher subscale. Teachers feel the most positive about themselves as teachers of APES, followed by their overall attitudes toward APES, attitudes toward their APES classes, and attitudes toward their APES students, but none of these differences in attitudes are statically significant. (see Table 4-4).

Regarding individual items, mean responses were two or above for 33 of the items and less than two for 12 of the items. The standard deviations of mean teacher attitude scores for the entire attitude scale ranged from 0.00 to 1.10, but did not vary as much as those of the student attitude scores, indicating there is not as much variability in the teachers' attitudes.

Teachers have less than positive attitudes toward the following items:

Class subscale:

- This course has met my expectations of having the opportunity to teach highly motivated students.
- As a result of teaching this class, my attitude toward the environment has become more positive.
- I feel the lab exercises designed for this course are excellent.
- I feel the fieldwork in this course is excellent.

Student subscale:

- I think the majority of my students do excellent work in this class.
- I think my students are the type to do well in science.
- I think my students work hard in this class.
- I think my students appreciate the hard work they do in this class.

Teacher subscale:

- I feel I do an excellent job teaching this course.
- I encourage independent research in this class.
- I encourage laboratory work in this class.
- I encourage fieldwork in this class.

Teachers had more positive attitudes toward the following items:

Class subscale (criteria = mean of 2.20 or higher):

- My decision to teach this course was a good one.
- I have learned a lot about environmental science in preparing to teach this class.
- I have enjoyed teaching this class.
- I wanted to teach this class because I believe that it is important for students to learn about the environment.
- I feel the textbook that is used for this class is helpful.

Student subscale (criteria = mean of 2.20 or higher):

- I think it is important to my students to get good grades.
- I think my students enjoy learning environmental science.

Teacher subscale (criteria = mean of 2.60 or higher):

- I care about my students.
- I am available to provide extra help for my students when needed.
- I have high expectations for all students in this class.
- I am fair to all students.
- I believe it is important for students to learn about the environment.
- I encourage my students to take the AP Environmental Science Exam.
- I like my students.
- I am enthusiastic about environmental science.

Teachers in this study feel that teaching APES is beneficial because in teaching the class they personally learn a lot about environmental science and how to take action to solve environmental problems, develop more positive behaviors toward the environment, and enjoy teaching APES. They feel it is important for students to learn about the environment and how to solve environmental problems. They feel their students are prepared to take the APES exam, think environmental science is an important subject to their students, and feel their students enjoy learning about environmental science. The teachers also feel qualified to teach APES, care about their students, display positive attitudes toward the environment, report that they encourage cooperative group work, and are enthusiastic about teaching environmental science. The teachers do not feel that the course has met their expectations of having the opportunity to teach highly motivated students, did not develop a more positive attitude toward the environment, and feel that the APES lab and fieldwork activities are poor. They do not think their students work hard, do excellent work in their classes, are the type of students to do well in science, or appreciate the hard work they do in APES. The teachers also admit they do not feel they do an excellent job teaching this course and do not encourage labs, fieldwork, or independent student research. These results are important because the College Board recommends that students complete at least one lab activity each week and spend a significant amount of time doing fieldwork.

Table 4-4. Descriptive statistics for the teacher attitude scale.

Item	Question	N	Mean	Std. Dev.
	Class Subscale			
1	The benefits of teaching this class outweighs the costs of the time needed to prepare to teach it.	12	2.167	0.718
2	This course has met my expectations of having the opportunity to teach highly motivated students.	12	1.750*	0.754
3	My decision to teach this course was a good one.	12	2.417	0.515
4	I have learned a lot about environmental science in preparing to teach this class.	12	2.667	0.651
5	In preparing to teach this class, I have learned a lot about how to take action to solve environmental problems.	12	2.083	0.996
6	As a result of teaching this class, my attitude toward the environment has become more positive.	11	1.818*	0.751
7	As a result of teaching this class, my behavior towards the environment has become more positive.	11	2.091	0.701
8	I have enjoyed teaching this class.	12	2.250	0.622
9	I wanted to teach this class because I believe that it is important for students to learn about the environment.	12	2.583	0.515
10	I feel the lab exercises designed for this course are excellent.	12	1.167*	0.577
11	I feel the fieldwork in this course is excellent.	12	1.250*	0.754
12	I feel the textbook that is used for this class is helpful.	12	2.250	0.622
	Student Subscale			
13	I feel my students are prepared to take the AP Environmental Science Exam.	12	2.000	0.000
14	I think the majority of my students do excellent work in this class.	12	1.500*	0.522
15	I think my students are the type to do well in science.	12	1.583*	0.515
16	I think it is important to my students to get good grades.	12	2.417	0.515
17	I think environmental science is an important subject to my students.	12	2.000	1.095
18	I think my students work hard in this class.	11	1.667*	0.492
19	I think my students appreciate the hard work they do in this class.	12	1.750*	0.622
20	I think my students enjoy learning environmental science.	12	2.250	0.622

Table 4-4. Continued.

Item	Question	N	Mean	Std. Dev.
	Teacher Subscale			
21	I feel I am well qualified to teach this course.	12	2.333	0.651
22	I feel I do an excellent job teaching this course.	12	1.917*	0.515
23	I feel I explain concepts well.	12	2.417	0.515
24	I am very knowledgeable about environmental science.	12	2.333	0.651
25	I care about my students.	12	2.750	0.452
26	I listen to my students.	12	2.583	0.515
27	I am available to provide extra help for my students when needed.	12	2.667	0.492
28	I tell my students when they have done a good job.	12	2.583	0.515
29	I have high expectations for all students in this class.	12	2.750	0.452
30	I am fair to all students.	12	2.667	0.492
31	I believe it is important for students to learn about the environment.	12	2.750	0.452
32	I believe it is important for students to learn how to solve environmental problems.	12	2.500	0.674
33	I display a positive attitude toward the environment.	12	2.500	0.674
34	I encourage my students to take the AP Environmental Science Exam.	12	2.750	0.452
35	I have made sure that my students are prepared to take the AP Environmental Science exam.	12	2.583	0.515
36	I give my students a lot of work in this class.	12	2.000	0.426
37	I use outside readings to supplement the textbook in this class.	12	2.417	0.669
38	I encourage independent research in this class.	12	1.500*	0.905
39	I encourage laboratory work in this class.	12	1.750*	0.622
40	I encourage cooperative group work in this class.	12	2.417	0.669
41	I encourage fieldwork in this class.	12	1.667*	1.073
42	I emphasize the benefits of taking an AP course to my students.	12	2.167	0.718
43	I respect my students.	12	2.583	0.515
44	I like my students.	12	2.750	0.452
45	I am enthusiastic about environmental science.	12	2.667	0.492

* = mean <2 (less than "agree")

When results of the student and teacher attitude scales are compared, teachers and students agree that APES is beneficial, has not met their expectations, has taught them a lot about environmental science and how to take action to solve environmental problems, and that their behaviors toward the environment are more positive. Both groups enjoy the class, but feel the lab activities and fieldwork are poor. They also agree that the students do not do excellent work in the class, that their teacher is qualified to teach APES, that the teacher does not encourage independent research, but does encourage cooperative group work, and that they both like and respect each other.

Student and teacher attitude scale results indicate a lack of consistency or agreement between the two groups pertaining to the following items: that their attitudes changed as a result of the APES class, that environmental science is important, that the teacher does an excellent job teaching the class, that the teacher encourages lab and fieldwork, and that students are prepared to take the APES exam. These inconsistencies are interesting, but must be interpreted with caution because the sample size for the teacher attitude survey was small (N=12) relative to the size of the student survey sample (N=355).

5. Do the attitudes of students toward APES differ by gender or ethnicity? A two-way ANOVA was used to determine if gender and ethnicity had an effect on students' attitude towards APES (items 1-42 and 57 and 61). Results indicate students' attitudes toward Advanced Placement Environmental Science did not statistically differ for males and females for the overall student attitude scale, $F(1, 325) = 2.525$, $p = 0.113$ or any of the subscales. The effect size for Omega Squared was 0.005, which indicates a very small effect size. Therefore, the non-significant effect of gender on attitude is likely attributable to the small effects size as opposed to a lack of power (see Table 4-5). Results indicate that students' attitudes toward Advanced Placement Environmental Science did not significantly differ across levels of ethnicity for the student total attitude scale $F(4, 325) = 0.977$, $p = 0.420$ or any of the subscales. The effect size for Omega Squared was zero, which indicates a very small effect size. Therefore, the non-significant effect of ethnicity on attitude is likely attributable to the small effect size as opposed to a lack of power (see Table 4-5). There was no interaction between gender and ethnicity for the student total attitude scale $F(4, 325) = 1.133$, $p = 0.341$ or any of the subscales. The effect size for Omega Squared was 0.002, which indicates a very small effect size. Effect sizes will only be reported if they are significant for the remainder of the paper. Although the differences were not significant, Table 4-6 results indicate that females have more positive attitudes toward APES overall than do their male counterparts. Other ethnic groups in this study have more positive attitudes toward APES overall than White, Black, Asian, or Hispanic students. However, none of the ethnic groups' differences in attitudes were statistically significant.

Table 4-5. Two-way ANOVA for gender and ethnicity.

Scale	Levene's Test of Equal Variances		SS	df	MS	F	P	Effect Size
Total	0.005	Gender	2.357	1	2.357	2.525	0.113	0.0045
		Ethnicity	3.649	4	0.912	0.977	0.420	-0.0003
		G X E	4.232	4	1.058	1.133	0.341	0.0016
		Total	303.359	334				

Table 4-6. Student total attitude scale and class, teacher, and student subscale descriptive statistics for gender and ethnicity.

	Total scale			Class subscale			Teacher subscale			Student subscale		
Group	X	SD	N	X	SD	N	X	SD	N	X	SD	N
All	1.994	0.402	355	1.596	0.434	355	2.195	0.441	355	2.235	0.596	355
Gender												
Male	1.986	0.398	126	1.584	0.470	126	2.189	0.446	126	2.222	0.641	126
Female	2.015	0.386	214	1.615	0.390	214	2.216	0.417	214	2.259	0.553	214
Ethnic												
White	2.012	0.404	194	1.606	0.438	194	2.219	0.433	194	2.236	0.587	194
Black	1.966	0.471	27	1.590	0.410	27	2.165	0.590	27	2.130	0.728	27
Asian	1.904	0.393	55	1.524	0.390	55	2.082	0.458	55	2.232	0.518	55
Hispanic	2.029	0.332	59	1.631	0.395	59	2.230	0.354	59	2.259	0.589	59
Other ethnic groups	2.129	0.372	13	1.716	0.495	13	2.328	0.377	13	2.442	0.542	13

Table 4-7 results indicate that the total attitude scale has the smallest 95% confidence interval, meaning that the mean of the total attitude is more stable than the mean of any of the three individual subscales and has a smaller range which will contain the population mean 95% of the time. The student attitude toward self subscale had the largest 95% confidence interval, meaning that the mean of this subscale is the least stable compared to the total attitude scale and the other two subscales and has a larger range which will contain the population mean 95% of the time. This may be due to the fact that students have a more difficult time determining how they feel about themselves as students in APES than they do about determining how they feel about the class in general and their teachers in particular.

Table 4.7. 95% confidence intervals for student total attitude scale and class, teacher, and student subscales for gender and ethnicity.

95% Confidence Intervals	Total Scale	Class Subscale	Teacher Subscale	Student Subscale
Group				
All	$1.799 < \mu < 2.189$	$1.253 < \mu < 1.939$	$1.966 < \mu < 2.425$	$1.616 < \mu < 2.855$
Gender				
Male	$1.793 < \mu < 2.179$	$1.213 < \mu < 1.955$	$1.957 < \mu < 2.421$	$1.556 < \mu < 2.888$
Female	$1.828 < \mu < 2.203$	$1.307 < \mu < 1.923$	$1.999 < \mu < 2.433$	$1.684 < \mu < 2.834$
Ethnicity				
White	$1.816 < \mu < 2.208$	$1.260 < \mu < 1.952$	$1.994 < \mu < 2.444$	$1.626 < \mu < 2.846$
Black	$1.737 < \mu < 2.195$	$1.266 < \mu < 1.914$	$1.858 < \mu < 2.472$	$1.373 < \mu < 2.887$
Asian	$1.713 < \mu < 2.095$	$1.216 < \mu < 1.832$	$1.844 < \mu < 2.320$	$1.694 < \mu < 2.770$
Hispanic	$1.868 < \mu < 2.190$	$1.319 < \mu < 1.943$	$2.046 < \mu < 2.414$	$1.647 < \mu < 2.871$
Other ethnic groups	$1.948 < \mu < 2.310$	$1.325 < \mu < 2.107$	$2.132 < \mu < 2.524$	$1.879 < \mu < 3.005$

For the total attitude scale and each of the subscales, females had the smallest confidence intervals. Students of other ethnic backgrounds had the smallest 95% confidence interval for the total attitude and teacher and the class subscales, while Asian students had the smallest 95% confidence interval for the class and student subscales. These findings are interesting. Perhaps the students of other ethnic backgrounds had the smallest confidence interval for the teacher subscale because their cultures have greater respect for teachers or elders in general. The Asian students may have had the smallest confidence intervals for the class and student subscales because they view school as very important, take their classes very seriously, and feel very confident in their ability as students to do well in science.

This chapter reported the results of each of the study's five quantitative research questions. Chapter 5 contains a case study that was developed from observations and interviews with students and teachers in one APES class. The results of the five mixed method quantitative/qualitative research questions along with the conclusions and implications based on results for all 10 research questions are provided in Chapter 6.

CHAPTER 5
CASE STUDY OF AN ADVANCED PLACEMENT ENVIRONMENTAL SCIENCE CLASS

Introduction

This chapter presents a case study of one intact Advanced Placement Environmental Science class based on observations and teacher and student interviews at a local high school in Gainesville, Florida. The case study was conducted to provide qualitative data to enrich the data set, provide more specific insights into the interpretation of the quantitative survey data, and for triangulation purposes.

Methods

Case Study Sample

The case study sample consisted of 30 students and their teacher in one intact AP Environmental Science class in a large, high socioeconomic, suburban high school in Gainesville, Florida. The case study site was chosen because it was one of two high school AP Environmental Science class sites in Gainesville, Florida that had a teacher willing to participate and was the most convenient location for the researcher to visit.

The instructor of the Advanced Placement Environmental Science class will be referred to as Mr. S. in this case study. Mr. S. is a White male teacher, in his mid-forties who lives in a rural area, has a bachelor's degree in biology education, has taught science for 11 years, and has taught APES three and a half years.

Of the 30 students in the class, 19 were female and 11 were male. All of the students were White except for one Asian female and two Black females. The majority of the students were 9th graders (12) with ten 10th, four 11th, and four 12th graders. Ten of the 30 students in this class were chosen to be interviewed based on gender, ethnicity, grade level, and APES class grade point average to make the sample as heterogeneous as possible. Each of the 10 students interviewed lived in the suburbs, their grade point averages ranged from 2.8 to 4.0, and their APES class grades ranged from A to C. There were six freshman, two juniors, and two seniors in the student interview sample. The highest academic degree of the students' mothers ranged from technical school certification to a master's degree, while the highest academic degree of their fathers ranged from a high school diploma to M.D. and Ph.D. degrees.

Data Sources

The two major qualitative data sources used to develop this case study were field notes of classroom observations and transcripts of teacher and student interviews. The observations and interviews were completed in the Fall semester of 2002.

APES Class Observations

The APES class observations were conducted during a first period class, which met from 8:30 am to 9:20 am. They began in September 2002 and ended in December 2002. A total of 10 fifty-minute class periods were observed. All observations were made on five Mondays and five Wednesdays according to the availability of the researcher. The researcher was a non-participant observer, and thus did not interact with the students or Mr. S. during observations. Mr. S. was only communicated with either before or after each observed class. Detailed field notes were collected during each observation day.

APES Class Interviews

The teacher and student interviews were conducted to enhance and clarify interpretations of the field note observational data. Teacher, parent, and student consent forms were distributed to the teacher and the 10 students to be interviewed in October, 2002. The interviews were conducted once all of the consent forms were signed and returned to the researcher. Interviews were conducted on days convenient for Mr. S. and students and occurred during November and December, 2002.

The 22-item teacher (Appendix D) and 20-item student (Appendix E) interview protocols were developed by the researcher and were based on observations and data collected during the previous 10 class observations and on the guidelines stated by the College Board regarding the amount of class time that should be spent on certain types of activities. The interviews were audiotaped and then transcribed. Mr. S. and each student were only interviewed on one occasion. Each interview lasted approximately 20 minutes.

Data Analysis

The field note and interview data were analyzed using the constant comparison method (Meyers, 1981). The teacher and student interview data were then compared to the field note data to see how well the teacher's and students' statements matched what was observed in the classroom. The observation and interview data were analyzed collectively and used to prepare a case study of one Advanced Placement Environmental Science class.

Areas of Focus

The following headings and subheadings outline major areas of focus for the case study:

Demographic Information
Curriculum
Classroom Learning Environment
Planning
Instructional Methodology
Classroom Management
Assessment

Match with APES Guidelines.

They were derived from a combination of the categories that emerged during analysis of the classroom observation and teacher and student interview data. Results presented here are based on data collected from 10 class observations, an interview with Mr. S., the instructor of the Advanced Placement Environmental Science class, and interviews of a sample of 10 students in the class.

Demographic Information

Description of the Teacher

During the period of the case study, Mr. S. taught four sections of APES in which the majority of students were 9th graders (12) with ten 10th, four 11th, and four 12th graders. Mr. S. has taught chemistry, AP biology, honors biology, general biology, physical science, physics, geology, marine biology, honors earth and space science and APES. He has been teaching APES for three and a half years without any formal AP training.

Description of the Students

Six freshman, two juniors, and two seniors were interviewed. The juniors and seniors interviewed had taken high school biology, chemistry, physics, and earth space science, as well as AP Calculus I & II, Economics, and APES. Table 5-1 summarizes other demographic characteristics of the student interview sample.

Table 5-1. Description of students interviewed.

Student	Grade Level	APES Grade	Gender	Race
1	9th/10th	A	Male	White
2	9th/10th	B	Male	White
3	9th/10th	C	Male	White
4	9th/10th	A	Female	White
5	9th/10th	B	Female	White
6	9th/10th	C	Female	White
7	11th/12th	A	Male	White
8	11th/12th	C	Male	White
9	11th/12th	A	Female	Asian
10	11th/12th	C	Female	Black

Curriculum

The textbook used in the APES case study class was the 11th edition of *Living in the Environment* by Miller copyrighted in 1999. This text was specifically designed for use in college environmental science classes. During the interview, Mr. S. explained that he designs his own labs based on previous AP exam questions instead of using a particular laboratory manual. He also reported that he supplements the textbook with videos on pollution, garbage, biogeochemical cycles, and rainforests, as well as newspaper articles and television news clips related to environmental science topics.

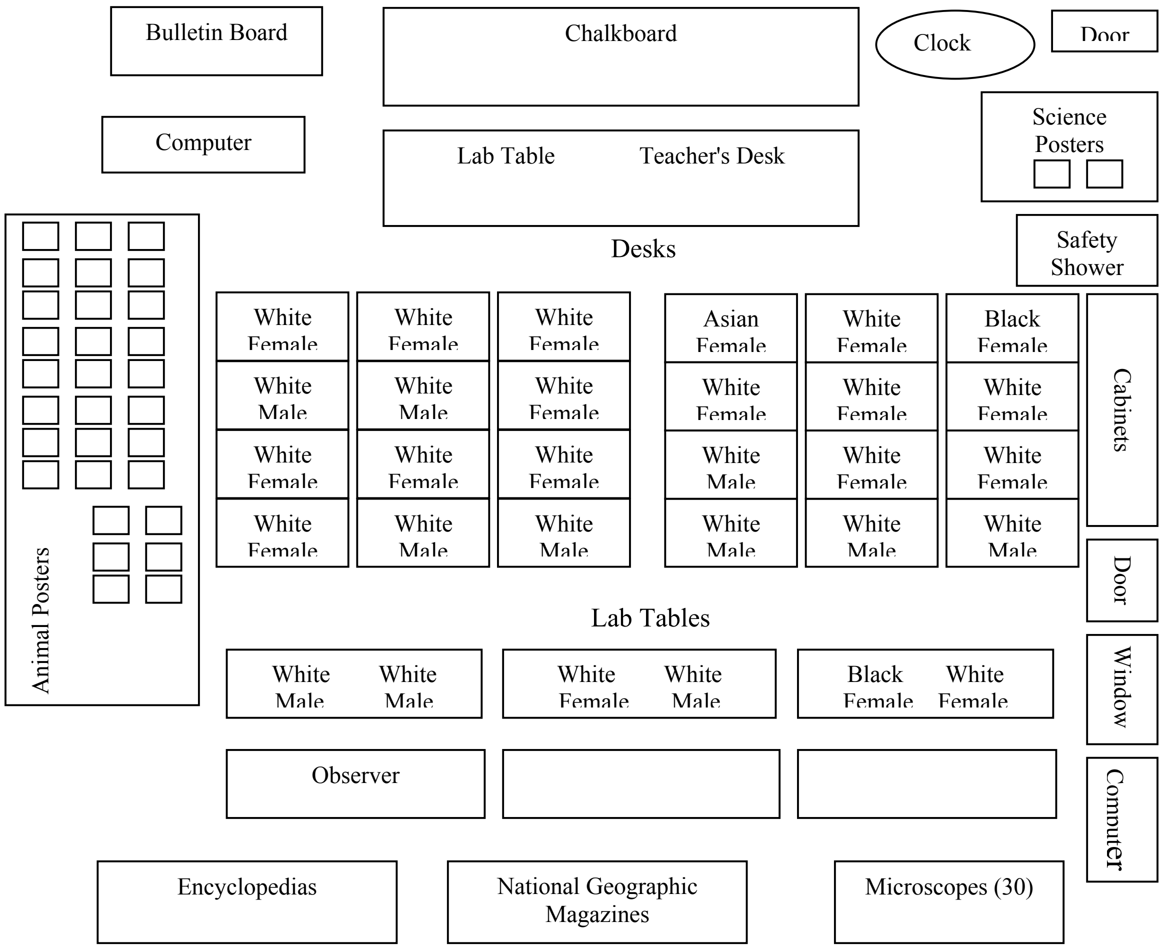
Mr. S. defined curriculum as "What is on the APES exam." He explained that the way in which he understands curriculum strongly influences what he teaches. As he explained, "I teach what is on the APES exam." He felt that it was important to be familiar with the curriculum so that he could teach the topics in a logical sequence in which each topic builds on knowledge from the previous topics.

During the interview, Mr. S. responded to the question, "Are there other content areas that you would like to teach but feel unable to because of the APES exam?" by stating, "I feel that I do not have enough time to spend with the curriculum that I got." He did not feel there was anything in particular he would like to change about the APES curriculum, but he said, "I do not think that I would change anything except that I would like to be able to spend more time on some of the topics."

Classroom Learning Environment

Physical Classroom Environment

During all 10 observations, the room was warm and the lighting was dim. The room had two computers, a set of encyclopedias, and a collection of older National Geographic magazines. A complete layout of the classroom is presented in Figure 5-1.



The dimensions of the classroom are 35 ft by 23 ft.

Figure 5-1. Diagram of the observed APES classroom

There were 30 microscopes and a safety shower as well as a bulletin board and 32 science-related posters focusing on topics such as endangered species and chemistry. There were 24 desks and three lab tables with very little lab counter space. This classroom was set up for lecture rather than lab activities. There was no seating chart, but the students always sat in the same seats. All three of the minority students in this class were female and they all sat on the right side of the room, but not all next to each other. The girls tended to sit next to girls and the boys tended to sit next to boys. The majority of the students sat at desks not lab tables.

During the 10 observations, the students used the computers in the classroom to download chapter outline notes and the students did not use the encyclopedias or National Geographic magazines. The microscopes were not used during any of the 10 class observations.

Planning

Content Selection

In an interview, Mr. S. explained that he selects content based on the topics covered on the APES exam. He pointed out that:

> The topics that are on the APES exam have a very strong influence on what I teach because if a lot of my students do not pass, then I do not get to teach this class anymore. For the students to take the APES exam, they have to have my permission, so some teachers, to have a high number of students pass the APES exam, only let the students who they know will pass take it. I feel that if you suffered with me all year long, you deserve the right to take the test and at the same time I want them to see what a college exam is like. It is a good learning experience for them to take the exam.

During observations, it was not evident that Mr. S. considered students' interests or students' preferred learning styles when planning his lessons. When asked if he considers students' interests and preferred learning styles when planning his learning activities, he responded, "If an activity or something works with a group of students, I use it again. I want it to be fun for the students, but at the same time I want them to learn."

Lesson Content

Mr. S. was very explicit about telling students what content and skills they needed to be able to perform to do well on the APES exam. For example, he told the students that it is important to know how to write a good essay because there are essays on the AP exam. During observations, Mr. S. spent an entire class period explaining how to develop a hypothesis and reviewing the format students should follow when writing an essay. He outlined what should go in the introduction paragraph, such as, the central theme of the essay and the definition of key terms. He also explained to the students that they would get points on the AP exam for defining the terms they use.

Mr. S. used the example of writing an essay on a food chain. He explained that in the introduction the students should discuss and define a food chain; in the first paragraph they should discuss the particular organisms involved in the food chain and draw and label a diagram of the food chain. Then he said they should talk about the flow of energy in the food chain and draw the proper arrows to show the direction of the energy flow. He explained that in the following paragraphs they should discuss their conclusions.

Mr. S. stressed to the students the importance of being specific about the laws and terms they used in their essays and why and how they relate to the question and their explanation. He also gave the students old APES essay questions to answer and discuss in class. Mr. S. also hinted about topics such as the three types of evolution and plate tectonics that would make good exam essay questions.

Mr. S. was very explicit in his interview statements and in his teaching that he bases his instruction on what is on the APES exam. He was very systematic in covering all of the material in each chapter by lecturing on the chapter outlines that he provided to his students. He also laid out exactly how the students should write their essays and what topics had the highest probability of being on the APES exam.

Observations indicated that Mr. S. purposely planned to provide a wide variety of real world examples for his students. He was very knowledgeable about many environmental topics and gave frequent real world examples pertaining to the content of the day. For example, Mr. S. used a lake and a cup of coffee to explain the heat capacity of water, and when talking about potential and kinetic energy, he used the example of a piece of chalk sitting on a desk and then falling off. He used the example of burning gas in an engine to teach the law of thermodynamics and the example of having aluminum everywhere or having a can made of aluminum to explain entropy to a student.

During one class observation, when talking about the cycle of phosphorous, he mentioned that "Florida has a lot of phosphorous because it was once under water." He shared a story about when he was a child in West Virginia. "I saw trains carrying coal and how the rivers would turn black because of the coal burning." When discussing nitrogen fixation, a student asked, "What is a nodule?" He drew a picture on the board and described it as looking like a Christmas tree bulb. When reviewing the nitrogen cycle, he explained that "In step one you make dinner, in step two you serve it, and in the last step you are just taking everything apart." He gave the example of the peppered moth in England as an example of co-evolution, and Cheerios floating on milk as an example of plate tectonics. All of these incidences illustrate his emphasis on real world examples when selecting lesson content.

Instructional Methodology and Teaching Strategies

The major types of instructional techniques used during the 10 observations and the percentage of class time allocated to each technique are presented in Table 5-2. Case study results regarding all eight of these instructional techniques are summarized in the following paragraphs.

Lecture

Lecture was the most frequently used mode of instruction in this APES class. When asked to describe his style of teaching in an interview, Mr. S. stated,

> I lecture for about 30-40 minutes during a 50-minute class period for most chapters. I lecture more on the more straightforward chapters and I use class discussions on the opinion chapters. During the opinion chapters I ask the students "What do you think about a particular topic?" The amount of time that we spend on class discussions depends on the topic and how much they interact with me. I try to promote that especially in the chapters where we are talking about ethics and possible solutions to environmental problems.

Table 5-2. Major types of instructional techniques used and the percentage of time observed.

Instructional Technique	Percentage of Class Time
Lecture	70%
Independent Study Days	10%
Cooperative Learning	5%
Review	5%
Discussion	5%
Questioning	3%
Student Presentations/Independent Student Research	1%
Hands-on Learning Activities	1%

On all 10 observations days, Mr. S. began the class by reviewing the content from the previous class, by mentioning the topics that were covered, and then spending an average of 32 minutes of the 50 minute class period (70%) lecturing. Mr. S. did go over the agenda for the day and/or week, but he did not give the students specific learning objectives. Only occasionally did he use visual aids, most of which the students had pictures of in their textbooks. Most of the students took additional notes as they listened to the lecture, but some students continued to talk.

Mr. S. stated that he spends 70% of each class period lecturing, which was consistent with the observations (70%) and students interview reports of time spent on lecture (71%). Mr. S. and the students agreed, and accurately reported, on the amount of class time spent on lecture.

Independent Study Days

The second most frequently used instructional technique used was independent study days (10% of class time). Mr. S. explained that he gives the students two class periods each nine weeks for independent study to make up any work they have missed so they will not earn zero points for missed assignments. During this time he walks around the room to answer student questions. There was disagreement between Mr. S. and the students regarding students' use of independent study time set aside for them by their teacher. As Mr. S. explained,

> The amount of independent study depends on if I am behind or not and if a lot of students have been absent or pulled out of class for sports, etc. I have an independent study day when I feel that I need to pull all of the students back together and get them all on the same page unless I am really behind. The amount of time that I spend on each chapter depends on what will be on the APES exam. I spend more time on the things that will be on the APES exam, and I spend more time on the topics depending on the percentage of that information that will be on the APES exam.

When asked if he felt students take advantage of the independent study time that he gives them, Mr. S. responded, "Yes, most of them use the time to study." Five students (two White females and three White male) agreed with the Asian female student who answered, "Yes, I study during the independent study time that he gives us before a test, at the end of class, or during the independent study days because I do not want to have to do all of my work at home." The other four students (one Black female, one White female and two White males) gave responses such as: "I like to do my work at home because I can concentrate better and am more comfortable in that environment." Another White male student explained, "I do not study during these times because Mr. S. does not really enforce it and I want to study at home so that I can talk to my friends during class."

During the observations, many of the students took advantage of the independent study days. Most of the students would talk for a while and then do some studying. Some studied independently and some studied in groups. A few students did not study, but talked the entire class period. More girls took advantage of the study time than the boys. Only a few students asked Mr. S. questions during independent study time. As time went on during class periods more and more students began to talk to each other instead of studying. Mr. S. did not say anything to the students who were talking, so they continued to talk. Students (one Asian female, two White females and one Black female) gave the following comments about why they felt girls take more advantage of the independent study time than the boys. "Girls do their work so that they do not have to do it at home. The boys just want to talk during class." "Boys are lazy." "Girls are more worried about their grades." "The girls feel that they have to work during class to keep up."

Cooperative Learning

The third most frequently used instructional techniques were cooperative group work, review, and discussion. Students initiated most cooperative group work during the 10 class observations. When asked if he used cooperative learning groups with his students, Mr. S. said,

> I believe in cooperative learning. I allow the students to choose their own groups, but I encourage them to teach and learn from each other, not to just give each other the answers. I use cooperative group work pretty frequently because a lot of times they are afraid to ask me questions, but they are not afraid to ask their friends. I try to have them work in groups about once a week or so.

Mr. S. encouraged his students to study together as evidenced by this comment,

> I use e-mail partners with my students. They get to choose their e-mail partner who is their study buddy. The purpose of this study buddy is for them to work on defining their vocabulary words and studying together. If a student is absent, his or

> her buddy can e-mail him or her the notes and anything else that he or she missed. Only about half of the students take advantage of their e-mail partners, but as the semester goes on and things get more difficult they will probably use them more.

Mr. S. felt that students do benefit from the study aids he provides, but in interviews, all 10 students said, "I do not use my e-mail partner." Five of the students (two White females, two White males and one Black female) agreed with a White male student who claimed, "I do not study with anyone because I like to study at home by myself." These five students gave the following responses: “ No, I just study by myself, but my friend and I do homework with each other;” “No, I study with my brother and his friend;” "I do not use my e-mail partner, but I do some work with other students in the class, those who I am friends with;" "No, I do not use my e-mail partner because I like to study on my own. I want to make sure that I understand it;" “No, I study on my own because I would rather learn on my own, but I would ask a student a question before I would ask Mr. S.”

During the 10 class observations, no teacher-initiated cooperative group work was observed. Some of the students did choose to work in pairs or small groups to complete worksheets or study during independent study days. In an interview, a White female student reported, "We have done group work three times this year. We worked in groups during the computer lab and for the group biome project." All of the students reported that they do not use their e-mail partners as study buddies. These results indicate a discrepancy between what Mr. S. reported regarding his use of cooperative learning and actual implementation of cooperative learning.

Review

Mr. S. spent approximately five percent of total class time providing reviews for his students. He gave students an outline and worksheets for each chapter and told them about the format of tests and quizzes. During reviews, he also highlighted the topics he felt were the most important. Mr. S. conducted his chapter reviews at the beginning of class and on average each review lasted approximately 30 minutes.

Discussions

During the 10 observation days, class discussions occurred approximately five percent of the total class time and were limited to brief answers to student-initiated questions. No teacher initiated class discussions were observed. If a student asked a question, Mr. S. sometimes used the questions to initiate a class discussion (five percent of the time), but primarily answered the student's question and then continued lecturing (95% of the time). The students' interview statements corroborated these observations. When asked "How much time do you spend on class discussions?" all 10 of the students interviewed made statements such as: "Mr. S. does not initiate class discussions. We only talk about a topic if a student has a question."

In an interview, Mr. S. explained that he felt he needed to spend the majority of his class time lecturing because he felt pressured to cover the huge amount of material on the APES exam. Thus, he felt the amount of time devoted to class discussion should be minimal. These results indicate that students felt a need for more frequent class discussions than did Mr. S. All of the students volunteered statements such as: "I would like to discuss topics that interest me and not just get a quick answer to my question."

Questioning

One of the least frequently used instructional methods during the 10 observations was questioning (three percent of total class time). On average Mr. S. asked about one question per class period. If Mr. S. did ask a question, he often answered it himself. Of the few questions he asked, most of them were at the level of knowledge and recall. For example, on day seven of the observations he asked, “What evidence do we have for evolution?” A White male student responded “Fossils.” Mr. S. then asked the students “What will happen if the tectonic plates keep moving?” Another White male student responded, “We will have another Pangea.” Due to the low level and infrequent nature of Mr. S.’s use of questions, he did not probe students to get them to think about topics further, nor did he re-direct students questions to help them come up with an answer to a question. He did not use wait time. For example, he would ask a question and if no student called out the answer or raised their hand to answer the question he would answer the question himself. About every 15 minutes Mr. S. said, “Any questions?” if no student immediately raised their hand he said, “Okay.” and moved on in his lecture.

Student Presentations/Independent Student Research

During the 10 observations, student presentations and independent student research occurred on one occasion accounting for one percent of total class time. As explained by Mr. S. when asked, "How much time do you spend on student presentations and independent student research?":

> I have to limit the amount of student presentations that we do because of the time constraints of all of the content that I have to cover for the APES exam. I would like to do more student presentations, but I can't. Some of the student presentations are individual and some are in groups. I like to have the students do some on their own. That way I know that each student really knows what they are talking about. Sometimes when the students work on group projects, a few students do all of the work and the other students just sit back and do nothing. Some of the projects that the students have done are an endangered species project that was individual and a biome group project. I try to give the students at least one class period to get some of the research done for these projects, but they do have to work on them outside of class to get them done.

Between the start of the school year in August and the observation dates (September- December) the students worked on one individual independent research project on endangered species and one independent group project on biomes. In interviews, all 10 of the students agreed that they had only performed one student presentation (the group biome project) during the year. They all reported that the independent endangered species projects were never presented.

Hands-on Learning Activities

Another infrequently used instructional method was hands-on learning activities (one percent of total class time). In an interview, Mr. S. stated that he uses a wide variety of learning activities in order to keep himself and the students from getting bored. "We do in-class hands-on projects, out-of-class projects, computer lab projects, chemistry labs, in class presentations, microchemistry labs, and we use computer software."

However, contrary to his self-report, no class projects, computer lab projects, labs, student presentations, or use of computer software occurred during the 10 class observations. In interviews, all 10 students stated that they had only performed one lab since the beginning of the year. As one White female student explained, "We did one lab, a titration lab, and the juniors and seniors moved around the room to see if we were doing it correctly because they had already done this lab before in chemistry class." These results indicate a discrepancy between the frequency of hands-on learning activities actually occurring in this particular APES class and Mr. S.'s perception of the amount of class time spent on hands-on activities.

Classroom Management

Due to the high academic ability levels of students in this class, discipline problems were not an issue. These students were highly motivated to learn and to perform well on the APES exam. The only time classroom management was a problem was during the independent study time the Mr. S. gave his students at the end of a few class periods and on days devoted completely to independent study. During these observation times, Mr.

S. walked around to answer student questions, but he spent most of his time on other administrative tasks. Therefore, he was not focused on the students during independent study time and did not enforce the fact that students should be studying during this time. As a result, most of the students ended up talking instead of studying.

Assessment

Mr. S. stated that he gives his students a quiz and a test about once a week and explained that the frequency of assessments increases as the topics become more difficult and as the percentage of that material on the APES exam increases. In response to the questions “How and how often do you evaluate your students?” “What is the format of your quizzes and tests?” “Describe the type of questions you ask of your students. Provide some example.” He said,

> I have to make sure that the students have read. The number of essays that the students answer depends on the chapter. Some chapters lend themselves to essays more than others. The students answer more essay questions on the topics that will be on the APES exam. The quizzes are matching and the tests are matching and multiple-choice because this is the format that the students will see on the APES exam.

Mr. S. explained that he gives the students matching and multiple-choice tests and quizzes because that is the format of the APES exam. When interviewed regarding assessment, the 10 students responded in a similar manner with statements such as, "We have a quiz about every week and a test about every week and a half to two weeks." "The quizzes are matching and the tests are multiple-choice and we have done one essay so far." Mr. S. and the students agreed on both the frequency and format of tests, quizzes, and other assessments.

Match With APES Guidelines

Lab Activities/Fieldwork

The College Board suggests that APES students perform a lab at least once a week and complete a significant amount of fieldwork. When asked “How much time do you spend on lab activities and fieldwork?" Mr. S. responded: "The number of labs and how often depends on which chapter we are on. We do some fieldwork. I take them outside on the school grounds to do some basic field testing because that is on the APES exam.” During all 10 observations, the students did not perform any lab or fieldwork.

All 10 students interviewed stated that they had only performed one lab since the beginning of the year. Based on 10 class observations and 10 student interviews it appears that this class did not meet the College Board goals regarding labs and fieldwork.

Environmental Problems/Solutions

The College Board also suggests that APES students spend time identifying, analyzing, assessing the risks associated with, and working on solutions to environmental problems. When interviewed regarding this component, Mr. S. said,

> In every chapter that has an environmental problem, I bring it up and we talk about it in class discussions. I ask the students “What solutions can you find?” “What do you think?” “What does your textbook say?” “Is there anything else?” “How can we modify these?”

As an example, during an observation, when talking about the law of conservation of matter, Mr. S. rhetorically asked the class, “What happens to tires when we throw them away?" Mr. S. went on to say that they go to a dump and get buried, or burned, but they just create air pollution. He asked, “What else can we do?” and a White male student responded "We could send it into space." Mr. S. also talked about the fact that developed countries burn a lot of oil and gas, and they burn more as the population increases, which leads to more waste and pollution. He pointed out that we only have X amount of resources on Earth, and when we run out our society is going to crash, so we need to recycle matter and create less pollution.

Other environmental problems that Mr. S. addressed during observations were acid rain, global warming, ozone depletion, and eutrophication. During a lecture, Mr. S. explained,

> Acid rain is caused by the release of sulfur dioxide into the atmosphere during the burning of coal and plastic manufacturing that causes problems such as damage to trees, changes the pH of aquatic ecosystems, corrodes metal, and damages marble, stone, and car finishes. The release of carbon dioxide and nitrous oxide into the atmosphere causes global warming and destroys ozone molecules. We mine nitrogen, burn grasslands and forests and harvest nitrogen-rich crops, which release carbon dioxide and nitrous oxide into the atmosphere. Excess nitrogen in aquatic ecosystems leads to eutrophication, which is an increase in algae and a decrease in dissolved oxygen.

When asked how much time they spend identifying, analyzing, assessing the risks associated with, and working on solutions to environmental problems, five interviewed students (one Asian female, two White females and two White males) responded with statements such as: "How much we talk about environmental problems depends on the chapter." "We talked about it a lot during the water quality chapter." "Mr. S. lays out the facts, but we do not really talk about them or work on solutions." "He tells us about them and asks us a few questions." "We do not really talk about environmental problems unless a student has a question." The other five students interviewed (one White female, three White males and one Black female) gave the following responses: “He lists a lot of environmental problems. He says humans do this and humans do that.” “He discusses the problems, but not so much the solutions.” He brings them up and we discuss the problems, but he does not ask us to come up with solutions.” “He is always talking about the environment and deforestation, but nobody really pays attention because he is so monotone and boring." "We talk about the problems and what is going on, but he does not really have us think about solutions."

Mr. S. presented factual information about several environmental problems to students, but he did not give them the opportunity to identify them on their own or analyze, assess the risks associated with, or work on solutions to environmental problems. Observations indicate that Mr. S. did expose students to environmental problems, but on the 10 days his class was observed, students were not actively engaged analyzing, assessing risks, or working on solutions to environmental problems. Instead, they listened to information presented by Mr. S. regarding these problems.

Characteristics of Students

Mr. S. and the students did not all agree with the recommendation of the College Board, which states that students who take APES should have had at least two years of high school laboratory science classes. This recommendation generally means that only juniors and seniors take the course after completing biology and chemistry. When asked if he felt that it was necessary for students to have at least two years of a lab science to do well in APES Mr. S. expressed,

> No, because I have 9th and 10th graders in my classes who have not had biology and chemistry. But, having these 9th and 10th graders in my class bugs me. Sometimes I get downright angry because the school puts them in my classes to have a higher number of students pass the APES exam. Sure, we enjoy all of the AP money because we have money that we have never had before and we can buy all of the stuff that we have ever wanted. Think about it. They are asking me to take a 9th grader and turn him into a junior and then have that junior pass the APES exam and that is a lot. I cannot change it to not have 9th and 10th graders because then we would not get all of that AP money. If middle schools would better prepare the 9th graders, then I would not have to spend as much time and have as much trouble trying to get the 9th graders caught up.

All 10 of the students interviewed agreed that students should not have to have at least two years of a lab science to take APES. Students gave the following responses to this question:

- "No, because the freshman seem to be doing okay, but they do study more."
- "No, because I like to be challenged."
- "I do feel at times that I am at a disadvantage because I have not had biology and chemistry."
- "No, but I think that it has helped me that I have had biology and chemistry."
- "The freshman are having a hard time, but it is an AP class and that is to be expected."
- "No, but having had biology and earth space science makes it easier for me, but it should be up to the student if they want to work harder to do well in the class."

APES Exam

There were mixed feelings among students regarding whether or not they feel prepared to pass the APES exam. Mr. S. was comfortable with his ability to effectively teach the Advanced Placement Environmental Science classes because "If I do not know something I ask my colleagues." He also felt his students were very capable of doing well in his class and on the APES exam, but explained, "It takes a lot to motivate them, but they've got great potential. There is a lot of information and some of them handle it very well."

Four students interviewed felt they would be prepared to do well on the APES exam if they spent a lot of time studying. The other six students felt they would not be prepared to take the test. As one White female student explained, "I am afraid that I am just going to forget everything that I am memorizing."

Eight students interviewed (two seniors, two juniors and four freshman) felt that Mr. S. was a good APES teacher. The other two students (two freshman) expressed some reservations. As one student said:

> He is alright. I feel lost sometimes because there is so much information and he goes so fast. It is easy to zone out in his class when he is talking because there is so much information and it gets all jumbled up together and he goes so fast. He teaches like we should already know all of this stuff. He should slow down and teach us like we are beginners because we are.

Strengths/Weakness of APES

Mr. S. and the10 students interviewed disagreed on the most important strengths and most significant weakness of their APES class. Mr. S. felt that the most important strength of APES was that "The students go on to do well in other classes because I prepare them well. I also get a lot of high caliber students." Mr. S. felt that he prepared his students well by teaching not only content, but also the processes of science.

The 10 students interviewed felt the most important strengths of APES were:

- "Having the notes before class and learning how to write essays for the APES exam."
- "High quality students who do their work."
- "The quality of the information, learning about the environment is important."
- "The teacher and his structure and routines."
- "The routines make everything easier because we know what we have to do every week for every chapter and when to expect quizzes and tests etc."
- "This class teaches you good study habits for college, such as how to take notes."
- "College credit."
- "There are no strengths in this class because I do not like this class. I do not like science. I just took this class because a teacher told me that I could get my science credit out of the way by taking this class without having to do a lot of math. I do not like math."

- "I do not know."

The most significant weakness of APES expressed by Mr. S. was:

> Middle schools need to better prepare students in science, so that I do not have to spend so much time teaching the 9^{th} grade students what they should have already learned. The students do not know how to study, or even how to write a complete sentence.

He believes middle schools are not preparing students with the content knowledge and skills to succeed in higher-level science classes in high school. For example, he stated, "The students do not even know how to use any science equipment." Mr. S. thought students should come to high school with the prerequisite knowledge and a repertoire of skills needed to perform well in upper level science classes without the teacher having to re-teach or teach for the first time the necessary content and skills.

The students interviewed felt the most significant weaknesses of APES were:

- "We need to spend more time learning how to write scientifically for the essay on the APES exam."
- "There is a lot of information."
- "I feel that I am learning a little about a lot of things and I am just memorizing a bunch of stuff so that I will do well on the AP exam."
- "Mr. S. just reads from the lecture outlines, but he should teach us like we are beginners because we do not know all of the stuff that he knows."
- "The routines and the set schedule of tests sometimes he will push them back, but it forces us to cover a lot of ground very quickly because he does not want to get behind."
- "We should have more labs and hands-on activities."
- "The teacher puts too much pressure on us to do well on the AP exam."
- "We are not learning anything in depth, we are just memorizing topics and learning how to do well on the AP exam."
- "We should turn in our worksheets to be graded so we know if they are correct before we study them."

- "I think that the quizzes should not be matching but short answer. I would learn the information better if I had to write it out in my own words instead of just having to recognize a definition."

- "He should go slower and he should ask us specific questions instead of just saying any questions and then moving on very quickly."

As the one Black female student expressed,

> We should have more group work and more hand-on activities. I think that when you socialize you learn a lot better when you are with people your own age. It is better when you get to know everybody's name. Independent stuff is boring because you do not get to interact. I think that we should have to write down all of the notes because I think that most people remember what they write. When you highlight you just go over it and you can do that without thinking.

A White male student explained, "I think that Mr. S. needs to slow down and interact with the students more instead of just lecturing all of the time." These perceptions regarding the strengths and weaknesses of the APES class will be further discussed in Chapter 6.

Chapter 6 includes a discussion and interpretation of the qualitative data presented in this case study by addressing the five mixed method research questions of this study (6-10). The overall conclusions drawn from all 10 research questions and the implications of these conclusions for the Advanced Placement Environmental Science Program are also discussed.

CHAPTER 6
QUANTITATIVE/QUALITATIVE RESULTS AND CONCLUSIONS/IMPLICATIONS

Introduction

This chapter reviews combined quantitative and qualitative data analysis techniques and reports the results of the five mixed method quantitative/qualitative research questions (6-10). The conclusions drawn based on all data sources for the 10 research questions and the implications of the results are also discussed. Each of the following sections summarizes the quantitative results and related qualitative results for each research question. Next, the quantitative results are compared and contrasted with the qualitative results. Where appropriate, the quantitative and qualitative results from students are compared with the quantitative and qualitative results from the teachers.

Research Questions

6. Are there differences in the amount of time spent on APES and other class activities reported by students and teachers?

Quantitative Results

The student survey sample included 355 APES students and the teacher survey sample consisted of 12 APES teachers. The frequencies of the most common survey responses for the student self-report data were compared to the most common survey responses for the teacher self-report data regarding the amount of time spent on different APES class activities (items 45, 46, and 49-53 student survey Appendix C; items 49, 51, and 57-61 teacher survey Appendix B). The frequencies of the most common survey responses for the student self-report data were compared to the most common survey responses for the teacher self-report data regarding the amount of time spent on other class activities (items 47-48, and 54-56 student survey; items 52-56 teacher survey). Based on these responses, the students and teachers both reported spending the same number of hours on the following APES activities:

- Fieldwork
- Cooperative group work
- Identifying environmental problems
- Assessing the risks associated with environmental problems
- Class discussions
- Student presentations
- Independent research.

Based on the quantitative survey data, teachers reported spending less time on lab activities and lecture than students did, and reported spending more time on analyzing, solving, and finding solutions to prevent environmental problems, than students said they did. This is interesting because it parallels the student and teacher attitude survey data indicating that students felt their teachers encouraged lab work while the teachers reported that they did not encourage labs. Teacher responses on the survey agreed with those of the students regarding the amount of class time spent on fieldwork, identifying environmental problems, assessing the risks associated with environmental problems, cooperative group work, student independent research, class discussions, and student presentations. Students reported lecture as the most frequent activity (three to five hours per week) and fieldwork, analyzing, solving, and working on solutions to environmental problems, student independent research, and student presentation as the least frequent activities (less than one hour per week). Teachers reported identifying, analyzing, assessing the risks associated with, and working on solutions to environmental problems, lecture, cooperative group work, and class discussions as the most frequent activities (one to three hours per week). The least frequent activities according to the teachers were: lab activities, fieldwork, student independent research, and student presentations (less than one hour per week). Table 6-1 summarizes the most frequent responses to the teacher and student survey items related to time spent on APES and other class activities. The response choices for these items were: less than one, one to three, three to five, and greater than five hours per week.

Table 6-1. Most frequent responses for the amount of time spent on APES and other class activities on the student and teacher surveys.

Student Item	Teacher Item	Abbreviations	Student Response (hrs./wk)	Student Valid Percent	Teacher Response (hrs./wk)	Teacher Valid Percent
		APES Class Activities				
45	49	Lab activities	1-3	42.7	<1	50.0
46	51	Fieldwork	<1	61.5	<1	70.0
49	57	Identify	1-3	34.2	1-3	55.6
50	58	Analyzing	<1	33.2	1-3	66.7
51	59	Solving	<1	52.3	1-3	44.4
52	60	Assessing	1-3	36.1	1-3	66.7
53	61	Solution	<1	41.8	1-3	66.7
		Other Class Activities				
47	52	Lecture	3.1-5	47.4	1-3	60.0
48	53	Group	1-3	42.7	1-3	80.0
56	54	Research	<1	60.0	<1	55.6
54	55	Discussion	1-3	32.0	1-3	55.6
55	56	Presentations	<1	57.8	<1	77.8

Overall, there is less variability in the teacher data than the student data. This is probably due to the fact that the teacher sample was much more homogeneous than the student sample and the teacher sample was much smaller than the student sample. Also, students may tend to be unclear as to what constitutes a particular activity whereas the teachers are not because they decide the activities and thus know how to categorize or label them.

Regarding least frequent activities, over 50% of the students and over 75% of the teachers surveyed reported spending less than three hours per week on all of the activities listed in Table 6-1, except for lecture. Regarding most frequent activities, over 65% of students felt their teacher spends either three to five or over five hours a week lecturing. Students overwhelmingly felt they spend most of their class time each week listening to their teacher lecture. In contrast, the majority of teachers (70%) felt they spend less than one to one to three hours a week lecturing. Obviously, a discrepancy exists between teacher and students perceptions of the amount of class time spent on lecture.

Qualitative Results

In addition to this quantitative survey data, the following qualitative data were collected during the 10 APES case study class observations, the teacher interview and the 10 student interviews. Qualitative case study results regarding the following activities are summarized below:

- Lab activities
- Fieldwork
- Identifying environmental problems
- Analyzing environmental problems
- Solving environmental problems
- Assessing the risks associated with environmental problems
- Working on solutions to prevent environmental problems
- Lecture
- Cooperative group work
- Student independent research
- Class discussions
- Student presentations.

Lab Activities

During an interview the case study teacher explained, "The number of labs and how often depends on which chapter we are on." During the 10 case study class observations, no lab activities occurred. During an interview, a student stated, "We did one lab, a titration lab, and the juniors and seniors moved around the room to see if we were doing it correctly because they had already done this lab before in chemistry class."

Fieldwork

During an interview, the case study teacher explained, "We do some fieldwork. I take them outside on the school grounds to do some basic field testing because that is on the APES exam." No fieldwork occurred during any of the 10 case study class observations. During an interview, a student stated, "We went outside for a fire drill." No fieldwork activities were reported by any of the 10 students interviewed.

Environmental Problems/Solutions

When asked how much time his students spend identifying, analyzing, solving, assessing the risks associated with, and working on solutions to environmental problems, the teacher said,

> In every chapter that has an environmental problem, I bring it up and we talk about it in class discussions. I ask the students "What solutions can you find?" "What do you think?" "What does your textbook say?" "Is there anything else?" "How can we modify these?"

Although the case study teacher reported focusing on environmental problems in the interview, students were not observed spending any time focusing on environmental problems during the 10 class observations. During student interviews, responses such as the following also indicated a lack of emphasis on environmental problems: "Mr. S. lays out the facts, but we do not really talk about them or work on solutions." "He tells us about them and asks us a few questions." "We do not really talk about environmental problems unless a student has a question."

Lecture

When asked to describe his style of teaching the case study teacher stated,

> I lecture for about 30-40 minutes during a 50-minute class period for most chapters. I lecture more on the more straightforward chapters, and I use class discussions on the opinion chapters. During the opinion chapters, I ask the students "What do you think about a particular topic?" The amount of time that we spend on class discussions depends on the topic and how much they interact with me. I try to promote that especially in the chapters where we are talking about ethics and possible solutions to environmental problems.

During an interview, the teacher stated that he spends 70% of his class time lecturing. Field note data from the 10 case study observations is consistent with this claim. Seven out of 10 students interviewed also felt the average amount of time their teacher lectured was 71%.

Cooperative Group Work

When asked if he used cooperative learning groups with his students, the case study teacher said,

> I believe in cooperative learning. I allow the students to choose their own groups, but I encourage them to teach and learn from each other, not to just give each other the answers. I use cooperative group work pretty frequently because a lot of times they are afraid to ask me questions, but they are not afraid to ask their friend. I try to have them work in groups about once a week or so.

During the 10 case study observations, no teacher-initiated cooperative group work occurred. Some of the students did choose to work in pairs or small groups to complete worksheets or study during independent study days. In an interview, one student reported, "We have done group work three times this year." Clearly, discrepancies exist between the teacher's perception regarding the amount of time spent on cooperative learning and the actual frequency of occurrence of cooperative learning activities.

Student Independent Research

During an interview, the case study teacher stated, "I limit student research because I cannot afford to give students class time to work on independent projects." The students did report working on independent research projects encompassing one individual project on endangered species and a group project on biomes. During an interview, one student explained, "We have researched biomes and endangered species so far." No independent student research occurred during the 10 case study observations.

Class Discussions

During an interview, the case study teacher stated, "The amount of class discussion depends on the chapter." No teacher-initiated class discussions occurred during the 10 case study observations. In addition all 10 of the students interviewed reported that, their teacher does not initiate class discussions. As one student stated, "We only talk about a topic if a student has a question."

Student Presentations

Regarding the frequency of student presentations, in an interview, the teacher explained,

> I have to limit the amount of student presentations that we do because of the time constraints of all of the content that I have to cover for the APES exam. I would like to do more student presentations, but I can't. I try to give the students at least one class period to get some of the research done for these projects, but they do have to work on them outside of class to get them done.

No student presentations occurred during the 10 class observations. During an interview, a student stated," The group project was the only presentation we have done."

Comparison of Quantitative and Qualitative Results

Regarding the amount of time spent on different APES class activities, the qualitative case study student interview data parallels the quantitative student survey data in most cases. For example, both groups of students reported spending very little class time on fieldwork, analyzing, solving, and working on solutions to environmental problems, student independent research, and student presentations. Interestingly, the 10 case study students interviewed reported spending less time on labs and fieldwork than their teacher did, which was not the case for the survey data. The students surveyed reported spending more time on lab activities than their teachers, and the students and the teachers surveyed reported spending the same amount of time on fieldwork. By far, the most frequent activity reported by both the students surveyed and the students interviewed was lecture.

The interviewed teacher and 10 students agreed on the amount of class time spent on lecture (70% of each class). The surveyed students felt they spent more time on cooperative group work (one to three hours per week) than did the interviewed students (a total of three times all year). The most frequent activity reported by the interviewed teacher was also lecture. This was the only activity the case study teacher reported an amount of time for, therefore the least frequent activities reported by the teacher cannot be determined.

7. What do students feel are the strengths/weaknesses of APES?

Quantitative Results

To determine the strengths and weaknesses of APES reported by the 355 students surveyed, strengths and weaknesses expressed were grouped and categorized and the frequency of responses in each category was calculated. The two survey items related to this research question were: "List the most important strengths of your AP Environmental Science class" (item 66 Appendix C) and "List the most significant weaknesses of your AP Environmental Science class" (item 67 Appendix C). Student responses to the most important APES strengths and the most significant APES weaknesses were categorized into 50 and 51 categories respectively. Tables 6-2 and 6-3 summarize the major categories of student-reported APES strengths and weaknesses.

As this table indicates, students surveyed felt the 10 most important strengths of their APES classes are:

- Teacher
- Lab work
- Class discussions/debates
- Fieldwork
- Group work
- Learning about problems in the environment and what we can do to solve them
- Lectures
- Small class
- Field trips
- Fun.

Students felt the most important strength of their APES class was their teacher. It was interesting that students identified student presentations, fieldwork, lab activities, and class discussions as strengths of APES considering they reported spending less than one class period per week on these activities. Perhaps it is because they highly value the time they do spend on these types of activities. Students also appreciated the content, small class size, the challenge, and the lectures associated with their APES classes.

The students surveyed identified the following as the 10 most significant weaknesses of their APES classes:

- Not enough fieldwork
- The textbook
- Not enough lab work
- Lack of an available review book
- Not enough class time to cover all of the material
- Difficult tests
- Not enough fieldtrips
- Not enough preparation for the AP exam
- Too much reading at home required
- Not enough lecture

Table 6-2. Categories of the most important APES strengths reported by students on the survey.

Response Category	Number of Students
Teacher	28
Lab work	22
Class Discussions/Debates	19
Fieldwork	19
Group Work	14
Learning about the problems in the environment and what we can do to solve them	13
Lectures	12
Small class	9
Field Trips	8
No Response	8
Fun	7
Hands-on Activities	6
Thorough	6
Emphasis on outside learning	5
Presentations (group or individual not specified)	5
Challenging	4
Interesting	4
Textbook	4
Typed notes	4
Class Unity	3
Focus on How Environment is Affected	3
Good Teacher/Student Relationships	3
Group Presentations	3
Independent study	3
Learn about many different sciences in one course	3
Recycling club	3
Relevant to everyday life	3
Aware of current events	2
Good use of class time	2
Guest speakers	2
Learning to work hard	2
Prepared for AP exam	2
Videos	2
Learning to work with others	2
Active role in solving problems	1
Assignments/Classwork	1
Broad range of subject matter	1
Computer Lab	1
Developing Study Habits	1
Different perspectives from all students	1
Friendly atmosphere	1
Individual presentations	1
Learning important facts	1

Table 6-2. Continued.

Learning to appreciate the environment	1
Little Homework	1
Memorization	1
Organized	1
Positive Support	1
Social abilities	1
Student involvement	1

The students felt very strongly that there were not enough fieldwork, fieldtrips, or lab activities in their APES classes. They also did not feel the textbook or their preparation for the APES exam was adequate. The students also indicated a desire for a review book, more class time to cover the large amount of content, easier tests, less out-of-class reading, and more lecture.

Qualitative Results

In addition to this quantitative survey data, the following qualitative data were collected during the APES case study class observations and the 10 student interviews. For the case study sample, each of the 10 students interviewed gave one of the following responses to the question “What do you feel are the most important strengths of APES and why?”

- "Having the notes before class and learning how to write essays for the APES exam."
- "High quality students who do their work."
- "The quality of the information.”
- “Learning about the environment is important."
- "The teacher and his structure and routines."
- "The routines make everything easier because we know what we have to do every week for every chapter and when to expect quizzes and tests etc."
- "This class teaches you good study habits for college, such as how to take notes."

- "College credit."
- "There are no strengths in this class because I do not like this class. I do not like science. I just took this class because a teacher told me that I could get my science credit out of the way by taking this class without having to do a lot of math. I do not like math."
- "I do not know."

Table 6-3. Categories of the most significant APES weaknesses reported by students on the survey.

Response Category	Number of Students
Need more Fieldwork	25
No Response	12
Textbook	12
Need more lab work	8
None	8
Lack of review book	7
Not enough time	7
Difficult tests	6
Lazy/senioritis	6
No field trips	6
Lack of prep for AP exam	5
Most learning through reading at home	5
Need more subjective mind	5
Lack of lecture	4
Disruptive classmates	3
Lot of work	3
Too little work	3
Too much information	3
Analysis	2
Depressing	2
Labs weren't connected to real world	2
Lack of class discussion	2
Lack of Independent Research	2
Lack of lab equipment	2
Lecture	2
Memorization	2
Not enough funding	2
Not prepared for tests	2
Poor quality equipment	2
Scheduled class time	2
The readings	2
Too independent	2
Under paid teachers	2
Teacher	2
Biased: all development is evil	1
Emphasis on outside reading	1
Flow of work inconsistent	1
Lack of hands-on activities	1

Table 6-3. Continued.

Lack of one-on-one interaction with teacher	1
Lack of presentations/projects	1
Large class size	1
Not always keeps up with current events	1
Not covering text book thoroughly enough	1
Not enough funding for field study	1
Nothing gets done	1
Pace too fast	1
Stressful	1
Students with no prior knowledge	1
Too few field trips	1
Too much Lecture	1
Unclear grading policy	1

For the case study sample, each of the10 students interviewed gave one of the following responses to the question “What do you feel are the most significant weaknesses of APES and why?”

- "We need to spend more time learning how to write scientifically for the essay on the APES exam."
- "There is a lot of information.” "I feel that I am learning a little about a lot of things and I am just memorizing a bunch of stuff so that I will do well on the AP exam."
- "Mr. S. just reads from the lecture outlines, but he should teach us like we are beginners because we do not know all of the stuff that he knows."
- "The routines and the set schedule of tests sometimes he will push them back, but it forces us to cover a lot of ground very quickly because he does not want to get behind."
- "We should have more labs and hands-on activities."
- "The teacher puts too much pressure on us to do well on the AP exam."
- "We are not learning anything in depth, we are just memorizing topics and learning how to do well on the AP exam."
- "We should turn in our worksheets to be graded so we know if they are correct before we study them."
- "I think that the quizzes should not be matching but short answer. I would learn the information better if I had to write it out in my own words instead of just having to recognize a definition."

- "He should go slower and he should ask us specific questions instead of just saying any questions and then moving on very quickly."

Comparison of Quantitative and Qualitative Results

No striking similarities were found between the perceived strengths of APES reported by the 355 students surveyed and those reported by the 10 interviewed case study students. The surveyed students tended to state more positive strengths such as good teacher/student relationships, student presentations, field and lab work, and class discussions than did the interviewed students. The two groups of students did agree that a lack of preparation for the AP exam, a lack of lab and hands-on activities, and not enough class time are weaknesses of their APES classes.

8. What do teachers feel are the strengths/weaknesses of APES?

Quantitative Results

To determine the strengths and weaknesses of APES reported by the 12 surveyed teachers, the strengths and weaknesses identified on the survey were categorized and the frequency of responses in each category was calculated.

The two survey items related to this research question were: "List the most important strengths of your AP Environmental Science class" (item 80 Appendix B) and "List the most significant weaknesses of your AP Environmental Science class" (item 81 Appendix B). Teacher responses to the most important APES strengths and the most significant APES weaknesses were categorized into 10 and 6 categories respectively. Tables 6-4 and 6-5 summarize the major categories of teacher-reported APES strengths and weaknesses. Only 10 of the 12 teachers responded to this question, and of those who did respond each identified a different strength. Only six of the 12 teachers responded to this questions and each teacher identified a different weakness.

Table 6-4. Categories of the most important APES strengths reported by teachers on the survey.

Response Category	Number of Teachers
As an AP- it is reasonable- enough time to cover material	1
Class Discussion	1
Courses tries to address needs of above average and the gifted student	1
Daily reading assignments	1
Fieldwork	1
Group Work	1
Motivated Students	1
Students feel that the information learned is useful	1
Students feel the information learned is applicable to their lives	1
Students presented with timely/current issues from newspapers	1

Table 6-5. Categories of the most important APES weaknesses reported by teachers on the survey.

Response Category	Number of Teachers
Lack of acceptable AP level question bank	1
Lack of Fieldwork	1
Lack of set labs	1
Large time commitment	1
No Lab	1
Not much lab equipment	1

Qualitative Results

During the teacher interview, the case study teacher the question "What are the most important strength of APES?" with this response "The students go on to do well in other classes because I prepare them well. I also get mostly high caliber students." He answered the question "What are the most significant weaknesses of APES?" as follows:

> Middle schools need to better prepare students in science, so that I do not have to spend so much time teaching the 9th grade students what they should have already learned. The students do not know how to study, or even how to write a complete sentence.

This is a very interesting response because the College Board recommends that only juniors and seniors take APES. The College Board believes that due to the interdisciplinary nature of environmental science, students should have had at least two years of high school laboratory science prior to enrolling in APES. Therefore, freshman and sophomores should not be taking APES according to the College Board.

Comparison of Quantitative and Qualitative Results

According to the survey data, teachers and students agree that class discussions, fieldwork and group work are the most important strengths of their APES classes. The survey data also indicates agreement between students and teachers regarding a lack of lab activities and fieldwork as a most significant weakness of their APES classes. Only one of the 10 case study students interviewed stated that a lack of lab activities was a weakness of their APES class. The strengths and weaknesses expressed by the one case study teacher did not pertain directly to the APES program and thus cannot be compared to those reported by the surveyed teachers.

9. How closely does the actual implementation of APES match the goals/guidelines stated by the College Board?

Quantitative Results

The standards set by the College Board for the amount of time that should be spent on APES class activities is outlined in Table 6-6. Table 6-7 reports the most common responses for the amount of time spent on APES class activities on the student and teacher surveys. Response choices were: less than one, one to three, three to five and greater than five hours per week.

Lab Activities/Fieldwork

The self-report data from the teacher and student surveys regarding the amount of time spent on APES class indicates that the greatest number of students report spending one to three hours a week doing lab activities while most teachers reported spending less than one hour a week on lab activities. The majority of students and teachers surveyed reported spending less than an hour per week on fieldwork.

Table 6-6. Standards set by the College Board for the amount of time that should be spent on APES class activities.

APES Class Activity	College Board Standard
Time spent on lab activities/fieldwork	Significant = at least 1 lab or field activity/week
Time spent identifying environmental problems	Goal = 3hours/week
Time spent analyzing environmental problems	Goal = 3hours/week
Time spent solving environmental problems	Goal = 3hours/week
Time spent assessing the risks associated with environmental problems	Goal = 3hours/week
Time spent working on solutions to prevent environmental problems	Goal = 3hours/week

Table 6-7. Most frequent responses for the amount of time spent on APES class activities on the student and teacher surveys.

Student Item	Teacher Item	Abbreviations	Student Response (hrs./wk)	Student Valid Percent	Teacher Response (hrs. /wk)	Teacher Valid Percent
45	49	Lab activities	1-3	42.7	<1	50.0
46	51	Fieldwork	<1	61.5	<1	70.0
49	57	Identify	1-3	34.2	1-3	55.6
50	58	Analyzing	<1	33.2	1-3	66.7
51	59	Solving	<1	52.3	1-3	44.4
52	60	Assessing	1-3	36.1	1-3	66.7
53	61	Solution	<1	41.8	1-3	66.7

Environmental Problems

The students surveyed reported spending less time analyzing, solving, and working on solutions to environmental problems (less than one hour per week) than did the teachers (one to three hours per week) of the class activities recommended by the College Board. The most frequent responses for students were one to three hours per week of lab, identifying and assessing the risks associated with environmental problems, and less than one hour per week of fieldwork, analyzing, solving, and working on solutions to environmental problems each week. For teachers, most frequent responses were less than one hour per week on lab activities and fieldwork and one to three hours per week on identifying, analyzing, solving, assessing the risks associated with, and working on solutions to environmental problems.

The students reported spending one to three hours per week on labs, but the teachers only reported spending less than an hour per week on labs. Both students and teachers reported spending less than one hour per week on fieldwork. Students reported spending less time per week analyzing, solving and working on solutions to environmental problems than was reported by their teachers. These results indicate that teachers may not be following the goals/guidelines stated by the College Board which specify that students should spend at least one class period per week in lab, a significant amount of time on fieldwork, and a significant amount of time identifying, analyzing, solving, assessing, and working on solutions to environmental problems.

Qualitative Results

Data from APES case study observations and teacher and student interviews corroborate the survey data regarding the amount of time spent on class activities recommended by the College Board. During the 10 case study observations, students did not complete any labs or fieldwork. In an interview, the teacher stated that they do some fieldwork and the amount of labs performed depends on the chapter. In interviews, students explained that they had done only one lab and no fieldwork during the first half of the school year. The case study teacher said he brings up environmental problems and they talk about them in class discussions, but the students disagreed with this perception. Again the qualitative results indicate that the goals/guidelines stated by the College Board are not being met.

10. What recommendations can be made to improve APES? Data from the teacher and student surveys, the APES case study class observations, and teacher and student case study interviews were compiled to answer this research question.

Conclusions

Research Questions

1. What is the profile of students who enroll in APES? Students enrolled in APES can be classified as students who spend an average of one to three hours a week studying for APES and do less than one hour of APES homework a week. Most APES students are 12^{th} grade females with high grade point averages and students who have taken more than the required three science classes in high school, but have not taken many other AP classes. APES students tend to have college-educated parents. Very few APES students are minorities and a high percentage of APES students live in suburban areas.

The dominance of females in APES is consistent with other research that indicates the number of females usually equals or exceeds the number of males enrolled in most advanced science classes (Greenfield, 1997). The relatively low enrollment of minorities in APES is also consistent with findings reported in other studies. For example, a study by Clark (1999) concluded that, in their early school years, minority students develop a fear and/or dislike for science, which results in their taking only the required minimum number of science classes in high school.

This current study identified demographics of APES students that are similar to those reported in previous studies of Advanced Placement students. For example, in this study, 52% of the APES students were in 12^{th} grade, 61% were female, and 25% were minority students. A demographic study by Curry, MacDonald, & Morgan (1999) reported that overall, 60% of APES students are in 12th grade and 55% are female. A study by the College Entrance Examination Board (2000) reported AP students as being 31% minority (primarily African American and Hispanic) and 69% White.

2 What is the profile of teachers who teach APES? Teachers of APES spend more hours preparing to teach than students spend studying and spend more time grading than students spend doing homework. They do not spend significant amounts of time preparing lab or field activities or engaging in professional development. They teach an average of two sections of APES containing 21-30 mostly 12th grade students. Seventy-five to 100% of their students take and pass the APES exam even though 60% of APES teachers do not have formal AP training. Half of the APES teachers have a master's degree, and 40% have more than 12 years of experience teaching science, including three to five years of AP teaching experience. Over half (60%) are female, 100% are White, and 60% live in the suburbs while 40% live in urban areas. On average, APES teachers assess their students once every two weeks with less than 10% of their tests and quizzes as matching, 31-59% as multiple-choice, less than 10% as true/false, and 31-59% as essay.

Studies have shown that overall, high school teachers tend to be White males (North Carolina State Department, 1983), which is in contrast to the findings of this study. Perhaps, women are more willing to respond to surveys than men are, or maybe there are now more women teaching high school science than there were in the past. More research in the area of the demographic characteristics of high school science teachers generally, and teachers of advanced science classes specifically, needs to be done.

3. What are the attitudes of students toward APES? APES students tend to have positive attitudes toward APES overall. Specifically, students have the most positive attitude toward themselves as students in APES, followed by positive attitudes toward their teachers, overall positive attitudes, and positive attitudes toward their APES class, but none of theses differences in attitudes are statistically significant.

In this study, the total attitude scale had the smallest 95% confidence interval, indicating that the mean of the total attitude scale provided the most stable measure of students' attitudes toward APES compared to the mean of each of the subscales. The student attitude toward self subscale provided the largest 95% confidence interval, meaning that the mean of this subscale provided the least stable measure of students' attitudes toward APES compared to the total attitude scale and the other two subscales (attitude toward the APES class and attitude toward the APES teacher).

These findings are consistent with those reported in other studies of students' attitudes toward science. Either students enjoy science because they feel it is important, or they feel that it is important because they enjoy it. Either way, research indicates that students with high academic self-confidence (gifted students) who have an internal locus of control and believe they control their academic fate have more positive attitudes toward science (Barrington & Hendricks, 1988). Thus, it is not surprising that advanced science students have more positive attitudes toward science and basic science students have less positive attitudes toward science (Cannon & Simpson, 1985).

Students in this study do not feel personally prepared to take the APES exam, nor do they feel this course had met their expectations of preparing them for college-level course work, but they do feel their teachers make sure their students are prepared to take the APES exam. They feel they have well qualified, knowledgeable, excellent, and caring teachers who encourage lab work, fieldwork, and cooperative, not independent group work, but at the same time feel the quality of the lab and fieldwork is poor. Finally, students like and respect their enthusiastic APES teachers who display positive attitudes toward the environment, and feel it is important to get good grades, but do not think they do excellent work in their APES classes.

Results indicate that APES is meeting some of the College Board's stated goals such as: having students learn about the environment and especially how to take action to solve environmental problems, having knowledgeable teachers who feel it is important to learn about the environment, preparing students for the APES exam, and promoting lab and fieldwork. But, students do not feel that APES meets their expectations of preparing them for college-level work or to take the APES exam, nor do they consider the lab and fieldwork to be of high quality. These findings are important because the College Board believes APES should prepare students for college-level work and the APES exam and that APES should include excellent labs and fieldwork.

Regarding student attitudes in high school environmental science courses, research indicates that most environmental science courses emphasize the cognitive domain over the affective domain (Iozzi, 1989a & b). Many environmental science teachers rationalize this emphasis on knowledge acquisition by reasoning that an increase in students' environmental knowledge is enough to promote environmentally responsible behaviors. But, without directly addressing both the affective and the cognitive domains and without providing students opportunities to practice behaviors that are more environmentally appropriate, it appears knowledge acquisition alone does not promote environmentally responsible behavior in most students (Singletary, 1992). The results of this study (see research question 9) indicate that because students are not spending a significant amount of time identifying, analyzing, solving, assessing the risks associated with, and working on solutions to prevent environmental problems, APES teachers emphasize the cognitive and not the affective domain. This appears to occur because the teachers feel a need to cover a large amount of content for the students to perform well on the APES exam. Also, without the chance to work on solutions to environmental problems, students are not given the opportunity to practice environmentally responsible behaviors.

Ideally, effective high school environmental science classes should devote a substantial amount of curricular time to the affective domain. A focus on how students feel about environmental topics, their environmental science classes, and their teachers should be considered an important goal. It is important to determine students' attitudes toward science as well as how and why such attitudes are formed. It should thus be an important objective of science education to promote positive attitudes toward science in schools. Once educators know what the attitudes of students are toward science and how and why they are formed, they can work towards improving these attitudes in their classrooms (Myers & Fouts, 1992).

4. What are the attitudes of teachers toward APES? The APES teachers in this study had overall positive attitudes toward APES. Specifically, teachers had the most positive attitudes toward themselves as teachers of APES followed by their overall attitudes toward APES, attitudes toward their APES class, and attitudes toward their APES students, but none of these differences in attitudes are statistically significant.

Teachers feel teaching APES is beneficial because they personally learn a lot about environmental science and how to take action to solve environmental problems, develop more positive behaviors toward the environment, and enjoy teaching APES. They feel it is important for students to learn about the environment and how to solve environmental problems. They feel their students are prepared to take the APES exam, think environmental science is an important subject to their students, and feel their students enjoy learning about environmental science. The teachers also feel qualified to teach APES, care about their students, display positive attitudes toward the environment, report that they encourage cooperative group work, and are enthusiastic about teaching environmental science.

The teachers do not feel the course has met their expectations of having the opportunity to teach highly motivated students, did not develop a more positive attitude toward the environment, and feel the APES lab and fieldwork activities are poor. They do not think their students work hard, do excellent work in their classes, and are the type of students to do well in science, or appreciate the hard work they do in APES. The teachers also admit they do not feel they do an excellent job teaching this course and do not encourage labs, fieldwork, or independent student research. These results are important because the College Board recommends that students complete at least one lab activity each week and spend a significant amount of time doing fieldwork.

When results of the student and teacher attitude scales are compared, teachers and students agree that APES is beneficial, has not met their expectations (for students, preparing them for college-level work; for teachers, having the opportunity to teach highly motivated students), has taught them a lot about environmental science and how to take action to solve environmental problems, and that their behaviors toward the environment are more positive. Both groups enjoy the class, but feel the lab activities and fieldwork are poor. They also agree that the students do not do excellent work in the class, that their teacher is qualified to teach APES, that the teacher does not encourage independent research, but does encourage cooperative group work, and that they both like and respect each other.

Student and teacher attitudes differed in several areas. Teachers felt they did not develop a more positive attitude toward the environment while students felt they did develop a more positive attitude toward the environment as a result of taking APES. Teachers felt it is important for students to learn about the environment while students did not. Teachers did not feel they do an excellent job teaching APES while the students felt their teachers did. Finally, teachers felt they do not encourage lab and fieldwork while their students felt they did. Thus, teacher and student attitude scale results indicate a lack of consistency or agreement between the two groups. These inconsistencies are interesting, but must be interpreted with caution because the sample size for the teacher attitude survey was small (N=12) relative to the size of the student survey sample (N=355).

5. Do the attitudes of students toward APES differ by gender or ethnicity? In this study, gender did not significantly influence students' attitudes toward Advanced Placement Environmental Science for the total attitude scale or any of the three subscales. Although the differences were not statistically significant, females had more positive attitudes toward APES overall and toward their APES class, teacher, and themselves as students in APES than did their male counterparts. None of the above differences in attitudes are statistically significant. For the total attitude scale and each of the subscales, females had the smallest confidence intervals.

Other studies of gender differences in attitudes toward science have yielded conflicting results. A study by Baker and Leary (1995) found that girls in grades 2, 5, 8, and 11 had slightly more positive attitudes toward science while Morrell and Lederman (1998) (5^{th}, 7^{th}, and 10^{th} grade students) and Greenfield (1997) (K-12 students) found that gender did not significantly affect students' attitude toward science. This evidence is in contrast to other studies. Research studies by Cannon and Simpson (1985), Schibeci and Riley (1986), and Weinburgh (1995) have all reported that males have more positive attitudes toward science than females. Other research has concluded that gender differences in students' attitudes toward science decrease as students get older (Steinkamp & Maehr, 1984). It appears that gender differences in students' attitudes toward science are smaller than previously assumed. If gender differences do exist, they usually tend to favor males (Steinkamp & Maehr, 1984).

In this study, ethnicity did not significantly influence students' attitudes toward Advanced Placement Environmental Science for the total attitude scale or any of the three subscales. Interestingly, the category "other ethnic groups" had more positive attitudes toward APES than any other group. None of the ethnic differences in attitudes were statistically significant. There was no significant interaction between gender and ethnicity. The findings of this study conflict with those reported in other studies of ethnic differences in science attitudes. Many studies have shown that Black students have more positive attitudes toward high school science than their White counterparts (Pearson & Bechtel, 1989) and that minority students do have positive attitudes toward science

(Catsambis, 1995). Bachman and O'Malley (1984) offered an explanation of why Black students might appear to have more positive attitudes toward science than other ethnic groups. They hypothesized it was because Black students are more likely than White students to choose responses at the positive end of a Likert-type response scale (as cited in Pearson & Bechtel, 1989).

6. Are there differences in the amount of time spent on APES and other class activities reported by students and teachers? In this study, teachers surveyed reported spending less time on lab activities (teachers less than one hour per week; students one to three hours per week) and lecture (teachers one to three hours per week; students three to five hours per week) than students did, and reported spending more time on analyzing, solving, and finding solutions to prevent environmental problems (teachers one to three hours per week; students less than one hour per week), than students said they did. This is interesting because it parallels the student and teacher attitude survey data indicating that students felt their teachers encouraged lab work while the teachers reported that they did not encourage labs. Teacher responses on the survey agreed with those of the students regarding the amount of class time spent on fieldwork (less than one hour per week), identifying environmental problems (one to three hours per week), assessing the risks associated with environmental problems (one to three hours per week), cooperative group work (one to three hours per week), student independent research (less than one hour per week), class discussions (one to three hours per week), and student presentations (less than one hour per week).

In the survey sample, students reported lecture as the most frequent activity (three to five hours per week) and fieldwork, analyzing, solving, and working on solutions to environmental problems, student independent research, and student presentations as the least frequent activities (less than one hour per week each). Teachers reported identifying, analyzing, assessing the risks associated with, and working on solutions to environmental problems, lecture, cooperative group work, and class discussions as the most frequent activities (one to three hours per week each). The least frequent activities according to the teachers were: lab activities, fieldwork, student independent research, and student presentations (less than one hour per week each).

Overall, there is less variability in the teacher data than the student data for the survey sample. This is probably due to the fact that the teacher sample was much more homogeneous than the student sample and the teacher sample was much smaller than the student sample. Also, students may tend to be unclear as to what constitutes a particular activity whereas the teachers are not because they decide the activities and thus know how to categorize or label them.

Regarding least frequent activities, over 50% of the students and over 75% of the teachers surveyed reported spending less than three hours per week on all of the above activities except for lecture. Regarding most frequent activities, over 65% of students felt their teacher spends either three to five or over five hours a week lecturing. Students overwhelmingly felt they spend most of their class time each week listening to their teacher lecture. In contrast, the majority of teachers (70%) felt they spend less than one to one to three hours a week lecturing. Obviously, a discrepancy exists between teacher and student perceptions of the amount of class time spent on lecture.

Regarding the amount of time spent on different APES class activities, the qualitative case study student interview data paralleled the quantitative student survey data in most cases. For example, both groups of students reported spending very little class time on fieldwork, analyzing, solving, and working on solutions to environmental problems, student independent research, and student presentations. Interestingly, the 10 case study students interviewed reported spending less time on labs and fieldwork than their teacher did, this was not the case for the survey sample. The students surveyed reported spending more time on lab activities than their teachers, and the students and the teachers surveyed reported spending the same amount of time on fieldwork. By far, the most frequent activity reported by both the students surveyed and the students interviewed was lecture. The interviewed teacher and case study students agreed on the amount of class time spent on lecture (70% of each class). The surveyed students felt they spent more time on cooperative group work (one to three hours per week) than did the interviewed students (a total of three times all year).

7. **What do students feel are the strengths/weaknesses of APES**? The surveyed students felt the most important strength of their APES class was their teacher. It was interesting that students identified student presentations, fieldwork, lab activities, and class discussions as strengths of APES considering they reported spending less than one class period per week on these activities. Perhaps it is because they highly value the time they do spend on these types of activities. Students also appreciated the content, small class size, the challenge, and the lectures associated with their APES classes.

The students felt very strongly that there were not enough fieldwork, fieldtrips, or lab activities in their APES classes. They also did not feel the textbook or their preparation for the APES exam was adequate. The students also indicated the lack of a review book, lack of class time to cover the large amount of content, difficult tests, too much out-of-class reading, and not enough lecture as the most significant weaknesses.

The case study students who were interviewed expressed having the notes before class, learning how to do well on the AP exam, high quality students, the quality of the information, learning about the environment, their teacher, class routines, good study habits for college, and college credit as the most important strengths of APES. During the interviews, the same students reported a lack of time spent on preparing for essays on the APES exam, the amount of information, their teacher's style of teaching (lecture, worksheets not graded, format of quizzes, and questioning technique), class routines, lack of labs and hands-on activities, too much pressure to do well on APES exam, and the emphasis on coverage and memorization as the most significant weaknesses of APES.

Interestingly, there were no striking similarities between the strengths reported by the 355 surveyed students and those identified by the 10 interviewed students. The surveyed students tended to state more positive strengths than did the interviewed students. The two groups of students did agree that a lack of preparation for the AP exam, labs, hands-on activities, and class time were weaknesses of APES.

8. What do teachers feel are the strengths/weaknesses of APES? Based on the teacher survey data, teachers reported class discussions, fieldwork and group work as important strengths of their APES classes, and reported a need for more fieldwork and lab work as the most significant weaknesses of their APES classes. The case study teacher interviewed did not address any strengths or weakness directly pertaining to the APES Program. Instead, he reported strengths and weaknesses specific to his experience as an APES teacher. The strength he expressed was preparing students well and the weakness was having 9^{th} graders in APES who were not ready to be there.

9. How closely does the actual implementation of APES match the goals/guidelines stated by the College Board? The data from the teacher and student surveys showed that students reported spending one to three hours a week doing lab activities, while the teachers reported spending less than one hour a week on labs. Both the students and teachers surveyed in this study reported only spending less than an hour per week on fieldwork. The students also reported spending less time analyzing, solving, and working on solutions to environmental problems (less than one hour per week), than did the teachers (one to three hours per week).

This study indicates that APES students spend very little time on lab activities, which can be detrimental to students in several ways. For example, Freedman (1997) found that for students of diverse backgrounds, hands-on laboratory activities positively influence students' attitudes toward science and increase their achievement on measures of science knowledge. Other relevant research has repeatedly supported the development of strong laboratory components in high school science classes. It is thought that a positive, supportive classroom environment incorporating laboratory instruction and more active student involvement (Hender, Fisher & Fraser, 1998) leads to both more positive attitudes toward science and greater science achievement for students (Talton & Simpson, 1987).

Data from the APES case study observations, teacher, and student interviews corroborates the survey data. During all 10 APES case study observations, no labs or fieldwork were witnessed. The teacher stated that they do some fieldwork and the amount of labs depends on the chapter. The students explained that they had completed only one lab and no fieldwork during the first half of the school year. The case study teacher said that he brings up environmental problems and they talk about them in class discussions, but the students disagreed. This lack of emphasis on labs, fieldwork, and environmental problem solving is a violation of the College Board APES guidelines, which state that students should perform at least one lab per week, a significant amount of fieldwork, and a significant amount of time identifying, analyzing, solving, assessing, and working on solutions to environmental problems (College Board, 1997).

It appears that APES is meeting some of the College Board's goals of environmental science classes such as: having students learn about the environment and especially how to take action to solve environmental problems, feeling prepared to take the APES exam, having teachers who promote lab and fieldwork (College Board, 1997), and developing a concern for the environment (Howell & Warmbrod, 1974). Unfortunately, APES is not meeting all of the goals of the College Board because APES classes are supposed to prepare students for college-level work and prepare teachers to provide excellent labs and fieldwork for their students as well as encourage independent research (College Board, 1997).

10. What recommendations can be made to improve APES?

Class Activities

APES teachers need to increase the amount of time they spend on lab activities and fieldwork, identifying, analyzing, solving, assessing, and working on solutions to environmental problems, cooperative group work, and hands-on activities. Teachers should increase the amount of time spent on these activities in order to meet the standards set by the College Board and because these were all major weaknesses of APES identified by teachers and students. Students should also be engaged in problem-based learning in the environment to promote higher order thinking and environmental problem solving skills.

Guidelines/Teacher Training

The College Board should provide better guidelines and training for teachers concerning what the students need to know to be better prepared for the APES exam and how to create high quality labs and fieldwork. Teachers feel they need more specific guidelines and better training to adequately prepare their students for the APES exam.

Funding

More funding should be provided to schools that offer APES classes because teachers identified a lack of lab equipment as a significant weakness of their APES classes. If teachers are going to plan and implement more high quality labs and fieldwork, they need funding to purchase the necessary equipment for such activities. Teachers should also be encouraged to spend more than five hours each month on professional development. The College Board could provide grants for teachers to attend conferences and seminars to learn about ways to improve their science teaching.

Teacher Recruitment/ Student Recruitment/Selection

This study reported an APES student population that was 61% female and 56% White. With few minority students taking advanced science classes, the United States is losing a valuable pool of potential scientists. It is encouraging, however, that more females are now enrolling in advanced science classes.

The demographic results of this study clearly support the need to develop more intensive strategies for targeting and recruiting minority APES students and teachers. Research on how to increase the enrollment of minority students in advanced science classes has suggested the use of minority teachers as role models (Clark, 1999). As this study has shown, the majority of APES teachers are female and White. Thus, to provide minority teachers as role models to recruit minority students into advanced science classes we must first discover ways to recruit minority teachers to teach such classes. If there are more minority teachers in APES, minority students may see them as role models and be more apt to take APES.

Other ideas for increasing minority enrollment in APES include using cooperative learning and varying teaching styles to accommodate the various learning styles of minority students. APES science classes themselves could also be redesigned to capture the interest of all students by providing opportunities for all students to engage in scientific problem-solving and by encouraging and challenging all students (Clark, 1999). The AP Program has become one of the top indicators used by educators to determine the status of education in the United States. Advanced Placement classes give students an opportunity to excel in an atmosphere that has high academic standards and thus, should not leave minority students behind (College Entrance Examination Board, 2000).

The way in which students are selected or allowed to participate in APES should also be re-examined. The College Board states that any student who chooses to do so may take APES and the APES exam, but they do recommend that students have at least two years of a high school lab science prior to enrolling in APES due to the interdisciplinary nature of an environmental science course. Perhaps, students should be required, rather than encouraged, to take at least two years of high school laboratory classes before they are permitted to enroll in APES.

Other Suggestions

The College Board should work with teachers and students in focus groups to find out why APES is not meeting their expectations, why teachers do not encourage independent research, labs, and fieldwork, and why teachers and students do not believe students do excellent work in APES. It is also important to determine why the students, but not the teachers, develop more positive attitudes toward the environment as a result of participating in APES.

The College Board could design a review book or study guide for students and an APES question bank for teachers to help them prepare their students for the APES exam as well as suggest textbooks for students and teachers to review. The College Board could also provide on-line services where AP teachers can share ideas. High schools could institute block scheduling to give APES students more class time to cover the large amount of material and provide lab space so that teachers can actually conduct laboratory activities.

Overall Implications for the APES Program

As this study concluded, students and teachers have overall positive attitudes toward their Advanced Placement Environmental Science classes. Other research has confirmed that advanced science students have more positive attitudes toward science (Cannon & Simpson, 1985). It is extremely important for students to have positive attitudes toward science, especially environmental science, because the stronger the commitment to, and the higher the interest in science, the more able students will be to make intelligent decisions regarding political and social issues involving science and the environment as adults, which is the overall goal of environmental education (Ramsey, Hungerford, & Volk, 1992).

Implications for Further Educational Research

The findings of this study have implications for the way similar educational research should be conducted. Based on this study's observations, it appears that the interviewed students were more honest about the amount of time spent on APES class activities than the surveyed students were. This may be due to the fact that the classroom teachers administered the student surveys and the researcher conducted the student interviews. It is very interesting that the surveyed teachers appeared to be more honest in their answers regarding the amount of class time spent on APES activities than was the interviewed teacher. Again, this may be due to the nature of the anonymous teacher survey versus a face-to-face interview. To ensure a complete, accurate data set in studies such as these, it is suggested that a mixed methods approach be used. Complementing survey data with on-site observations and face-to-face interviews may help researchers obtain a clearer picture than either method could produce alone.

Overall Conclusions

Recently, the AP Program has received criticism for encouraging too much coverage at the expense of depth. Further recent criticisms include: concerns about the preparation of AP teachers and restricted access to AP classes especially for minority students and those living in urban areas. The College Board reports that few teachers are qualified to teach AP classes and thus their students have poor AP backgrounds (Trounson & Colvin, 2002). Some schools have even dropped their AP Programs, stating that they focus too much on memorization and not on real learning. The College Board has responded by offering more AP teacher training sessions, creating more clear AP guidelines, and developing programs to better prepare middle and high school students for AP classes. Students have responded by explaining that they feel they are just memorizing a huge about of information that they forget after they take the test. Colleges and universities are also frustrated because the students who perform well on AP exams do not always do well in their college classes (Trounson & Colvin, 2002).

These criticisms and concerns are validated by the data collected in this study. It appears as though the once highly valued, prestigious Advanced Placement Program is now facing the challenge of preparing students for college classes in the face of an ever-increasing information explosion. It is becoming more apparent that students need to learn, not simply memorize, the information in these classes to be successful in college and in their careers. A new era is emerging in which it must be decided what information is most important for our students to know to be able to adequately function in our changing society. With the Internet at our fingertips, we are entering deeper into the information age, and are facing more information on a daily basis than ever before. Educators, scientists, and members of the College Board need to work together to address these concerns.

APPENDIX A
APES CONTENT GUIDELINES

Table A-1. Advanced Placement Environmental Science Content Guidelines

Topic	Percent of Class Time
I. Scientific Analysis	5%
A. Observing the natural world and developing hypotheses	
B. Collecting data	
1. observation controlled experiments	
C. Modeling	
D. Critical interpretation of data	
II. Interdependence of Earth's Systems: Fundamental Principles and Concepts	25%
A. The Flow of Energy	
1. forms and quality of energy	
2. energy units and measurement	
3. sources and sinks; conversions	
B. The Cycling of Matter	
1. water	
2. carbon	
3. major nutrients	
a) nitrogen	
b) phosphorous	
4. differences between cycling of major trace elements	
C. The Solid Earth	
1. Earth history and the geologic time scale	
2. Earth dynamics: plate tectonics, volcanism, the rock cycle, soil formation	
D. The Atmosphere	
1. atmospheric history: origin, evolution, composition, and structure	
2. atmospheric dynamic: weather, climate	
E. The Biosphere	
1. organisms: adaptations to their environment	
2. populations and the communities: exponential growth, carrying capacity	
3. ecosystems and change: biomass, energy transfer, succession	
4. evolution of life: natural selection, extinction	

Table A-1. Continued.

III. Human Population Dynamics	10%
A. History of Human Population	
B. Global Distribution of Population	
1. numbers	
2. demographics	
3. patterns of resource utilization	
C. Carrying Capacity- Local, Regional, Global	
D. Cultural and Economic Influences	
IV. Renewable and Nonrenewable Resources: Distribution, Ownership, Use, Degradation	15%
A. Water	
1. fresh: agriculture, industrial, domestic	
2. oceans: fisheries	
B. Minerals	
C. Soils	
1. soil types	
2. erosion control	
D. Biological	
1. natural areas	
2. genetic diversity	
3. food and other agricultural products	
E. Energy	
1. conventional sources	
2. alternative sources	
F. Land	
1. residential and commercial	
2. agricultural and forestry	
3. recreation and wilderness	
V. Environmental Quality	20%
A. Air/Water/Soil	
1. major pollutants	
a) types such as SO_x, No_x, and pesticides	
b) measurement and the units of measure such as ppm, pH, μg/L	
c) point and nonpoint sources (domestic, industrial, agricultural)	
effects of pollutants on:	
a) aquatic systems	
b) vegetation	
c) natural features, buildings, and structures	
d) wildlife	
3. pollution reduction, remediation, and control	

Table A-1. Continued.

B. Solid Waste	
1. types, sources, and amounts	
2. current disposal methods and their limitations	
3. alternatives	
C. Impact on Human Health	
1. agents: chemical and biological	
2. effects: acute and chronic, dose-response relationships	
3. relative risks: evaluation and response	
VI. Global Changes and Their Consequences	15%
A. First-Order Effects	
1. atmosphere: CO_2, CH_4, stratospheric O_3	
2. oceans: surface temperatures, currents, sea level	
3. biota: habitat destruction, loss of biodiversity, introduced exotics	
B. High-Order Interactions	
1. CO_2 - photosynthesis	
2. ocean currents - climate and biological communities	
3. ultraviolet light - cell damage	
VII. Environment and Society: Trade-Offs and Decision Making	5%
A. Economic Forces	
1. cost-benefit analysis	
2. marginal costs	
Ownership and external costs	
B. Cultural and Aesthetic Considerations	
C. Environmental Ethics	
D. Environmental Laws and Regulations (International, National, and Regional)	
VIII. Choices for the Future	5%
A. Conservation	
B. Preservation	
C. Remediation	
D. Sustainability	

APPENDIX B
TEACHER SURVEY

Advanced Placement Environmental Science
Teacher Survey

General Directions

1. There are 81 statements on the following pages. These items deal with educational ideas and problems in Advanced Placement Environmental Science about which we all have opinions, beliefs, and attitudes.

2. The purpose of this survey is to determine student and teacher attitudes toward AP Environmental Science and to evaluate the AP Environmental Science Program. It should take approximately 30 minutes to complete.

3. Please indicate what you personally think about the Advanced Placement Environmental Science course in your high school. There are no right or wrong answers.

4. Please mark only one response to each question on the enclosed form. If a question does not pertain to your class leave it blank. For example, if your class does not do any fieldwork, leave those questions blank.

5. Please place all scantrons and written response sheets from all of your sections of AP Environmental Science in the envelope provided, indicate the name of your school and return the surveys to: Rebecca Penwell in the enclosed envelope.

Thank you for your cooperation.

Instructions: There are four possible responses to each statement: Strongly Disagree (SD), Disagree (D), Agree (A), and Strongly Agree (SA). Please indicate your agreement or disagreement with each item by filling in on the scantron the response that most closely matches your feelings. For example, Strongly Disagree (SD) = A, Disagree (D)= B, Agree (A) = C, and Strongly Agree (SA)= D on the scantron. Remember these statements reflect your personal attitudes toward the AP Environmental Science Program.

The following questions pertain to how you feel about your AP Environmental Science class.

Class Subscale (items 1-12)	SD	D	A	SA
1. The benefits of teaching this class outweigh the costs of the time needed to prepare to teach it.	1	2	3	4
2. This course has met my expectations of having the opportunity to teach highly motivated students.	1	2	3	4
3. My decision to teach this course was a good one.	1	2	3	4
4. I have learned a lot about environmental science in preparing to teach this class.	1	2	3	4
5. In preparing to teach this class, I have learned a lot about how to take action to solve environmental problems.	1	2	3	4
6. As a result of teaching this class, my attitude toward the environment has become more positive.	1	2	3	4
7. As a result of teaching this class, my behavior towards the environment has become more positive.	1	2	3	4
8. I have enjoyed teaching this class.	1	2	3	4
9. I wanted to teach this class because I believe that it is important for students to learn about the environment.	1	2	3	4
10. I feel the lab exercises designed for this course are excellent.	1	2	3	4
11. I feel the fieldwork in this course is excellent.	1	2	3	4
12. I feel the textbook that is used for this class is helpful.	1	2	3	4

The following questions pertain to how you feel about the students in your AP Environmental Science Class.

Student Subscale (items 13-20)	SD	D	A	SA
13. I feel my students are prepared to take the AP Environmental Science Exam.	1	2	3	4
14. I think the majority of my students do excellent work in this class.	1	2	3	4
15. I think my students are the type to do well in science.	1	2	3	4
16. I think it is important to my students to get good grades.	1	2	3	4
17. I think environmental science is an important subject to my students.	1	2	3	4
18. I think my students work hard in this class.	1	2	3	4
19. I think my students appreciate the hard work they do in this class.	1	2	3	4
20. I think my students enjoy learning environmental science.	1	2	3	4

The following questions pertain to how you feel about yourself as an AP Environmental Science teacher.

Teacher Subscale (items 21-45)	SD	D	A	SA
21. I feel I am well qualified to teach this course.	1	2	3	4
22. I feel I do an excellent job teaching this course.	1	2	3	4
23. I feel I explain concepts well.	1	2	3	4
24. I am very knowledgeable about environmental science.	1	2	3	4
25. I care about my students.	1	2	3	4
26. I listen to my students.	1	2	3	4

	SD	D	A	SA
27. I am available to provide extra help for my students when needed.	1	2	3	4
28. I tell my students when they have done a good job.	1	2	3	4
29. I have high expectations for all students in this class.	1	2	3	4
30. I am fair to all students.	1	2	3	4
31. I believe it is important for students to learn about the environment.	1	2	3	4
32. I believe it is important for students to learn how to solve environmental problems.	1	2	3	4
33. I display a positive attitude toward the environment.	1	2	3	4
34. I encourage my students to take the AP Environmental Science exam	1	2	3	4
35. I have made sure that my students are prepared to take the AP Environmental Science exam.	1	2	3	4
36. I give my students a lot of work in this class.	1	2	3	4
37. I use outside readings to supplement the textbook in this class	1	2	3	4
38. I encourage independent research in this class.	1	2	3	4
39. I encourage laboratory work in this class.	1	2	3	4
40. I encourage cooperative group work in this class.	1	2	3	4
41. I encourage fieldwork in this class.	1	2	3	4

	SD	D	A	SA
42. I emphasize the benefits of taking an AP course to my students.	1	2	3	4
43. I respect my students	1	2	3	4
44. I like my students.	1	2	3	4
45. I am enthusiastic about environmental science	1	2	3	4

Instructions: Each statement has several response options. Please indicate your response on the scantron. For example, <1= A, etc.

The following questions pertain to how much time you spend on activities related to AP Environmental Science.

	Number of hours			
46. How many hours a week do you spend preparing to teach?.	<1	1-3	3.1-5	>5
47. How many hours a week do you spend grading?	<1	1-3	3.1-5	>5
48. How many hours a week do you spend preparing for lab activities?	<1	1-3	3.1-5	>5
49. How many hours a week do you spend doing lab activities?	<1	1-3	3.1-5	>5
50. How many hours a week do spend preparing for fieldwork?	<1	1-3	3.1-5	>5
51. How many hours a week do you spend doing fieldwork?.	<1	1-3	3.1-5	>5
52. How many hours a week do you spend lecturing?	<1	1-3	3.1-5	>5
53. How many hours a week do your students spend doing cooperative group work?	<1	1-3	3.1-5	>5
54. How many hours a week do your students spend doing independent research?	<1	1-3	3.1-5	>5
55. How many hours a week do you engage in class discussions with your students?	<1	1-3	3.1-5	>5

56. How many hours a week do your students engage in presentations?	<1	1-3	3.1-5	>5
57. How many hours a week do you spend helping students identify environmental problems?	<1	1-3	3.1-5	>5
58. How many hours a week do you spend helping students analyze environmental problems?.	<1	1-3	3.1-5	>5
59. How many hours a week do you spend helping students solve environmental problems?	<1	1-3	3.1-5	>5
60. How many hours a week do you spend helping students assess the risks associated with environmental problems?	<1	1-3	3.1-5	>5
61. How many hours a week do you spend helping students prevent environmental problems?.	<1	1-3	3.1-5	>5
62. How many hours a month do you spend on professional development?.	<1	1-3	3.1-5	>5

The following questions pertain to your AP Environmental Science Class.

63. How many sections of AP Environmental Science do you teach?	1	2	3	4
64. About how many students do you have in each section?	<20	21-30	31-40	>41
65. In what grade are the majority of your students?.	9^{th}	10^{th}	11^{th}	12^{th}
66. What is the percent of students who take the AP Environmental Science Exam?	0-24%	25-49%	50-74%	75-100%
67. What is the percent of students who pass the AP Environmental Science Exam?	0-24%	25-49%	50-74%	75-100%
68. Did you complete formal training for the AP Environmental Science course?	Yes	No		

Instructions: Each statement has several response options. Please indicate your response on the scantron. For example, <1= A, etc.

The following questions pertain to general information.

69. What is your gender?	□ Male	□ Female			
70. In what type of area do you live?	□ Urban	□ Suburban	□ Rural		
71. What is your ethnic background?	□ White	□ Black	□ Asian	□ Latin	□ Other
72. Indicate your highest academic degree.	□ Bachelor Degree	□ Master Degree	□ Specialist	□ Ph.D.	□ Other
73. How many years of science teaching experience do you have including this year?	□ 0-2	□ 3-5	□ 6-8	□ 9-11	□ >12
74. How many years have you been teaching AP classes?	□ 0-2	□ 3-5	□ 6-8	□ 9-11	□ >12
75. Indicate the percentage of your assessments that are matching.	□ <10%	□ 11-30%	□ 31-59%	□ 60-79%	□ >80%
76. Indicate the percentage of your assessments that are multiple-choice.	□ <10%	□ 11-30%	□ 31-59%	□ 60-79%	□ >80%
77. Indicate the percentage of your assessments that are true/false.	□ <10%	□ 11-30%	□ 31-59%	□ 60-79%	□ >80%
78. Indicate the percentage of your assessments that are essay.	□ <10%	□ 11-30%	□ 31-59%	□ 60-79%	□ >80%
79. How often do you assess your students?	□ 2X/Wk	□ 1X/Wk	□ 1X/2Wk	□ 1X/3wk	□ 1X/Mo

Instructions: Please write your response to the following questions.

80. List the most important strengths of your AP Environmental Science class.

____

____

____

81. List the most significant weaknesses of your AP Environmental Science class.

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Thank you very much for taking the time to complete this survey. Your input is greatly appreciated and will be used to evaluate and make suggestions for the improvement of the Advanced Placement Environmental Science Program.

* Please collect the scantrons and the separate sheets of paper with the student responses to questions 66-67 on the student survey from your students and place them the last page of this survey along with your signed consent form and the signed student and parent consent forms in the envelope provided. Please mail to Rebecca Penwell in the enclosed envelope.

Would you like to receive a copy of the results of this study? Yes____ No____

If yes, please indicate your preferred mailing address:

Name

____

Street Address

____

City, State, Zip

____

e-mail:

____

APPENDIX C
STUDENT SURVEY

Advanced Placement Environmental Science
Student Survey

General Directions

1. There are 67 statements on the following pages. These items deal with educational ideas and problems in Advanced Placement Environmental Science about which we all have opinions, beliefs, and attitudes.

2. The purpose of this survey is to determine student and teacher attitudes toward AP Environmental Science and to evaluate the AP Environmental Science Program. It should take approximately 30 minutes to complete.

3. Please indicate what you personally think about the Advanced Placement Environmental Science course in your high school. There are no right or wrong answers.

4. Please mark only one response to each question on the enclosed form. If a question does not pertain to your class leave it blank. For example, if your class does not do any fieldwork, leave those questions blank.

5. REMEMBER: Do not sign your name. When you are finished, give your survey to your teacher. Your teacher will answer any questions you may have.

Thank you for your cooperation.

Instructions: There are four possible responses to each statement: Strongly Disagree (SD), Disagree (D), Agree (A), and Strongly Agree (SA). Please indicate your agreement or disagreement with each item by filling in on the scantron the response that most closely matches your feelings. For example, Strongly Disagree (SD) = A, Disagree (D)= B, Agree (A) = C, and Strongly Agree (SA)= D on the scantron. Remember these statements reflect your personal attitudes toward the AP Environmental Science Program.

The following questions pertain to how you feel about your AP Environmental Science class.

Class Subscale (items 1-13)	SD	D	A	SA
1. The benefits of taking this class outweigh the amount of put into it.	1	2	3	4
2. This course has met my expectations of preparing me for college level course work	1	2	3	4
3. My decision to take this course was a good one	1	2	3	4
4. I have learned a lot about environmental science in this class.	1	2	3	4
5. As a result of taking this class, I have learned a lot about how to take action to solve environmental problems.	1	2	3	4
6. As a result of taking this class, my attitude toward the environment has become more positive.	1	2	3	4
7. As a result of taking this class, my behavior towards the environment has become more positive.	1	2	3	4
8. I enjoy this class.	1	2	3	4
9. I took this class because I believe it is important to learn about the environment.	1	2	3	4
10. Given the opportunity, I would take this class again.	1	2	3	4
11. The lab exercises in this course are excellent.	1	2	3	4
12. The fieldwork in this course is excellent.	1	2	3	4
13. I feel prepared to take the AP Environmental Science Exam.	1	2	3	4

The following questions pertain to how you feel about your AP Environmental Science teacher.

Teacher Subscale (items 14-38)	SD	D	A	SA
14. My teacher is well qualified to teach this course.	1	2	3	4
15. My teacher does an excellent job teaching this course.	1	2	3	4
16. My teacher explains concepts well.	1	2	3	4
17. My teacher enjoys teaching this course.	1	2	3	4
18. My teacher is very knowledgeable about environmental science.	1	2	3	4
19. My teacher cares about his/her students.	1	2	3	4
20. My teacher listens to his/her students.	1	2	3	4
21. My teacher is available to provide extra help for his/her students when needed.	1	2	3	4
22. My teacher tells his/her students when they have done a good job.	1	2	3	4
23. My teacher has high expectations for all students in this class.	1	2	3	4
24. My teacher is fair to all students.	1	2	3	4
25. My teacher believes it is important to learn about the environment	1	2	3	4
26. My teacher believes it is important to learn how to solve environmental problems.	1	2	3	4
27. My teacher displays a positive attitude toward the environment.	1	2	3	4
28. My teacher encourages his/her students to take the AP Environmental Science Exam.	1	2	3	4

	SD	D	A	SA
29. My teacher has made sure that his/her students are prepared to take the AP Environmental Science Exam.	1	2	3	4
30. My teacher uses outside readings to supplement the textbook in this class.	1	2	3	4
31. My teacher encourages independent research in this class.	1	2	3	4
32. My teacher encourages laboratory work in this class.	1	2	3	4
33. My teacher encourages cooperative group work in this class.	1	2	3	4
34. My teacher encourages fieldwork in this class.	1	2	3	4
35. My teacher emphasizes to his/her students the benefits of taking an AP course.	1	2	3	4
36. I respect my teacher.	1	2	3	4
37. I like my teacher.	1	2	3	4
38. My teacher is enthusiastic about environmental science.	1	2	3	4

The following questions pertain to how you feel about yourself as a student in AP Environmental Science.

Student Subscale (items 39-42)	SD	D	A	SA
39. I do excellent work in this class.	1	2	3	4
40. It is important to me to get good grades.	1	2	3	4
41. Environmental science is an important subject.	1	2	3	4
42. I enjoy learning environmental science.	1	2	3	4

Instructions: Each statement has several response options. Please indicate your response on the scantron. For example, <1= A, etc.

The following questions pertain to how much time you spend on activities in AP Environmental Science.

	Number of hours			
43. How many hours a week do you spend studying?	<1	1-3	3.1-5	>5
44. How many hours a week do you spend on homework.	<1	1-3	3.1-5	>5
45. How many hours a week do you spend on lab activities.	<1	1-3	3.1-5	>5
46. How many hours a week do you spend doing fieldwork.	<1	1-3	3.1-5	>5
47. How many hours a week does your teacher spend lecturing.	<1	1-3	3.1-5	>5
48. How many hours a week do you spend doing cooperative group work.	<1	1-3	3.1-5	>5
49. How many hours a week do you spend identifying environmental problems.	<1	1-3	3.1-5	>5
50. How many hours a week do you spend analyzing environmental problems.	<1	1-3	3.1-5	>5
51. How many hours a week do you spend solving environmental problems.	<1	1-3	3.1-5	>5
52. How many hours a week do you spend assessing the risks associated with environmental problems.	<1	1-3	3.1-5	>5
53. How many hours a week do you spend working on solutions to prevent environmental problems.	<1	1-3	3.1-5	>5
54. How many hours a week do you engage in class discussions with your teacher.	<1	1-3	3.1-5	>5
55. How many hours a week do students engage in presentations.	<1	1-3	3.1-5	>5
56. How many hours a week do you spend doing independent research.	<1	1-3	3.1-5	>5

Instructions: Each statement has several response options. Please indicate your response on the scantron. For example, male =A, etc.

The following questions pertain to general information.

57. What is your gender?	☐ Male	☐ Female			
58. In what type of area do you live?	☐ Urban	☐ Suburban	☐ Rural		
59. What grade level are you in school?	☐ 9^{th}	☐ 10^{th}	☐ 11^{th}	☐ 12^{th}	
60. What is your approximate grade point average?	☐ 2.0-2.4	☐ 2.5-2.9	☐ 3.0-3.4	☐ 3.5-4.0	
61. What is your ethnic background?	☐ White	☐ Black	☐ Asian	☐ Latin	☐ Other
62. Indicate the highest academic degree of your mother.	☐ High School Diploma	☐ Bachelor Degree	☐ Master Degree	☐ Ph.D.	☐ NA
63. Indicate the highest academic degree of your father.	☐ High School Diploma	☐ Bachelor Degree	☐ Master Degree	☐ Ph.D.	☐ NA
64. How many high school science courses have you completed?	☐ <1	☐ 2-3	☐ 4-5	☐ 6-7	☐ >8
65. How many other AP courses have you taken?	☐ <1	☐ 2-3	☐ 4-5	☐ 6-7	☐ >8

Instructions: Please write your response to the following questions on a separate sheet of paper.

66. List the most important strengths of your AP Environmental Science class.

____

____

____

67. List the most significant weaknesses of your AP Environmental Science class.

____

____

____

Thank you very much for taking the time to complete this survey. Your input is greatly appreciated and will be used to evaluate and make suggestions for the improvement of the Advanced Placement Environmental Science Program.

* Please return your scantron and a separate sheet of paper with your answers to questions 66-67 along with your signed student and parent consent forms to your teacher.

APPENDIX D
TEACHER INTERVIEW QUESTIONS

Table D-1. APES teacher interview questions.

1a. How do you define curriculum?
1b. How does your understanding of curriculum influence how you teach APES?
2. In your view, how important is it that you have a working knowledge of the principles of curriculum
and why?
3a. What activities do you use to promote student learning and why?
3b. Do you feel that the students benefit from the independent study days that you give them? Why or
why not?
3c. Do you feel that the students benefit from the study time that you give students at the end of the class
period? Why or why not?
4. Describe some of the learning activities that you use in order to facilitate successful outcomes for all
students irrespective of various learning style preference?
5. Cite examples of how the type of instruction you provide reflects a multicultural approach?
6a. How and how often do you evaluate your students?
6b. What is the format of your quizzes and tests?
7a. Describe how you teach.
7b. What do you do best as a teacher?
8a. Describe the type of questions you ask of your students. Provide some examples.
8b. Why do you think that students do not ask many questions during class?
9a. How do you group students?
9b. What factors influence the ways in which students are grouped?
9c. What are the e-mail partners?
9d. How are they assigned?
9e. Do you think that the students benefit from the use of their e-mail partners?
10a. Do you believe that you interact with male and female students in equal proportions? If not, why?
10b. Do you believe that male and female students differ in their ability and interest in APES?
10c. Why do you think that the boys ask more questions than the girls?
10d. Why do you think that girls make better use of the study time that you give them than the boys?
11. Do you consider students' interests when planning learning activities? Provide an example.
12a. How does the AP exam influence what and how you teach?
12b. Are there other content areas that you would like to teach but feel unable to because of the AP exam?
13. What do you feel are the most important strengths of APES and why?
14. What do you feel are the most significant weaknesses of APES and why?
15. If you could design the APES curriculum, how would you change it and why?

Table D-1. Continued..

16a. How much time do you spend on lab activities, fieldwork, lecture, cooperative group work, class discussions, student presentations, student independent study, independent student research, identifying environmental problems, analyzing environmental problems, assessing the risks associated with environmental problems, and working on solutions to environmental problems?
16b. How does the proportionate amount of time spent on these activities relate to your desired outcomes?
16c. What types of projects do the students do?
16d. Do they have class time to work on their projects?
16e. Is the class time that you give them to work on their projects enough time to finish, or do they have to spend outside class time to finish their projects?
16f. Are all of the projects individual, or are there any group projects?
16g. What is your rationale for the grouping that you use for student research projects?
17a. How do you feel about your ability to teach APES effectively?
17b. How do you feel about your students' ability to learn what you teach in APES?
18. Do you feel that it is necessary for students to have at least two years of a lab science to do well in APES and why?
19. What is your gender?
20. In what type of area do you live?
21. What is your ethnic background?
22. What is your highest academic degree?

APPENDIX E
STUDENT INTERVIEW QUESTIONS

Table E-1. APES student interview questions.

1a. What type of activities help you learn material most easily and why?
1b. Do you benefit from the independent study days? Why or why not?
1c. Do you benefit from having the class notes before class? Why or why not?
1d. Do you benefit from the use of your e-mail partners? Why or why not?
1e. Do you benefit from the class time that you have to study? Why or why not?
2. How and how often does your teacher evaluate your work?
3. Describe how you feel about the quality of your teacher's instruction?
4a. Do you feel that your teacher interacts with female students as often as male students and why?
4b. Why do you think the boys ask more questions than the girls?
4c. Why do you think that girls make better use of the study time that you are given than the boys?
5. Does your teacher incorporate student interests into his teaching?
6. What do you feel are the most important strengths of APES and why?
7. What do you feel are the most significant weaknesses of APES and why?
8. If you could design the APES curriculum, how would you change it and why?
How much time do you spend on lab activities, fieldwork, lecture, cooperative group work, class discussions, student independent study, student presentations, independent student research, identifying environmental problems, analyzing environmental problems, assessing the risks associated with environmental problems, and working on solutions to environmental problems?
10. How do you feel about taking APES and why?
Do you feel that it is necessary for students to have at least two years of a lab science to do well in APES and why?
12. What is your gender?
13. In what type of area do you live?
14. What is your ethnic background?
15a. What is your approximate grade point average?
15b. What is your current grade in this class?
16. What grade are you in school?
17. What is the highest academic degree of your mother?
18. What is the highest academic degree of your father?
19. How many high school science courses have you completed?
20. What other AP classes have you taken?

APPENDIX F
STUDY DESIGN AND TIMELINE

Date	Action
November	Develop teacher and student surveys
March	IRB approval
April	Pilot test surveys
	Revise surveys based on factor and item analysis
	Randomly choose APES schools for first mailing
	Mail first letter
	Mail reminder postcards
May 1^{st}	Send out first round of surveys
May 15^{th}	Send out reminder postcards
June	Receive surveys
July	t-tests
	ANOVAS
August	Write quantitative results
September	Determine observation and interview protocol
	Begin observations
October	Continue observations
November	Continue observations
December	Teacher and student interviews
January	Write case study
	Write quantitative/qualitative results
	Write conclusions and implications

APPENDIX G
ITEM ANALYSIS

Table G-1. First item analysis for all 47 items of the student attitude scale pilot data.

Item	Mean	Standard Deviation	Alpha if Item Deleted	Corrected Item-Total Correlation
1	3.0710	.7427	.9278	.4065
2	2.8097	.7795	.9273	.4589
3	3.3968	.6925	.9267	.5473
4	3.5484	.5933	.9271	.5129
5	3.1161	.7370	.9266	.5469
6	3.2710	.7444	.9274	.4491
7	3.1355	.7639	.9272	.4709
8	3.2194	.7265	.9271	.4892
9	2.8581	.8918	.9278	.4154
10*	2.2774	.8441	.9322	-.0587
11	2.9161	.8810	.9274	.4597
12	2.5742	.8001	.9277	.4226
13	2.6710	.7768	.9276	.4271
14	2.2516	.9354	.9314	.0781
15	2.9355	.8566	.9271	.4847
16	3.5871	.7741	.9296	.1919
17	3.6097	.6629	.9263	.6021
18	3.4097	.7695	.9252	.6997
19	3.4065	.6750	.9260	.6365
20	3.6355	.6227	.9268	.5477
21	3.7032	.5297	.9266	.6199
22	3.5129	.6766	.9262	.6070
23	3.4065	.7169	.9264	.5701
24	3.4290	.7149	.9271	.4890
25	3.3484	.7469	.9259	.6284
26	3.3290	.7513	.9280	.3765
27	3.3484	.7425	.9263	.5778
28	3.7290	.5252	.9270	.5476
29	3.6065	.5912	.9267	.5686
30	3.5484	.6604	.9267	.5491
31	3.6581	.5960	.9280	.3778
32	3.3903	.7456	.9258	.6345
33	2.8290	.8921	.9299	.2079
34*	2.2452	.9019	.9324	-.0416
35	3.1452	.8292	.9279	.3964
36	2.9839	.8494	.9281	.3765
37	3.1355	.7203	.9272	.4804
38	3.3065	.7011	.9266	.5583
39	3.1419	.7542	.9271	.4912
40	3.0806	.8184	.9271	.4909
41	3.5677	.6438	.9265	.5783
42	3.5065	.6767	.9259	.6453
43	3.6161	.6162	.9266	.5765
44	3.0000	.7717	.9284	.3337
45	3.4742	.6997	.9281	.3617
46	3.3806	.6992	.9269	.5191
47	3.2774	.7550	.9261	.6007

*Items that should be reverse coded

Table G-2. Second item analysis for all 47 items of the student attitude scale pilot data with items 10 and 34 reverse coded.

Item	Mean	Standard Deviation	Alpha if Item Deleted	Corrected Item-Total Correlation
1	3.0710	.7427	.9305	.4486
2	2.8097	.7795	.9307	.4205
3	3.3968	.6925	.9296	.5662
4	3.5484	.5933	.9301	.5201
5	3.1161	.7370	.9298	.5349
6	3.2710	.7444	.9304	.4584
7	3.1355	.7639	.9305	.4480
8	3.2194	.7265	.9299	.5188
9	2.8581	.8918	.9312	.3894
10*	3.7226	.8441	.9335	.1185
11	2.9161	.8810	.9304	.4702
12	2.5742	.8001	.9309	.4004
13	2.6710	.7768	.9310	.3936
14*	2.2516	.9354	.9345	.0502
15	2.9355	.8566	.9300	.5051
16*	3.5871	.7741	.9324	.2222
17	3.6097	.6629	.9293	.6199
18	3.4097	.7695	.9284	.7068
19	3.4065	.6750	.9290	.6563
20	3.6355	.6227	.9299	.5442
21	3.7032	.5297	.9296	.6228
22	3.5129	.6766	.9291	.6461
23	3.4065	.7169	.9293	.6091
24	3.4290	.7149	.9300	.5136
25	3.3484	.7469	.9291	.6196
26	3.3290	.7513	.9312	.3647
27	3.3484	.7425	.9294	.5891
28	3.7290	.5252	.9301	.5482
29	3.6065	.5912	.9298	.5719
30	3.5484	.6604	.9297	.5560
31	3.6581	.5960	.9310	.3850
32	3.3903	.7456	.9289	.6453
33*	2.8290	.8921	.9331	.1791
34*	3.7548	.9019	.9339	.0976
35	3.1452	.8292	.9311	.3881
36	2.9839	.8494	.9315	.3428
37	3.1355	.7203	.9303	.4685
38	3.3065	.7011	.9297	.5515
39	3.1419	.7542	.9304	.4574
40	3.0806	.8184	.9303	.4701
41	3.5677	.6438	.9295	.6024
42	3.5065	.6767	.9289	.6709
43	3.6161	.6162	.9296	.5955
44	3.0000	.7717	.9315	.3232
45	3.4742	.6997	.9311	.3718
46	3.3806	.6992	.9299	.5227
47	3.2774	.7550	.9292	.6031

*Poor Items

Table G-3. Third item analysis for all 42 items of the revised student attitude scale pilot data with items 10, 14, 16, 33, and 34 deleted.

Item	Mean	Standard Deviation	Alpha if Item Deleted	Corrected Item-Total Correlation
1	3.0710	.7427	.9403	.4317
2	2.8097	.7795	.9403	.4299
3	3.3968	.6925	.9393	.5607
4	3.5484	.5933	.9397	.5176
5	3.1161	.7370	.9395	.5358
6	3.2710	.7444	.9400	.4610
7	3.1355	.7639	.9401	.4564
8	3.2194	.7265	.9396	.5206
9	2.8581	.8918	.9407	.4134
11	2.9161	.8810	.9400	.4792
12	2.5742	.8001	.9405	.4115
13	2.6710	.7768	.9405	.4067
15	2.9355	.8566	.9399	.4957
17	3.6097	.6629	.9390	.6087
18	3.4097	.7695	.9381	.7031
19	3.4065	.6750	.9387	.6475
20	3.6355	.6227	.9394	.5587
21	3.7032	.5297	.9392	.6202
22	3.5129	.6766	.9388	.6286
23	3.4065	.7169	.9390	.5993
24	3.4290	.7149	.9397	.5081
25	3.3484	.7469	.9388	.6271
26	3.3290	.7513	.9407	.3760
27	3.3484	.7425	.9391	.5879
28	3.7290	.5252	.9396	.5442
29	3.6065	.5912	.9394	.5662
30	3.5484	.6604	.9394	.5538
31	3.6581	.5960	.9405	.3790
32	3.3903	.7456	.9387	.6368
35	3.1452	.8292	.9408	.3873
36	2.9839	.8494	.9410	.3627
37	3.1355	.7203	.9399	.4760
38	3.3065	.7011	.9393	.5636
39	3.1419	.7542	.9399	.4817
40	3.0806	.8184	.9400	.4796
41	3.5677	.6438	.9391	.5976
42	3.5065	.6767	.9386	.6658
43	3.6161	.6162	.9392	.5942
44	3.0000	.7717	.9411	.3363
45	3.4742	.6997	.9406	.3745
46	3.3806	.6992	.9396	.5257
47	3.2774	.7550	.9389	.6118

*Poor Items

APPENDIX H
FACTOR ANALYSIS

Table H-1. First factor analysis for all 47 items of the student attitude scale pilot data with items 10 and 34 reverse coded.

Item	Factor	Loadings on Factor	Communalities (Extracted)	# of Factors in Model	Total Loading	% Variance
1	2	.545	.413	1	13.219	28.125
2	10	.384	.417	2	2.976	6.332
3	2	.647	.558	3	2.744	5.838
4	2	.330	.423	4	1.990	4.235
5	1	.338	.432	5	1.637	3.483
6	5	.700	.589	6	1.523	3.239
7	5	.624	.518	7	1.250	2.660
8	2	.654	.575	8	1.160	2.469
9	2	.349	.392	9	1.113	2.367
10	8	.770	.664	10	1.077	2.291
11	2	.565	.458	11	1.023	2.177
12	3	.384	.498	12	.984	2.093
13	3	.451	.526	13	.937	1.993
14*	10	.418	.227	14	.895	1.904
15	9	.408	.470	15	.877	1.865
16*	11	.341	.208	16	.855	1.818
17	6	.642	.701	17	.809	1.721
18	6	.593	.779	18	.775	1.648
19	6	.458	.617	19	.668	1.421
20	1	.510	.579	20	.658	1.400
21	1	.477	.609	21	.630	1.339
22	4	.589	.647	22	.592	1.260
23	4	.697	.707	23	.555	1.181
24	4	.587	.525	24	.545	1.160
25	4	.427	.549	25	.528	1.123
26*	1	.314	.241	26	.482	1.025
27	4	.436	.476	27	.479	1.018
28	1	.759	.705	28	.455	.968
29	1	.742	.655	29	.430	.915
30	1	.561	.478	30	.422	.899
31	1	.378	.370	31	.403	.857
32	4	.387	.651	32	.392	.835
33*	1	.297	.220	33	.378	.804
34	8	.697	.563	34	.368	.783
35*	3	.397	.268	35	.343	.729
36	3	.585	.401	36	.324	.690
37	3	.690	.573	37	.297	.633
38	3	.533	.544	38	.291	.619
39	3	.715	.605	39	.267	.569
40	3	.371	.365	40	.265	.563
41	7	.715	.797	41	.244	.520
42	7	.581	.747	42	.240	.150
43	1	.499	.554	43	.215	.457
44	2	.244	.564	44	.204	.434
45	1	.283	.444	45	.180	.383
46	5	.457	.614	46	.154	.327
47	2	.528	.710	47	.149	.317

Table H-2. Second factor analysis for all 42 items of the revised student attitude scale pilot data with items 10, 14, 16, 33, and 34 deleted.

Item	Factor	Loadings on Factor	Communalities (Extracted)	# of Factors in Model	Total Loading	% Variance
1	3	.526	.361	1	13.084	31.152
2	4	.289	.338	2	2.803	6.673
3	3	.632	.548	3	2.288	5.448
4	5	.438	.448	4	1.795	4.274
5	6	.366	.461	5	1.545	3.679
6	6	.666	.531	6	1.296	3.085
7	6	.643	.508	7	1.198	2.852
8	3	.634	.562	8	1.071	2.550
9	6	.433	.357	9	1.022	2.434
11	3	.586	.454	11	.953	2.270
12	4	.462	.464	12	.938	2.234
13	4	.546	.521	13	.918	2.186
15	7	363	.437	15	.876	2.087
17	2	.276	.664	17	.830	1.976
18	5	.656	.774	18	.761	1.811
19	5	.522	.621	19	.734	1.748
20	2	.466	.581	20	.659	1.570
21	2	.488	.599	21	.619	1.475
22	1	.637	.629	22	.584	1.391
23	1	.695	.615	23	.565	1.344
24	1	.650	.551	24	.559	1.332
25	1	.496	.553	25	.524	1.248
26*	2	.304	.229	26	.505	1.203
27	1	.481	.495	27	.472	1.124
28	2	.777	.725	28	.443	1.055
29	2	.713	.626	29	.422	1.005
30	2	.526	.449	30	.418	.995
31	2	.375	.346	31	.407	.970
32	5	.554	.660	32	.393	.935
35*	4	.369	.265	35	.361	.859
36	4	.590	.391	36	.328	.781
37	4	.671	.563	37	.316	.753
38	4	.504	.540	38	.306	.728
39	4	.723	.597	39	.279	.664
40	4	.409	.377	40	.273	.651
41	1	.582	.604	41	.254	.605
42	1	.620	.686	42	.245	.584
43	2	.475	.537	43	.234	.557
44	7	.656	.552	44	.218	.520
45	7	.511	.443	45	.189	.451
46	6	.495	.576	46	.160	.382
47	3	.549	.675	47	.151	.360

*Poor Items

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BIOGRAPHICAL SKETCH

Rebecca Ann Penwell was born in Dayton, Ohio on March 31, 1974, two days before the big tornado hit. She moved to Washington, Pennsylvania, with her mother and younger sister at the age of five. Rebecca grew up in little Washington and attended Joe Walker Elementary School and McGuffey Middle and High School. She graduated in 1992.

After graduation Rebecca moved north to the frozen tundra of Meadville, Pennsylvania, to study biology and environmental science at Allegheny College. In the fall of 1994 she studied marine biology at the Duke University Marine Laboratory in Beaufort, North Carolina. She graduated in 1996 with a bachelor's degree in biology and environmental science.

Next, she moved to Miami, Florida, to pursue a master's degree in biology at Florida International University, where she studied the effects of turbidity on coral. As a teaching assistant she taught marine and general biology labs for three years. Rebecca also had the opportunity to teach a marine biology lecture class before she graduated with her biology master's in 1996.

After graduation, she took a job teaching general biology at Miami-Dade Community College. It was through this teaching experience that Rebecca was convinced she had a love for teaching and thus decided to pursue a doctorate in science education at the University of Florida in the Fall of 1999.

She received a M.Ed. in science education from the University of Florida in 2001. As a teaching assistant there she had the privilege of teaching Elementary Science Methods classes for three years. Rebecca has learned a great deal about teaching and about herself through her many years and experiences in graduate school.