

AN ASSESSMENT OF THE APPLIED BIOLOGY/CHEMISTRY
CURRICULUM IN SELECTED OKLAHOMA SCHOOLS

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1991

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1993

Submitted to the Faculty of the
Graduate College of
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF EDUCATION
May, 1995

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ACKNOWLEDGMENTS

My sincere appreciation is extended to those assisted with this research effort.

Initially, I thank Dr. James Key for his leadership and supervision while serving as major adviser of my doctoral program. Gratitude is also extended to Dr. H. Robert Terry, Dr. James White and Dr. David Henneberry for their advice while serving as members of my doctoral committee.

Special recognition is given to fellow graduate students Dr. Billye Foster and Dr. Fred Rayfield for their support. Others who have provided me with exceptional guidance include Mr. Jonathon Pierce, Mr. Kenneth Mitchell, Dr. John Todd, Dr. Glen Hall and Dr. Eddy Finley. My regards are extended to Mr. Shane Williams and Mr. Steve Munsey for their trusted friendship. I also thank my other personal and professional associates for their assistance in my endeavors.

Finally, I am most appreciative to my family for their encouragement. Specifically, I thank my parents, Julian (late) and Billie, and brother, Garren, for their unyielding love. I also recognize my grandmother, Mary Lee Garren, for her support. My deepest respect is given to Julie Key for her loving companionship.

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Chapter I

Introduction

Fifty percent of all careers require a functional knowledge of fundamental biology and chemistry. Therefore, it is of vital importance that all people entering the job force possess a working framework of the biological and chemical sciences. Furthermore, it should be noted that the labor market continually requires expanded and diversified skills from new entrants. This is especially true for those in technological fields like biology and chemistry (United States Department of Commerce, 1991).

Unfortunately, secondary students in the United States are typically underachievers in science. This has led many education experts to question whether the typical instructional methodologies used in science are effective (Johnson and Johnson, 1987). Science instruction has traditionally focused on developing theoretical knowledge through memorization of information. Limited emphasis has been placed on practical application of memorized data. In addition, little effort has been directed toward fostering a positive student attitude toward science.

Increased interest has recently surfaced concerning the use of applied instructional techniques for disseminating scientific instruction. Harvey (1991) referenced the need for applied curricula which will make academic concepts relevant to the workplace. Furthermore, he contended that students enrolled in applied curriculum courses exhibit a

more positive subject attitude than their traditional curriculum peers. If students do truly develop an enhanced perspective of the subject due to more practical instruction, then it is reasonable to assume that their subject competence would improve as well.

Problem

Traditional science teaching methods may be an ineffective preparation venue for students assuming careers in a technologically advanced labor market. Most science based occupations require the active application of information commonly found in public school science curricula. However, traditional science curricula utilize instruction techniques such as rote memorization which do not focus on pragmatic occupational preparation. It has been indicated that instruction which mirrors the environment where it will be used is most effective. Therefore, it is arguable that a curriculum which stresses an applied approach employing the cooperative learning method may be a more effective means of teaching a diverse base of scientific information. For this reason, the relative effectiveness of an applied science curriculum needs to be evaluated.

Purpose

The purpose of this study was to compare the Applied Biology/Chemistry (ABC) curriculum taught using the cooperative learning method with the traditional biology curriculum taught using more typical instruction by means of student scores on a standardized biology test and science attitude survey.

Objectives

Six objectives were established in efforts to achieve the purpose of the study.

The objectives of this study were:

1. To compare pre-test and post-test scores on the National Association of Biology Teachers/National Science Teachers Association (NABT/NSTA) biology test of those students taught the ABC curriculum using the cooperative learning method in selected Oklahoma schools.
2. To compare pre-test and post-test scores on the NABT/NSTA biology test of those students taught the traditional biology curriculum using typical teaching methods in selected Oklahoma schools.
3. To compare pre-test and post-test difference scores on the NABT/NSTA biology test of those students taught the ABC curriculum using the cooperative learning method with those taught the traditional biology curriculum using typical teaching methods in selected Oklahoma schools.
4. To compare pre-test and post-test scores on the science attitude survey of those students taught the ABC curriculum using the cooperative learning method in selected Oklahoma schools.
5. To compare pre-test and post-test scores on the science attitude survey of those students taught the traditional biology curriculum using typical teaching methods in selected Oklahoma schools.
6. To compare pre-test and post-test scores on the science attitude survey of those students taught the ABC curriculum using the cooperative learning method with those

taught the traditional biology curriculum using typical teaching methods in selected Oklahoma schools.

Hypotheses

Listed below are the hypotheses which were constructed to achieve the objectives of the study. Hypotheses are categorized by related assessment instrument.

NABT/NSTA Biology Test Hypotheses

- H_{01} - There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in ABC Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- H_{02} - There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- H_{03} - There is no significant difference between the pre-test and post-test difference scores on the NABT/NSTA biology test of students enrolled in ABC Biology I and students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- H_{04} - There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in ABC Biology I at the First

Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.

- Ho₀- There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₀- There is no significant difference between the pre-test and post-test difference scores on the NABT/NSTA biology test of students enrolled in ABC Biology I and students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₀- There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in ABC Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₀- There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in traditional Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₀- There is no significant difference between the pre-test and post-test difference scores on the NABT/NSTA biology test of students enrolled in ABC Biology I and students enrolled in traditional Biology I in each section at the First Metropolitan High

School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.

Science Attitude Survey Hypotheses

- $H_{0_{10}}$ - There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in ABC Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- $H_{0_{11}}$ - There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- $H_{0_{12}}$ - There is no significant difference between the pre-test and post-test difference scores on the science attitude survey of students enrolled in ABC Biology I and students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- $H_{0_{13}}$ - There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in ABC Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.

- Ho₁₄- There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₁₅- There is no significant difference between the pre-test and post-test difference scores on the science attitude survey of students enrolled in ABC Biology I and students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₁₆- There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in ABC Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₁₇- There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in traditional Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₁₈- There is no significant difference between the pre-test and post-test difference scores on the science attitude survey of students enrolled in ABC Biology I and students enrolled in traditional Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.

Definitions

Applied Biology Curriculum

The ABC curriculum consisted of materials developed at the Center for Occupational Research and Development (CORD) in Waco, Texas. Instructional materials included printed text, true story scenarios, career profiles, realistic role play situations, instructional videos, practical laboratory exercises and vocabulary worksheets.

Cooperative Learning Method

Cooperative learning is students working together toward a common goal, with all group members succeeding or failing as a unit. It has positive interdependence and individual accountability (Sharan, 1990). This method utilizes a variety of instructional methods focusing on student groups and student and teacher interaction. Teachers utilizing this method are interested in conveying material and enhancing interpersonal communication skills.

Metropolitan Schools

Metropolitan schools refers to those schools located in direct proximity to an urban area with a population of greater than 25,000 (Mosley, 1993).

Rural Schools

Rural schools refer to schools located in a community with a population of less than 25,000 (Mosley, 1993).

Traditional Biology Curriculum

The traditional curriculum approach involved the use of state adopted textbooks, lab manuals, and study guides which principally focus on theoretical biological concepts. Instructional methods most often the use of modified lecture and teacher demonstration. Student activities usually include completing activities in lab manuals and study guides.

Traditional Teaching Method

The traditional teaching method is typified by theory based presentation of curriculum primarily using lecture as the teaching method of instruction. Teachers utilizing this method are most concerned with disseminating the subject matter contained in the units of instruction within the curriculum.

Assumptions

1. It was assumed that students performed to the best of their abilities on the pre-test and post-test of the NABT/NSTA biology test.
2. It was assumed that students responded honestly on the pre-test and post-test on the science attitude survey.

Limitation

Randomization of students between the two curricula within each school was not possible. Intact classes which had been pre-assigned to ABC or traditional biology

curricula had to be utilized. Furthermore, it was not possible to control for teacher differences in this study.

Scope

The scope of the study consisted of students enrolled in either a traditional biology course or an ABC biology course at four Oklahoma high schools. Three of the locations were in metropolitan areas and the other was in an area classified as rural.

Chapter II

Review of Literature

The purpose of this chapter is to provide an overview of the available literature in science education as it pertains to the objectives of the Applied Biology/Chemistry curriculum. This study is a continuation of research efforts directed toward evaluating the ABC curriculum. Therefore, this exploration of relevant literature principally addresses writings not available or not extensively considered by previous researchers in this area. A compilation of books, professional journals, government documents and magazines has been obtained to give a broad representation of the review of literature for this study. Chapter II has been divided into the following sections: 1) Introduction, 2) Applied Basic Science Courses, 3) Cooperative Learning, 4) The Nature of Effective Instruction, 5) Attitudes Toward Science, 6) Related Research and 7) Summary.

Introduction

The teaching of science is in need of reforms which will increase the relationship of education to the economic viability of the United States. At present, high school students are not being offered the type of scientific methodologies applicable to everyday life. This problem spans from the intense teaching of abstractions and terminology, extended monologic expositions of the topic, at the beginning of science courses with little or no

effort to introduce practical experience (Aldridge, 1991). This leaves little or no provision for students to contribute their interpretations and reformulations as well as other expertise they may possess (Sharan, 1990.)

Without education in the sciences, the United States will not be able to produce the human resources needed for the twenty-first century and competitive nations, such as Japan and the European Community, will overtake the U.S. resource market (Aldridge, 1991). The alarm, caused by inadequate training of our youth in the sciences, is due to the increase in the number of information-based jobs. Since innovation requires knowledge in the workplace, there is an increasing need for improvement in the management of science and technology.

The emphasis on basic work skills has been an issue studied by educational reformists. The National Secondary Vocational Education Commission (1984) believed students must be more proficient in the basic academic subjects. One way this was made possible was by placing more emphasis on the relevance of the subject matter being taught. This concept, used in vocational education, along with the idea of applied learning has been adopted by many in the educational field.

According to the U.S. Department of Education (1992), approximately 30 percent of secondary students leave school before graduating, depriving the nation of technically trained personnel for the workforce. Therefore, applied academics is a vital component of educational reform in this decade. Business and industry recognize the need for workers who have received the academic basics.

Kolde (1991) noted it is not enough that a person have a cognitive knowledge of science and technology; they must have affective and psychomotor skills related to the area of study inherent to the skills needed for the job being performed. Vocational education has been an integral part of meeting the specific occupational needs of students, but now the need arises for academic basics in the preparation student for the workforce.

Applied Basic Science Courses

Our educational strategies must be re-evaluated to prepare students for the information age (St. Armand, 1992). The old methods of abstractions and terminology may not be the best choices for students in today's classroom. Face-to-face interaction and critical thinking skills are essential teaching methods in the application of scientific methodology. This shift in curriculum philosophy from essentialist to experimentalist is the first step in making academic basics more relevant to the students assuming productive roles in today's rapidly changing society (Dobson, Dobson and Koetting, 1985).

Applied academic curriculum was established principally to serve general education students who do not initially plan to pursue a four-year college degree. That is to say, most of these students will find jobs in the workforce immediately following high school, or they may continue their education in a two-year post-secondary program.

These students have a greater need for direct application of science and technology rather than the basic theoretical foundation of scientific knowledge. This is due to the demand for a working knowledge in real-life situations of those students who do not plan to pursue a degree at a four-year institution of higher education. Parnell (1992) noted:

When will we learn in this country that we must meet the educational needs of the neglected majority of high schools students- 75 percent in most places- who are not likely to earn a college degree? If the sole purpose of education is to prepare students and graduate studies, our educational system is a failure by design, leaving the majority of students unprepared for the jobs of the future or even the next step in education (p.24).

The learning needs of these students are best met by courses emphasizing applications of abstract concepts to real-world situations which involve them in hands-on learning. Application relevant to life and work and hands-on learning are the fundamental principals that guided the design and development of the ABC curriculum (CORD, 1991). In-depth studies expect to show students will gain a greater appreciation for science and technology while acquiring skills that will help them gain a better working knowledge for entry into today's workforce.

Applied curriculum seeks to enhance the learning and retention of scientific and technological information, while serving as a way for students to develop an appreciation for the workings of the scientific and natural world. Applied curriculum is taught in a way which emphasizes the use of real-life examples of and activities to help teachers instill a more positive attitude about science in secondary students.

The problem with developing a more positive attitude toward science on the part of students starts with teachers. Many high school teachers have only been educated in one science field. Others lack any formal preparation in scientific instruction. They do not understand the difference between teaching science as a reading and lecturing course and

the real understanding that comes from hands-on experience with scientific phenomena (Aldridge, 1991).

Hands-on experience will provide students with direct, concrete experience with science phenomena, instead of the abstractions and terminology commonly used in science courses. Once an appreciation for the subject has been established, creativity on the part of the students and teacher can flow with ease (Rubin, 1985).

The other aim of applied curriculum is to retain students and develop greater self-esteem through positive learning experiences. When students increase their self-esteem, they work harder toward their goals and schools have a decrease in dropout rates (Musko, 1992). Franz (1979) stated:

If unmotivated students come to feel they are learning something useful, I believe, then those students will stop fighting the system. They may then surprise their teachers with the energy and enthusiasm they bring to science; they may even surprise themselves by succeeding in an academic course (p.36).

The concept of applied learning has been used in vocational education since its inception. The results have been favorable, especially in the development of "Tech Prep." This model intertwines both the academic and vocational subjects in applied learning. Many educators believe the move toward a more applied approach is a direct result of the implementation of the tech prep model.

In order to create an educated citizenry, through the use of applied academic curriculum, the tech prep model is one that may well be both effective and efficient for

academic programs. The key to success is getting academic and vocational faculties to cooperate (Coorough, 1992).

Cooperative Learning

Cooperative learning is students working together toward a common goal, with all group members succeeding or failing as a unit. It has positive interdependence and individual accountability (Sharan, 1990). It has proven to be complimentary to the various aspects of the applied scientific curriculum. This research utilized the cooperative learning method for the ABC curriculum taught at Oklahoma high schools. The ABC curriculum lends itself more openly to the use of creative learning environments such as cooperative learning than the traditional curriculum model.

Rottier and Ogan (1991) contended cooperative learning promotes the use of basic learning skills on material. They noted that it also promotes: 1) higher achievement- especially in average to below average students, 2) greater use of reasoning strategies and improves students' ability to problem solve due to social interaction, 3) positive relationships between students, 4) more positive attitude toward subject matter due to the reduced frustration which builds a more positive learning experience and 5) higher self-esteem through positive interaction with fellow students.

Cooperative learning involves seven basic components, including face-to-face interaction, evaluation, individual accountability, group cohesion, social skill development, monitoring and processing. It has been demonstrated that groups consisting of high and low achievers; males and females; and students of different ages, races, social, economic

and ethnic backgrounds can work together effectively and experience significant increases in reading and learning (Flood, 1980; Graves and Graves, 1983; and Slavin, 1985).

This approach of using cooperative learning with applied learning is well suited to the ABC curriculum since group projects are the most prevalent aspects of both methods. For example, students in ABC classes at a rural high school were given various group research assignments which were to be presented in class. The presenters of each group project were given constructive critiques. Interaction from these group activities continued in the hallways, parking lots and school cafeterias (Roy, Laurie and Brown, 1983).

This is similar to the Jigsaw I method of cooperative learning in which each student in a five to six member team is given unique information on a topic that the whole group is studying (Aronson, 1978). After reading their sections, the students meet in “expert groups” with counterparts from other groups to discuss the information. They then return to their respective groups and teach their teammates what they have learned. At the end the group is tested for individual accomplishment.

In a kindred approach, Jigsaw II, students are assigned to four to five member teams. They read narrative materials and each team member is given a specific topic to study. The students discuss their topics in “expert groups”. Then, they return to their teammates to teach the information. Finally, the students are quizzed to determine both individual and group achievement.

Jigsaw I and II differ on one critical dimension: positive interdependence in the within-team task structure. Students in Jigsaw II do not necessarily have to depend on

each other to do well. It is possible their attitudes towards each other and toward the need for cooperation are quite different compared to those in Jigsaw I, in which true interdependence occurs due to the task structure (Slavin, Sharan, Kagan, Hertz-Lazarowitz, Webb and Schmuck, 1985).

The Nature of Effective Instruction

The nature of effective instruction has been defined as a science implemented that is by artists (Kindsvatter, 1988). With its readily identified and easily understood concepts, the scientific aspect of instruction naturally receives the most attention from educational writers and researchers. It is not a difficult endeavor to find an array of books, journals and magazines dedicated to addressing the technical principles and practices utilized in successful instruction. However, those elements of quality teaching identified as artistry are much more ambiguous and extend beyond society's ability to adequately analyze or even fully recognize. For this reason, teaching must be considered a complex behavior. Any attempt to interpret it in simple analytical terms would lead to a distorted perception.

It is comforting to note that many of the studies undertaken to identify key components of superior instruction have produced similar results (Levin and Long, 1981). This consistency allows for the identification of certain variables that, when successfully practiced will enhance a teacher's ability to provide effective instruction (Pellicer, 1984). The parallelism also lends credibility to the belief that teaching can be a learned behavior. Undoubtedly, there are some teachers who can rely almost exclusively on instinct to guide

their instructional efforts. But, those not blessed with natural artistic ability can also develop great skill through dedicated study and practice.

Pellicer (1984) reported on the Beginning Teacher Evaluation Study (BTES) which was conducted by the California Commission for Teacher preparation and Licensing, with support from the National Institute for Education. Many conclusions were drawn from this six-year study, but the most important related to the identification of five variables which significantly influenced the success of teaching efforts. These components were listed as diagnosis, prescription, presentation, monitoring and feedback. Each of these variables are explained below.

- 1) diagnosis- founded on the assumption that the quality of teaching is dependent on the quality of the decision making process that precedes teaching. It focuses on the issue of what to teach and requires that the instructor has a comprehensive knowledge of the course content area.
- 2) prescription- relates to the identification of learning objectives in accordance to desired educational outcomes. The process concludes with the formulation of a plan of study or lesson plan which answers the question of how the material will be taught.
- 3) presentation- refers to the implementation of the plan of study or lesson plan.
- 4) monitoring- involves the use of formal and informal methods of evaluating student progress toward mastering educational objectives.

Testing is the most common formal monitoring method, while questioning is the typical informal approach.

5) feedback- provides a response to students in relation to the efforts to meet specific objectives. This element is often the most consistent and direct positive influence on student achievement.

The BTES focuses on identifying a systematic instructional approach for effective teaching. A teacher who is attuned to this type of scientific system can undeniably produce an environment conducive to student achievement. However, pupil success should not be the sole criteria for to judge the goodness or effectiveness of instruction. For example, a teacher may produce substantial educational gains but use an authoritative classroom management which may frighten or alienate students. Although some may argue that such a teacher is effective, few would consider this teacher to be good. Therefore, any attempt to explain the concept of quality instruction must consider both achievement of education objectives and the presence of positive learning environment. This latter characteristic is best developed by the use of a teacher's artistic abilities (Brophy and Evertson, 1976).

It should be the effort should be the effort of all teachers to provide an educational atmosphere that is enjoyable to all students. The most important aspect of creating a suitable environment is that the educational methods utilized be flexible for adaptation to unexpected opportunity (Rubin, 1985). Next, the artistic effective develops an individualized format for specific classes and students (Kourilsky, 1987). This personalization of instruction fosters increased student participation. Bloom (1976) also

indicated that the most successful teachers were quick to use and recognize classroom cues. Cues are defined as communicative efforts which indicate progress toward reaching an educational objective. In practice, teachers use cues to highlight important ideas or facts, while students' questions and comments provide teachers cues in relation to student understanding. Finally, the artistic teacher provides students an opportunity to internalize instruction through creative efforts (Labonty and Danielson, 1988). Vocational education's efforts to provide hands-on experience is an excellent example of this type of exceptional instruction.

In the final analysis, quality instruction is a person invention. The observation has also been made that excellent teachers tend to more diverse among themselves, while mediocre teachers tend to be more alike (Kindsvatter, 1988). Indeed, volumes have been written in attempting to qualify the concept of effective instruction. However, the only safe assumption is that quality instruction is both a science and an art.

Attitudes Toward Science

Numerous research efforts have indicated a positive relationship between attitude toward science and performance in science courses (Hounshell and Hill, 1989). And, since course performance is directly related to subject knowledge, a positive attitude toward science is reflective of a knowledgeable student. Therefore, assessment of student attitude is of importance in gauging the effectiveness of science curricula.

A scientific attitude may be defined as an opinion or position taken with respect to a psychological object in the field of science (Moore and Sutman, 1970). It is important

to note that many such objects exist in science. With this in mind, any instrument used to assess a student's attitude toward science must be broad in nature.

The instrument used in this study ascribes to these aforementioned parameters. Specifically, the survey has four characteristics: 1) preparation based upon specification of the particular attitude to be assessed; 2) use of several items to assess each attitude; 3) provision for the respondent to indicate the extent of acceptance or rejection of an attitude statement; and 4) concern with the intellectual and emotional attitudes.

Related Research

This section of the review of literature provides an overview of research studies related to applied academic curricula. Specifically, three comprehensive studies relating to this research effort are outlined in the following text.

Dugger and Johnson (1989) conducted a staff study at Iowa State University of the Principles of Technology (PT) curriculum. This curriculum, developed by CORD, is designed to teach basic physics concepts through an applied approach. It consists of fourteen instructional units which focus on basic physics topics such as force, work, rate, resistance, energy and power. Each unit addresses the mechanical, fluid, electrical, and thermal aspects of the aforementioned topic areas.

This two year study compared student performance in traditional physics classes with that of students enrolled in PT courses. The study encompassed 675 students in fifteen Iowa school districts. The research effort analyzed the students' gain scores on a standardized examination given as a pre-test and post-test to each course. In essence, the

study revealed that students enrolled in the PT course posted gain scores that were, on average, 141 percent higher than those students enrolled in traditional chemistry.

Another study conducted at Auburn University (Baker, Wilmoth, and Lewis, 1990) compared eight pilot PT classes with eighteen randomly selected traditional physics classes in Alabama. The study encompassed a total of 532 students with 226 enrolled in PT and 306 receiving traditional instruction. Based on the findings of the study, it was concluded that the PT course was equivalent to the traditional physics approach in terms of student achievement.

Christian (1993) did a study similar to the Iowa and Auburn research in Oklahoma. He, too, found no significant difference between the applied (PT) instructional approach and the traditional methods of teaching physics. The greatest conclusion from the data was that the applied curriculum seized a student clientele who otherwise would not have taken a course in physics; and these students achieved learning of physics fundamentals approximately equal to students provided traditional physics instruction.

In a pilot study which compared traditional biology to the ABC curriculum, Beadles (1992) found no significant differences in terms student achievement or attitude when comparing the applied ABC curriculum with the traditional biology curriculum. He concluded that the use of the ABC curriculum had neither a positive or negative effect on the amount of biology learned or on attitude toward science by students when compared to their traditional peers. Furthermore, he recommended that the ABC curriculum be accepted as an equivalent substitute for traditional biology in meeting high school graduation and college entrance requirements.

A study conducted by Key and Lee-Cooper (1994) also focused on comparing the traditional biology curriculum and the ABC curriculum in Oklahoma high schools. They found no significant differences between the curricula in terms of student achievement and attitude. The principal recommendation from this study was that administrators consider the needs of students, teachers, and society when determining curriculum needs for their schools.

Miles-Wilson (1994) conducted another study to ascertain differences between the traditional biology curriculum and the ABC curriculum. She found that there was some evidence to support the hypothesis that the achievement of students enrolled in a course using the ABC curriculum was significantly higher than those students enrolled in a traditional biology course. Furthermore, the ABC students possessed significantly higher attitudes toward science and the environment than their traditional counterparts.

MPR Associates Incorporated (1994) studied students enrolled in ABC biology and traditional biology in two metropolitan high schools and a rural high school in Oklahoma. This private consulting firm assessed the same students in three of the four high schools analyzed in this study. However, the statistical techniques and measurement instruments employed had some variation to those used in this research effort. Overall, they found no significant difference between the ABC students and the traditional biology students in terms academic achievement. But, when comparing students who previously performed in the bottom half of their peer group in math and reading, the ABC biology students actually had significantly higher academic achievement than their traditional biology counterparts.

Summary

Applied academics allows students to better realize the relevance of their academic endeavors. This fact typically translates into greater subject matter interest on the part of students. Therefore, students are likely to learn more in applied academic courses and be more apt to pursue continually higher levels of education (Musko, 1992).

Cooperative learning also plays a role in enhancing learning and capturing student interest. James (1989) stated:

Cooperative learning places the responsibility for learning where it belongs—on the students. Cooperative learning increases achievement and improves students' attitude toward school, learning and classmates. Cooperative learning makes teaching and learning more fun (p. 89).

When applied and cooperative techniques are coupled together by an effective, artistic teacher, positive results have undeniably occurred. Formal research studies have shown greater or equivalent achievement of students in applied academic courses as compared to those students in traditional courses. It is evident that applied academic coursework utilizing cooperative components is a viable alternative to the traditional curriculum.

Chapter III

Design and Methodology

Purpose

The purpose of this study was to compare the Applied Biology/Chemistry (ABC) curriculum taught using the cooperative learning method with the traditional biology curriculum taught using more typical instruction by means of student scores on a standardized biology test and science attitude survey.

Objectives

Six objectives were established in efforts to achieve the purpose of the study.

The objectives of this study were:

1. To compare pre-test and post-test scores on the National Association of Biology Teachers/National Science Teachers Association (NABT/NSTA) biology test of those students taught the ABC curriculum using the cooperative learning method in selected Oklahoma schools.
2. To compare pre-test and post-test scores on the NABT/NSTA biology test of those students taught the traditional biology curriculum using typical teaching methods in selected Oklahoma schools.

3. To compare pre-test and post-test difference scores on the NABT/NSTA biology test of those students taught the ABC curriculum using the cooperative learning method with those taught the traditional biology curriculum using typical teaching methods in selected Oklahoma schools.
4. To compare pre-test and post-test scores on the science attitude survey of those students taught the ABC curriculum using the cooperative learning method in selected Oklahoma schools.
5. To compare pre-test and post-test scores on the science attitude survey of those students taught the traditional biology curriculum using typical teaching methods in selected Oklahoma schools.
6. To compare pre-test and post-test scores on the science attitude survey of those students taught the ABC curriculum using the cooperative learning method with those taught the traditional biology curriculum using typical teaching methods in selected Oklahoma schools.

Hypotheses

Listed below are the hypotheses which were constructed to achieve the objectives of the study. Hypotheses are categorized by related assessment instrument.

NABT/NSTA Biology Test Hypotheses

- H_{01} - There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in ABC Biology I at the First

Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.

- H_{0_2} - There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- H_{0_3} - There is no significant difference between the pre-test and post-test difference scores on the NABT/NSTA biology test of students enrolled in ABC Biology I and students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- H_{0_4} - There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in ABC Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- H_{0_5} - There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- H_{0_6} - There is no significant difference between the pre-test and post-test difference scores on the NABT/NSTA biology test of students enrolled in ABC Biology I and students enrolled in traditional Biology I at the First Metropolitan High School, the

Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.

- Ho₇- There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in ABC Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₈- There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in traditional Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₉- There is no significant difference between the pre-test and post-test difference scores on the NABT/NSTA biology test of students enrolled in ABC Biology I and students enrolled in traditional Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.

Science Attitude Survey Hypotheses

- Ho₁₀- There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in ABC Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.

- H_{011} - There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- H_{012} - There is no significant difference between the pre-test and post-test difference scores on the science attitude survey of students enrolled in ABC Biology I and students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- H_{013} - There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in ABC Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- H_{014} - There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- H_{015} - There is no significant difference between the pre-test and post-test difference scores on the science attitude survey of students enrolled in ABC Biology I and students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.

- $H_{0,16}$ - There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in ABC Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- $H_{0,17}$ - There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in traditional Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- $H_{0,18}$ - There is no significant difference between the pre-test and post-test difference scores on the science attitude survey of students enrolled in ABC Biology I and students enrolled in traditional Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.

Hypothesis Testing

A t-test analysis was used to determine whether significant differences existed for each of the null hypotheses. An alpha level of $\alpha = .05$ was used to determine statistical significance. The use of t-tests was explained by Popham (1973) as follows:

The t-test is used to determine just how great the difference between two means must be for it to be judged significant, that is, a significant departure from differences, which might be expected from chance alone.

Another way of stating the function of the t-test is to assert that, through

its use, we test the null hypothesis that two group means are not significantly different, that is, the means are so similar that the same groups can be considered to have been drawn from the same population (pp. 124-125).

All data were analyzed by the researcher using Microsoft Excel for Windows 5.0. Specifically, the t-tests were conducted using the t-test for two samples assuming unequal variances contained in the Analysis Tools of the spreadsheet program. Raw scores, means, and standard deviations are also presented in the analysis.

In addition to the methods previously described, covariance and regression analyses were conducted. However, the secondary data employed to calculate these analyses were incomplete. Therefore, the results of such analyses were no benefit in addressing the objectives or hypotheses of this study. For this reason, the covariance and regression analyses are not presented in the findings of the study.

Institutional Review Board

Federal regulations and Oklahoma State University policy require review and approval of all research studies that involve human subjects before investigators can initiate their research. The Office of University Research at Oklahoma State University and the Institutional Review Board conduct the aforementioned review to protect the rights and welfare of human subjects involved in biomedical and behavioral research. In compliance with this policy, this study received the proper surveillance and was granted permission to continue. The Institutional Review Board approval code was AG-95-007.

Scope

The scope of the study consisted of students enrolled in either a traditional biology course or an ABC biology course at four Oklahoma high schools. Three of the locations were in metropolitan areas and the other was in an area classified as rural. The first metropolitan school had a total of 79 and 77 traditional students record scores on the NABT/NSTA biology test and the science attitude survey, respectively. In contrast, the ABC biology students posted 93 NABT/NSTA biology test scores and 92 science attitude survey scores. At the second metropolitan school, the ABC students had 54 scores on the NABT/NSTA biology test and 53 scores on the science attitude survey. In contrast, 65 traditional biology scores were recorded for both the test and the survey. The third metropolitan school had a total of 32 and 31 traditional biology scores on the NABT/NSTA biology test and science attitude survey, respectively. In contrast, there were 23 ABC biology scores for both instruments. At the rural school, ABC biology scores were collected from 20 students on the NABT/NSTA biology test and the science attitude survey. In contrast, traditional biology scores were garnered from 16 students on the NABT/NSTA biology test and from 15 students on the science attitude survey.

Measurement Instruments

The 1990 version of the National Association of Biology Teachers/National Science Teachers Association (NABT/NSTA) Biology examination was used as a pre-test and post-test for all biology students. The test was composed by the High School Biology Examination Development Committee of the (NABT/NSTA). This committee has eight

members of equal gender distribution representing all geographic regions of the United States. The examination was developed to ascertain skills and understanding in eight science areas: 1) bioenergetics, 2) genetics, 3) ecology, 4) behavior, 5) STS (Science, Technology and Society), 6) systems and 7) technology. It was normed on 889 students with a mean of 45.092, standard deviation of 13.771 and a standard error of .462.

The science attitude survey uses responses to 20 statements to accomplish its purpose. It was focused toward determining biology attitude. Students could either strongly agree, agree, neither agree or disagree, disagree or strongly disagree to each of the statements. Constant increment point values were assigned to each possible response. Values from question to question were consistent. Thirteen of the items were positive attitude statements; seven were negative attitude statements. On the negative attitude items, the point values were reversed. Higher scores were associated with a more positive attitude. The instrument was administered as a pre-test and post-test to all biology students.

Measurement Procedures

The pre-tests were administered to students within the first four weeks of the 1993-94 academic year. One of two versions of the NABT/NSTA biology test, differing in only in item order, was randomly administered to each student. All of the science attitude surveys were identical in content and form. Both the ABC and traditional students were provided identical instructions. During the last three weeks of the school year, the post-tests were given. The alternative version of the achievement test was given to each student.

Course Content

ABC Curriculum

Table I outlines the units of instruction taught in the ABC biology curriculum area for each school. The following information related to the content areas is provided:

1) time taught in weeks, 2) number of labs, 3) time in lab in percent and 4) number of activities.

At the first metropolitan school, five content areas covered were 1) Disease and Wellness, 2) Animal Life Processes, 3) Continuity of Life, 4) Natural Resources and 5) Taxonomy. Time dedicated to each topic ranged from nine to four weeks. During the school year, there were 28 labs which occupied 34 percent of the instructional time. A total of 101 activities were incorporated into the instructional program.

The second metropolitan school covered the following content areas: 1) Natural Resources, 2) Disease and Wellness, 3) Continuity of Life, 4) Plant Growth and 5) Nutrition. Time spent teaching each topic varied from nine to four weeks. Lab exercises totaled 20 with 31 percent of instructional time devoted to them. A total of 62 activities were provided.

Students were taught the following curriculum units at the third metropolitan school: 1) Natural Resources, 2) Water, 3) Air and Gases, 4) Continuity of Life, 5) Nutrition, and 6) Disease and Wellness. Instructional time used teaching each unit spanned from six to four weeks. A total of 27 labs were taught with 50 percent of

TABLE I

UNITS OF INSTRUCTION TAUGHT AND RELATED PERTINENT STATISTICS IN
THE ABC BIOLOGY CURRICULUM AREA FOR ALL SCHOOLS

Unit of Instruction	Time Taught (Weeks)	Number of Labs	Time in Lab (Percent)	Number of Activities
First Metropolitan School				
Disease and Wellness	8	6	40	24
Animal Life Processes	9	5	32	22
Continuity of Life	6	5	45	25
Natural Resources	5	8	30	20
Taxonomy	4	4	25	10
Total	32	28	34.4	101
Second Metropolitan School				
Natural Resources	6	4	30	12
Disease and Wellness	9	6	40	15
Continuity of Life	9	6	45	17
Plant Growth	4	2	25	10
Nutrition	4	2	20	8
Total	32	20	31	62
Third Metropolitan School				
Natural Resources	6	7	60	30
Water	6	2	50	2
Air and Gases	4	2	40	2
Continuity of Life	6	5	45	11
Nutrition	6	6	60	11
Disease and Wellness	4	5	50	11
Total	32	27	50	67
Rural School				
Natural Resources	10	4	24	27
Plant Growth and Reproduction	13	6	40	32
Disease and Wellness	9	5	35	22
Total	32	15	33	81

teaching time dedicated to them. The students participated in a total of 67 instructional activities.

The rural students participated in the following content areas: 1) Natural Resources, 2) Plant Growth and Reproduction and 3) Disease and Wellness. The instructional time spent on each topic ranged from thirteen to nine weeks. A total of 15 labs were provided which encompassed 33 percent of the instructional time. Students were provided a sum of 81 instructional activities.

Traditional Biology Curriculum

Table II outlines the units of instruction taught in the ABC biology curriculum area for each school. The following information related to the content areas is provided: 1) time taught in weeks, 2) number of labs, 3) time in lab in percent and 4) number of activities.

At the first metropolitan school, five content areas covered were 1) Biological Principles, 2) Biochemistry, 3) Cell Structure, 4) Genetics and 5) Human Body Genetics. Time dedicated to each topic ranged from eight to four weeks. During the school year, there were 18 labs which occupied 10 percent of the instructional time. There were no activities incorporated into the instructional program.

The second metropolitan school covered the following content areas: 1) Biological Principles, 2) Cell Structure, 3) Genetics, 4) Human Body Systems, 5) Biochemistry and 6) Taxonomy. Time spent teaching each topic varied from eight to three weeks. Lab exercises totaled 15 with 10 percent of instructional time devoted to them. No supplemental activities were provided.

TABLE II

UNITS OF INSTRUCTION TAUGHT AND RELATED PERTINENT STATISTICS IN
THE TRADITIONAL BIOLOGY CURRICULUM AREA FOR ALL SCHOOLS

Unit of Instruction	Time Taught (Weeks)	Number of Labs	Time in Lab (Percent)	Number of Activities
First Metropolitan School				
Biological Principles	6	4	13	0
Biochemistry	4	3	15	0
Cell Structure	6	4	13	0
Genetics	8	3	8	0
Human Body Systems	8	4	10	0
Total	32	18	10	0
Second Metropolitan School				
Biological Principles	5	2	8	0
Cell Structure	6	3	10	0
Genetics	6	3	10	0
Human Body Systems	8	3	6	0
Biochemistry	3	2	13	0
Taxonomy	4	2	10	0
Total	32	15	10	0
Third Metropolitan School				
Cell Theory	6	7	23	0
Energy	6	4	13	0
Evolution	2	3	21	0
Genetics	4	6	30	0
Ecology	2	7	50	0
Behaviors	2	2	14	0
Systems	7	9	25	0
Taxonomy	3	5	33	0
Total	32	43	26	0
Rural School				
Cell Theory	6	3	10	0
Energy	4	2	10	0
Evolution	2	0	0	0
Genetics	6	3	1	0
Ecology	2	1	7	0
Systems	8	5	13	0
Taxonomy	4	2	10	0
Total	32	16	9	0

Students were taught the following curriculum units at the third metropolitan school: 1) Cell Theory, 2) Energy, 3) Evolution, 4) Genetics, 5) Ecology, 6) Behaviors, 7) Systems and 8) Taxonomy. Instructional time used teaching each unit spanned from seven to two weeks. A total of 43 labs were taught with 26 percent of teaching time dedicated to them. The students participated in no additional instructional activities.

The rural students participated in the following content areas: 1) Cell Theory, 2) Energy, 3) Evolution, 4) Genetics, 5) Ecology, 6) Systems and 7) Taxonomy. The instructional time spent on each topic ranged from eight to two weeks. A total of 16 labs were provided which encompassed 9 percent of the instructional time. No additional instructional activities were provided.

Chapter IV

Analysis of Data

The purpose of this study was to compare the Applied Biology/Chemistry curriculum with the traditional biology curriculum by analyzing scores of students on a standardized biology test and an attitude toward science survey. The following chapter is included to present the data collected relative to the objectives of the study.

Findings of the Study

Standardized Biology Test Data

Table III illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled in section I of ABC biology and traditional biology at the first metropolitan school. The twenty ABC curriculum scores on the pre-test ranged from a high of 33 to a low of 12 with a mean of 24.95. On the post-test, ABC students posted a high score of 55 and a low score of 18 with a mean of 31.40. By contrast, the nine traditional biology students had a pre-test average of 26.89 with individual scores ranging from 40 to 17. The traditional biology students established a two point mean advantage on the pre-test as compared to the ABC students. On the post-test, traditional students scored from 47 to 16 with a mean score of 28.78. Interestingly, the ABC biology students rebounded to average over two points

TABLE III

DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE NABT/NSTA TEST FOR SECTION I ABC BIOLOGY
STUDENTS AND SECTION I TRADITIONAL BIOLOGY STUDENTS
AT THE FIRST METROPOLITAN HIGH SCHOOL

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	31	30	-1	1	28	18	-10
2	18	30	12	2	40	47	7
3	20	20	0	3	17	24	7
4	27	33	6	4	22	29	7
5	22	30	8	5	33	42	9
6	26	25	-1	6	21	24	3
7	28	55	27	7	30	16	-14
8	22	28	6	8	33	32	-1
9	12	24	12	9	18	27	9
10	28	39	11				
11	27	35	8				
12	30	27	-3				
13	27	23	-4				
14	17	24	7				
15	27	48	21				
16	32	40	8				
17	29	34	5				
18	21	18	-3				
19	33	36	3				
20	22	29	7				
Mean	24.95	31.40	6.45	Mean	26.89	28.78	1.89
S.D.	5.50	9.12	7.88	S.D.	7.85	10.28	8.54
Pre-Test versus Post-Test $t = 3.66$ $p < .00$				Pre-Test versus Post-Test $t = 0.66$ $p < .53$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 1.36$ $p < .19$							

higher than the traditional students on the post-test. Overall, the ABC students had a difference score of 6.45 and the traditional students had a difference score of 1.89. Only the ABC students recorded a significant gain in score at the $\alpha = .05$ level of significance. However, it should be noted that two severely negative difference scores skewed that traditional curriculum data. Finally, no significant difference between the groups was discovered at the $\alpha = .05$ level of significance.

Table IV illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled in section II of ABC biology and traditional biology at the first metropolitan school. The fifteen ABC students had a pre-test average of 25.13 and a post-test average of 28.53 for a difference average of 3.40. ABC pre-test performance ranged from 39 to 12 and post-test scores varied from 45 to 11. Six of the ABC students recorded a decrease in performance on the test. Difference scores ranged from 23 to -9. Traditional students only increased scores by an average of 0.70 as eight students declined in achievement. The traditional curriculum pre-test average was 21.80 for twenty students with scores ranging from 31 to 14. On the post-test, the high score was 40 and the low score was 9 with an average of 22.50. Difference scores ranged from a high of 24 to a low of -17. Overall, there were no significant differences in pre-test and post-test performance for either group, nor was there a difference in achievement between groups at the $\alpha = .05$ level of significance.

Table V illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled in section III of ABC biology and traditional biology at the first metropolitan school. ABC students posted a

TABLE IV

**DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE NABT/NSTA TEST FOR SECTION II ABC BIOLOGY
STUDENTS AND SECTION II TRADITIONAL BIOLOGY STUDENTS
AT THE FIRST METROPOLITAN HIGH SCHOOL**

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	27	39	12	1	28	28	0
2	18	23	5	2	21	24	3
3	22	45	23	3	26	9	-17
4	19	17	-2	4	22	27	5
5	32	40	8	5	20	37	17
6	31	35	4	6	21	16	-5
7	35	35	0	7	21	25	4
8	12	22	10	8	18	20	2
9	24	23	-1	9	31	33	2
10	26	34	8	10	17	16	-1
11	12	11	-1	11	24	17	-7
12	20	17	-3	12	28	21	-7
13	39	30	-9	13	14	17	3
14	25	29	4	14	16	40	24
15	35	28	-7	15	17	12	-5
				16	25	21	-4
				17	14	14	0
				18	28	36	8
				19	28	16	-12
				20	17	21	4
Mean	25.13	28.53	3.40	Mean	21.80	22.50	0.70
S.D.	8.21	9.66	8.15	S.D.	5.21	8.68	9.18
Pre-Test versus Post-Test $t = 1.61$ $p < .13$				Pre-Test versus Post-Test $t = 0.34$ $p < .74$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 0.91$ $p < .37$							

TABLE V

DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE SCORES ON THE NABT/NSTA TEST FOR SECTION III ABC BIOLOGY STUDENTS AND SECTION III TRADITIONAL BIOLOGY STUDENTS AT THE FIRST METROPOLITAN HIGH SCHOOL

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	29	25	-4	1	31	21	-10
2	26	35	9	2	26	23	-3
3	13	15	2	3	27	27	0
4	14	30	16	4	32	35	3
5	26	25	-1	5	23	31	8
6	25	43	18	6	31	29	-2
7	29	40	11	7	7	28	21
8	39	38	-1	8	21	21	0
9	28	40	12	9	24	28	4
10	8	14	6	10	6	11	5
11	28	37	9	11	26	28	2
12	32	30	-2	12	19	12	-7
13	28	33	5	13	17	14	-3
14	27	26	-1	14	27	26	-1
15	17	19	2	15	26	31	5
16	25	12	-13	16	11	25	14
17	13	17	4	17	14	14	0
18	38	43	5				
19	32	41	9				
20	21	40	19				
21	25	35	10				
22	37	46	9				
23	17	14	-3				
Mean	25.09	30.35	5.26	Mean	21.64	23.76	2.12
S.D.	8.30	10.87	7.70	S.D.	8.15	7.23	7.40
Pre-Test versus Post-Test $t = 3.28$ $p < .00$				Pre-Test versus Post-Test $t = 1.18$ $p < .26$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 1.35$ $p < .20$							

twenty-three score average of 25.09 on the pre-test and 30.35 on the post-test which combine for a mean difference of 5.26. ABC pre-test scores ranged from a high of 39 to a low of 8 and post-test scores ranged from 46 to 12. Difference scores varied from a high of 19 to a low of -13. Sixteen students in the ABC group posted a positive difference score. Seventeen traditional biology students scored an average of 21.64 on the pre-test and 23.76 on the post-test for a mean difference score of 2.12. Pre-test scores for the traditional students ranged from 32 to 6 and post-test scores ranged from 35 to 11. In terms of difference scores, the high score was 21 and the low was -10. The ABC students had a significant increase in score at the $\alpha = .05$ level of significance. The traditional group failed to demonstrate an $\alpha = .05$ significant increase in score. However, there was no significant difference between the groups at the $\alpha = .05$ level of significance.

Table VI illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled in section IV of ABC biology and traditional biology at the first metropolitan school. Fifteen ABC curriculum students had a pre-test mean of 24.80 with a high score of 35 and a low score of 12. On the post-test, the ABC students had a high score of 49 and a low score of 15 with a mean of 29.13. In terms of differences, ABC scores ranged from 20 and -10 with a mean of 4.33. Twenty-one traditional students scored between 44 and 13 to compile a mean of 25.19 on the pre-test. Post-test results for the same group varied between 49 and 9 for a mean of 23.67. Examination of the pre-test and post-test means reveals a decline of 1.52 in student performance. Twelve traditional students posted negative difference scores with the lowest being a -20. Overall analysis indicates no significant difference at the $\alpha = .05$ level of significance between the pre-test and post-test scores for either group or for

TABLE VI

DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE NABT/NSTA TEST FOR SECTION IV ABC BIOLOGY
STUDENTS AND SECTION IV TRADITIONAL BIOLOGY STUDENTS
AT THE FIRST METROPOLITAN HIGH SCHOOL

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	12	30	18	1	23	15	-8
2	33	28	-5	2	22	9	-13
3	21	20	-1	3	32	27	-5
4	23	35	12	4	20	13	-7
5	33	23	-10	5	23	19	-4
6	18	17	-1	6	31	33	2
7	19	25	6	7	13	17	4
8	26	36	10	8	28	33	5
9	25	26	1	9	37	17	-20
10	29	49	20	10	20	18	-2
11	28	26	-2	11	22	27	5
12	20	15	-5	12	19	26	7
13	15	31	16	13	30	18	-12
14	35	38	3	14	14	24	10
15	35	38	3	15	15	24	9
				16	33	49	16
				17	26	25	-1
				18	20	23	3
				19	23	17	-6
				20	34	21	-13
				21	44	42	-2
Mean	24.80	29.13	4.33	Mean	25.19	23.67	-1.52
S.D.	7.33	9.04	9.08	S.D.	7.99	9.52	8.94
Pre-Test versus Post-Test $t = 1.85$ $p < .09$				Pre-Test versus Post-Test $t = 0.78$ $p < .44$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 1.92$ $p < .06$							

the group to group comparison.

Table VII illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled in section V of ABC biology and traditional biology at the first metropolitan school. The twenty ABC students averaged 22.00 on the pre-test and 30.00 on the post-test for a mean gain of 8.00 points. Scores ranged from 37 to 12 on the pre-test and from 45 to 17 on the post-test. Difference scores varied from 21 to 13 with only two students recording a performance decrease. Meanwhile, twelve traditional students had a pre-test mean of 20.08 and a post-test mean of 23.75 for an average difference score of 3.67. Pre-test scores ranged from 27 to 13 on the pre-test and from 33 to 15 on the post-test. Difference scores spanned from 12 to -4. Students in both curriculum groups recorded a significant increase in test score at the $\alpha = .05$ level of significance. In direct comparison, there was no $\alpha = .05$ level of significance difference.

Table VI illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled in section I of ABC biology and traditional biology at the second metropolitan school. The eight ABC students had a mean pre-test score of 21.50 and a mean post-test score of 24.00 which yielded an average difference score of 2.50. Scores ranged from 33 to 13 and from 45 to 9 on the pre-test and post-test, respectively. Difference scores spanned from 12 to -16 with three students recording a decrease in score. In contrast, six traditional students had scores ranging from 40 to 15 on the pre-test which combined for an average of 24.67. On the post-test, scores averaged 37.00 with a range from 47 to 22. The mean difference was a 12.33 with individual scores ranging from 28 to -1. It should be noted that the difference

TABLE VII

DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE NABT/NSTA TEST FOR SECTION V ABC BIOLOGY
STUDENTS AND SECTION V TRADITIONAL BIOLOGY STUDENTS
AT THE FIRST METROPOLITAN HIGH SCHOOL

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	16	24	8	1	22	22	0
2	25	38	13	2	21	33	12
3	27	30	3	3	23	22	-1
4	27	36	9	4	27	29	2
5	34	42	8	5	16	15	-1
6	18	25	7	6	24	20	-4
7	14	25	11	7	16	25	9
8	25	26	1	8	17	25	8
9	37	24	-13	9	13	20	7
10	25	44	19	10	26	27	1
11	21	40	19	11	22	24	2
12	12	30	18	12	14	23	9
13	14	21	7				
14	19	22	3				
15	28	20	-8				
16	25	39	14				
17	16	17	1				
18	16	28	12				
19	24	45	21				
20	17	24	7				
Mean	22.00	30.00	8.00	Mean	20.08	23.75	3.67
S.D.	6.81	8.70	8.72	S.D.	4.72	4.65	5.09
Pre-Test versus Post-Test $t = 4.10 \quad p < .00$				Pre-Test versus Post-Test $t = 2.50 \quad p < .03$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 1.77 \quad p < .09$							

TABLE VIII

**DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE NABT/NSTA TEST FOR SECTION I ABC BIOLOGY
STUDENTS AND SECTION I TRADITIONAL BIOLOGY STUDENTS
AT THE SECOND METROPOLITAN HIGH SCHOOL**

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	33	45	12	1	24	33	9
2	25	9	-16	2	40	47	7
3	18	22	4	3	23	22	-1
4	28	34	6	4	19	38	19
5	14	19	5	5	27	39	12
6	23	22	-1	6	15	43	28
7	18	29	11				
8	13	12	-1				
Mean	21.50	24.00	2.50	Mean	24.67	37.00	12.33
S.D.	6.99	11.76	8.86	S.D.	8.59	8.74	10.07
Pre-Test versus Post-Test $t = 0.80$ $p < .45$				Pre-Test versus Post-Test $t = 3.00$ $p < .03$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 1.90$ $p < .09$							

scores had a 10.07 standard deviation. The traditional students had a significant increase in test score at the $\alpha = .05$ level of significance, but the ABC students failed to exhibit a significant increase at that level. There was also no significant difference in student performance at the $\alpha = .05$ level of significance when the two groups were compared.

Table IX illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled in section II of ABC biology and traditional biology at the second metropolitan school. Four ABC students posted a 21.40 average on the pre-test with scores ranging from 22 to 14. Post-test results ranged from 41 to 16 and the mean was 31.40. The pre-test and post-test means combined to yield a difference mean of 10.00. The standard deviation for the difference scores was 14.85 with a span of 27 to -4. The fifteen traditional students had a pre-test and post-test average of 17.50 and 23.50, respectively. The pre-test scores varied from 29 to 14 and post-test results ranged from 47 to 10. The traditional students had a mean difference score of 6.00 with individual scores spanning from 31 to -12. In summary, both groups had relatively low pre-test standard deviations and relatively high post-test standard deviations. The only significant difference at the $\alpha = .05$ level of significance found was in terms of an increase in the traditional student performance on the post-test versus the pre-test. Although posting a higher mean difference score than the traditional students, the ABC students failed to record a corresponding significant increase at the $\alpha = .05$ level of significance due to smaller student numbers coupled with higher difference standard deviation.

TABLE IX

DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE NABT/NSTA TEST FOR SECTION II ABC BIOLOGY
STUDENTS AND SECTION II TRADITIONAL BIOLOGY STUDENTS
AT THE SECOND METROPOLITAN HIGH SCHOOL

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	14	20	6	1	15	16	1
2	22	17	-5	2	25	20	-5
3	14	41	27	3	20	31	11
4	20	16	-4	4	14	32	18
				5	25	40	15
				6	29	47	18
				7	29	40	11
				8	18	41	23
				9	27	58	31
				10	17	22	5
				11	23	25	2
				12	23	29	6
				13	15	23	8
				14	19	37	18
				15	22	10	-12
Mean	21.40	31.40	10.00	Mean	17.50	23.50	6.00
S.D.	4.12	11.79	14.85	S.D.	5.02	12.69	11.11
Pre-Test versus Post-Test $t = 0.81 \quad p < .48$				Pre-Test versus Post-Test $t = 3.49 \quad p < .00$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 0.50 \quad p < .65$							

Table X illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled in section III of ABC biology and traditional biology at the second metropolitan school. The fourteen ABC students recorded mean scores of 19.14 on the pre-test and 29.07 on the post-test for a average gain of 9.93. Pre-test scores ranged from 33 to 0 and post-test scores ranged from 36 to 20. Difference scores varied between 28 and -5. In the fifteen student traditional group, the pre-test scores ranged from 34 to 9 and averaged 19.33. Post-test results revealed a mean of 32.20 as scores ranged from 46 to 16. Traditional curriculum students increased performance by an average of 12.87 as variations in difference scores ranged from 30 to -3. Overall, only one student in each group decreased in performance on the test. And, both groups posted a significant increase in test score at the $\alpha = .05$ level of significance. Since group achievement was relatively equitable, no significant difference between groups was found at the $\alpha = .05$ level of significance.

Table XI illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled in section IV of ABC biology and traditional biology at the second metropolitan school. The fourteen ABC students averaged 25.86 on the pre-test and 26.50 on the post-test. ABC pre-test scores ranged from 37 to 16 on the pre-test and from 41 to 16 on the post-test. These students posted a 0.64 mean gain in score. Difference scores spanned from 9 to -10. In contrast, the sixteen traditional students scored an average of 22.13 on the pre-test, but gained a mean of 10.00 on the post-test. Traditional curriculum pre-test scores ranged from 38 to 11 and post-test scores varied from 57 to 14. Difference scores ranged an increase of

TABLE X

**DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE NABT/NSTA TEST FOR SECTION III ABC BIOLOGY
STUDENTS AND SECTION III TRADITIONAL BIOLOGY STUDENTS
AT THE SECOND METROPOLITAN HIGH SCHOOL**

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	9	20	11	1	14	24	10
2	27	32	5	2	19	26	7
3	11	24	13	3	26	31	5
4	15	34	19	4	14	40	26
5	24	36	12	5	24	37	13
6	22	35	13	6	23	46	23
7	22	35	13	7	11	35	24
8	27	29	2	8	18	33	15
9	10	22	12	9	34	35	1
10	21	24	3	10	13	43	30
11	25	20	-5	11	15	17	2
12	22	34	12	12	9	24	15
13	33	34	1	13	29	36	7
14	0	28	28	14	22	40	18
				15	19	16	-3
Mean	19.14	29.07	9.93	Mean	19.33	32.20	12.87
S.D.	8.93	5.99	8.27	S.D.	7.01	9.06	9.92
Pre-Test versus Post-Test $t = 4.49$ $p < .00$				Pre-Test versus Post-Test $t = 5.02$ $p < .00$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 0.87$ $p < .39$							

TABLE XI

DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE NABT/NSTA TEST FOR SECTION IV ABC BIOLOGY
STUDENTS AND SECTION IV TRADITIONAL BIOLOGY STUDENTS
AT THE SECOND METROPOLITAN HIGH SCHOOL

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	37	38	1	1	32	57	25
2	14	20	6	2	16	25	9
3	31	30	-1	3	21	14	-7
4	36	37	1	4	23	29	6
5	21	17	-4	5	21	30	9
6	42	41	-1	6	15	27	12
7	35	25	-10	7	25	45	20
8	23	16	-7	8	22	35	13
9	18	16	-2	9	38	45	7
10	23	23	0	10	23	21	-2
11	22	25	3	11	20	33	13
12	24	30	6	12	16	30	14
13	20	29	9	13	11	23	12
14	16	24	8	14	23	33	10
				15	21	24	3
				16	27	43	16
Mean	25.86	26.50	0.64	Mean	22.13	32.13	10.00
S.D.	8.73	8.13	5.50	S.D.	6.54	10.88	7.80
Pre-Test versus Post-Test $t = 0.44$ $p < .67$				Pre-Test versus Post-Test $t = 5.12$ $p < .00$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 3.83$ $p < .00$							

25 to a decrease of 7. Summary analysis revealed no significant increase in score for the ABC students at the $\alpha = .05$ level of significance. However, the traditional students did record a significant gain in test score at the $\alpha = .05$ level of significance. Furthermore, the traditional curriculum was found to be superior to the ABC curriculum at the $\alpha = .05$ level of significance.

Table XII illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled in section V of ABC biology and traditional biology at the second metropolitan school. Fourteen ABC students recorded a significant increase in test score at the $\alpha = .05$ level of significance. Pre-test and post-test scores averaged 24.57 and 31.00, respectively for a mean gain of 6.43. Pre-test scores varied by 38 as scores ranged from 47 to 9. On the post-test, the score span tightened with a high of 52 and a low of 19. Difference scores ranged from 24 to -10. Meanwhile, the thirteen traditional students also recorded a significant gain in score at the $\alpha = .05$ level of significance. The range of pre-test scores spanned from 34 to 12 with a mean of 21.84. On the post-test, the average increased to by 7.54 to total 29.34 with scores varying between 45 and 15. The traditional students increased scores by as much as 25 and decreased scores by as much as 5. In conclusion, there was no significant difference between the traditional and ABC curricula at the $\alpha = .05$ level of significance.

Table XIII illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled in section I of ABC biology and traditional biology at the third metropolitan school. Twelve ABC students averaged 22.92 on the pre-test and 27.67 on the post-test for a mean increase of 4.75.

TABLE XII

DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE NABT/NSTA TEST FOR SECTION V ABC BIOLOGY
STUDENTS AND SECTION V TRADITIONAL BIOLOGY STUDENTS
AT THE SECOND METROPOLITAN HIGH SCHOOL

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	9	35	24	1	29	24	-5
2	17	27	10	2	12	27	15
3	34	29	-5	3	15	19	4
4	35	47	12	4	19	18	-1
5	26	37	11	5	34	35	1
6	19	21	2	6	28	34	6
7	10	22	12	7	20	45	25
8	22	28	6	8	22	26	4
9	25	23	-2	9	23	38	15
10	29	19	-10	10	14	15	1
11	16	24	8	11	16	25	9
12	16	28	12	12	23	41	18
13	39	42	3	13	29	35	6
14	47	52	5				
Mean	24.57	31.00	6.43	Mean	21.84	29.38	7.54
S.D.	11.19	10.18	8.52	S.D.	6.72	9.34	8.53
Pre-Test versus Post-Test $t = 2.71 \quad p < .02$				Pre-Test versus Post-Test $t = 3.18 \quad p < .01$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 0.38 \quad p < .71$							

TABLE XIII

DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE NABT/NSTA TEST FOR SECTION I ABC BIOLOGY
STUDENTS AND SECTION I TRADITIONAL BIOLOGY STUDENTS
AT THE THIRD METROPOLITAN HIGH SCHOOL

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	19	23	4	1	23	34	11
2	27	35	8	2	27	40	13
3	23	27	4	3	8	32	24
4	26	34	8	4	22	29	7
5	11	31	20	5	22	44	22
6	31	38	7	6	24	35	11
7	30	27	-3	7	22	40	18
8	28	21	-7	8	13	30	17
9	20	19	-1	9	21	38	17
10	22	23	1	10	21	48	27
11	7	22	15	11	32	45	13
12	31	32	1	12	34	45	11
				13	20	36	16
				14	24	34	10
				15	10	24	14
				16	23	43	20
Mean	22.92	27.67	4.75	Mean	21.63	37.31	15.69
S.D.	7.70	6.22	7.53	S.D.	6.85	6.74	5.51
Pre-Test versus Post-Test $t = 2.18$ $p < .05$				Pre-Test versus Post-Test $t = 11.39$ $p < .00$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 4.25$ $p < .00$							

Individual scores on the pre-test averaged from 31 to 7 and from 38 to 19 on the post-test. Difference scores varied from 20 to -7. At the $\alpha = .05$ level of significance the ABC students had a significant gain in score. The sixteen traditional students averaged 1.29 lower on the pre-test than the ABC students. But, the traditional students rebounded to average 37.31 on the post-test for a mean gain in score of 15.67. No traditional students declined in performance as difference scores ranged from 27 to 7. The traditional students also had a significant increase in score at the $\alpha = .05$ level of significance. Although both groups had a significant increase, the traditional curricula was still found to be superior at the $\alpha = .05$ level of significance.

Table XIV illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled in section II of ABC biology and traditional biology at the third metropolitan school. Pre-tests for eleven ABC students averaged 22.91 with scores ranging from 34 to 5. Post-tests results indicated a mean increase of 7.00 in score as the students averaged 29.91. The difference scores varied from 18 to -7. The sixteen traditional biology students experienced a similar increase in scores. The averages were 21.63 on the pre-test and 28.88 on the post-test. Pre-test scores ranged from 33 to 6 and post-test scores varied from 43 to 15. Changes in performance spanned from 25 to -13. Both ABC and traditional students had a significant increase in score at the $\alpha = .05$ level of significance with no significant difference between groups found.

Table XV illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled in section I of ABC

TABLE XIV

**DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE NABT/NSTA TEST FOR SECTION II ABC BIOLOGY
STUDENTS AND SECTION II TRADITIONAL BIOLOGY STUDENTS
AT THE THIRD METROPOLITAN HIGH SCHOOL**

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	18	30	12	1	28	15	-13
2	26	32	6	2	21	22	1
3	34	29	-5	3	33	34	1
4	22	27	5	4	6	23	17
5	21	23	2	5	24	23	-1
6	35	49	14	6	13	36	23
7	34	27	-7	7	25	29	4
8	15	18	3	8	20	21	1
9	20	32	12	9	29	34	5
10	5	23	18	10	15	26	11
11	22	39	17	11	20	26	6
				12	25	43	18
				13	30	41	11
				14	12	37	25
				15	23	31	8
				16	22	21	-1
Mean	22.91	29.91	7.00	Mean	21.63	28.88	7.25
S.D.	9.07	8.43	8.40	S.D.	7.23	8.04	9.94
Pre-Test versus Post-Test $t = 2.76$ $p < .02$				Pre-Test versus Post-Test $t = 2.92$ $p < .01$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 0.07$ $p < .95$							

TABLE XV

**DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE NABT/NSTA TEST FOR SECTION I ABC BIOLOGY
STUDENTS AND SECTION I TRADITIONAL BIOLOGY STUDENTS
AT THE RURAL HIGH SCHOOL**

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	18	26	8	1	22	23	1
2	35	36	1	2	29	39	10
3	29	25	-4	3	16	24	8
4	26	31	5	4	29	30	1
5	17	22	5	5	13	13	0
6	18	29	11	6	23	37	14
7	20	19	-1	7	26	22	-4
8	32	35	3	8	29	24	-5
9	20	24	4	9	30	28	-2
10	32	32	0	10	42	53	11
11	26	31	5	11	40	36	-4
12	22	31	9	12	30	37	7
13	25	35	10	13	28	28	0
14	23	25	2	14	33	44	11
15	41	46	5	15	18	31	13
16	26	32	6	16	30	40	10
17	36	45	9				
18	14	23	9				
19	17	23	6				
20	22	23	1				
Mean	24.95	29.65	4.70	Mean	27.38	31.81	4.44
S.D.	7.30	7.29	4.01	S.D.	7.78	9.90	6.67
Pre-Test versus Post-Test $t = 5.24 \quad p < .00$				Pre-Test versus Post-Test $t = 2.66 \quad p < .01$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 0.01 \quad p < .98$							

biology and traditional biology at the rural high school. Twenty ABC students recorded a pre-test average of 24.95 with scores ranging from 41 to 14. Post-test results revealed an mean increase of 4.70 with an average of 29.65. Difference scores ranged from 11 to -4. These results indicate a significant gain in score at the $\alpha = .05$ level of significance. Sixteen traditional students averaged 27.38 on the pre-test and 31.81 on the post-test for a mean difference of 4.44. Pre-test scores ranged from 42 to 13 and post-test results varied between 44 and 13. Difference scores spanned from 13 to -5. The traditional curriculum students also recorded a significant increase in score at the $\alpha = .05$ level of significance. No significant difference between groups was found at the $\alpha = .05$ level of significance.

Table XVI illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled ABC biology and traditional biology at the first metropolitan high school. Ninety-three ABC biology students averaged 24.35 on the pre-test and 30.01 on the post-test for a mean difference score of 5.66. At the $\alpha = .05$ level of significance, there was a significant gain in test score for the ABC biology students. Seventy-nine traditional biology students averaged 22.99 on the pre-test and 23.99 on the post-test for a difference mean of 1.00. There was no significant change in test score at the $\alpha = .05$ level of significance. In cross comparison, the ABC curriculum was superior was to the traditional curriculum at the $\alpha = .05$ level of significance.

Table XVII illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled ABC biology and traditional biology at the second metropolitan high school. Fifty-four ABC students had a

TABLE XVI

ANALYSIS OF THE NABT/NSTA TEST FOR STUDENTS ENROLLED IN ALL SECTIONS OF ABC BIOLOGY AND TRADITIONAL BIOLOGY AT THE FIRST METROPOLITAN HIGH SCHOOL

	ABC Biology (n = 93)	Traditional Biology (n = 79)
Pre-Test Mean	24.35	22.99
Pre-Test S.D.	7.23	7.15
Post-Test Mean	30.01	23.99
Post-Test S.D.	9.41	8.39
Difference Mean	5.66	1.00
Difference S.D.	8.24	8.16
Pre-Test versus Post-Test	t = 4.59 p < .00	t = 0.81 p < .42
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) t = 3.71 p < .00		

TABLE XVII

ANALYSIS OF THE NABT/NSTA TEST FOR STUDENTS ENROLLED IN ALL SECTIONS OF ABC BIOLOGY AND TRADITIONAL BIOLOGY AT THE SECOND METROPOLITAN HIGH SCHOOL

	ABC Biology (n = 54)	Traditional Biology (n = 65)
Pre-Test Mean	22.51	21.49
Pre-Test S.D.	9.25	6.54
Post-Test Mean	27.74	31.88
Post-Test S.D.	9.15	10.35
Difference Mean	5.19	10.38
Difference S.D.	8.81	9.37
Pre-Test versus Post-Test	t = 2.95 p < .00	t = 3.98 p < .00
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) t = 3.11 p < .00		

mean difference score of 5.19. The pre-test and post-test averages for these students was 22.51 and 27.74, respectively. Sixty-five traditional biology students had a mean difference score of 10.38. The pre-test and post-test averages for these students were 21.49 and 31.88, respectively. Both the ABC biology students and the traditional biology students recorded a significant gain in test score at the $\alpha = .05$ level of significance. However, the traditional curriculum was found superior at the $\alpha = .05$ level of significance.

Table XVIII illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled ABC biology and traditional biology at the third metropolitan high school. Twenty-three ABC students recorded a pre-test average of 22.91, a post-test average of 28.74 and a corresponding difference mean of 5.83. At the $\alpha = .05$ level of significance, this gain in score was significant. In comparison, thirty-two traditional biology students posted a pre-test average of 21.63, a post-test average of 33.09 and a corresponding difference mean of 11.47. These students also had a significant gain in score at the $\alpha = .05$ level of significance. Furthermore, the traditional curriculum was also found to be superior to the ABC curriculum at the $\alpha = .05$ level of significance.

Table XIX illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled ABC biology and traditional biology at the rural high school. Since there was only one section of data for this school, the information contained in this table is identical to that found in Table XV. The data are reported again in this summary for continuity of reading. Twenty ABC

TABLE XVIII

ANALYSIS OF THE NABT/NSTA TEST FOR STUDENTS ENROLLED IN ALL
SECTIONS OF ABC BIOLOGY AND TRADITIONAL BIOLOGY AT THE
THIRD METROPOLITAN HIGH SCHOOL

	ABC Biology (n = 23)	Traditional Biology (n = 32)
Pre-Test Mean	22.91	21.63
Pre-Test S.D.	8.19	6.93
Post-Test Mean	28.74	33.09
Post-Test S.D.	7.28	8.46
Difference Mean	5.83	-11.47
Difference S.D.	7.86	8.49
Pre-Test versus Post-Test	t = 2.55 p < .01	t = 5.93 p < .00
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) t = 2.47 p < .02		

TABLE XIX

ANALYSIS OF THE NABT/NSTA TEST FOR STUDENTS ENROLLED IN ALL
SECTIONS OF ABC BIOLOGY AND TRADITIONAL BIOLOGY AT THE
RURAL HIGH SCHOOL

	ABC Biology (n = 20)	Traditional Biology (n = 16)
Pre-Test Mean	24.95	27.38
Pre-Test S.D.	7.30	7.78
Post-Test Mean	29.65	31.81
Post-Test S.D.	7.29	9.90
Difference Mean	4.70	4.44
Difference S.D.	4.01	6.67
Pre-Test versus Post-Test	t = 5.24 p < .00	t = 2.66 p < .01
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) t = 0.01 p < .98		

students recorded a pre-test average of 24.95. Post-test results revealed an mean increase of 4.70 with an average of 29.65. These results indicate a significant gain in score at the $\alpha = .05$ level of significance. Sixteen traditional students averaged 27.38 on the pre-test and 31.81 on the post-test for a mean difference of 4.44. The traditional curriculum students also recorded a significant increase in score at the $\alpha = .05$ level of significance. No significant difference between groups was found at the $\alpha = .05$ level of significance.

Table XX illustrates the distribution and analysis of the pre-test, post-test and difference scores on the NABT/NSTA test for students enrolled ABC biology and traditional biology at all high schools. The ABC biology students ($n = 190$) recorded a pre-test average of 23.72 and a post-test average of 29.17. These numbers dictate a difference mean of 5.44. At the $\alpha = .05$ level of significance, a significant gain in score was evident. The traditional biology students ($n = 192$) recorded a pre-test average of 22.62 and a post-test average of 28.82 for a difference mean of 6.21. These students had a significant gain in score at the $\alpha = .05$ level of significance. In review, the ABC biology students had a higher pre-test and post-test average than the traditional biology students. However, the traditional students had a difference mean 0.77 higher than the traditional biology students. In terms of score variation, the ABC students had a higher standard deviation on the pre-test, but the traditional students had higher figures on the post-test and difference scores. Overall, there was no significant difference between the ABC and traditional curricula at the $\alpha = .05$ level of significance.

TABLE XX

ANALYSIS OF THE NABT/NSTA TEST FOR STUDENTS ENROLLED IN ALL
SECTIONS OF ABC BIOLOGY AND TRADITIONAL BIOLOGY AT ALL
HIGH SCHOOLS

	ABC Biology (n = 190)	Traditional Biology (n = 192)
Pre-Test Mean	23.72	22.62
Pre-Test S.D.	7.96	7.09
Post-Test Mean	29.17	28.82
Post-Test S.D.	8.89	10.01
Difference Mean	5.44	6.20
Difference S.D.	7.98	9.76
Pre-Test versus Post-Test	t = 6.29 p < .00	t = 7.01 p < .00
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) t = 0.84 p < .40		

Attitude Toward Science Survey

Table XXI illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled in section I of ABC biology and traditional biology at the first metropolitan school. The twenty one ABC curriculum scores on the pre-test ranged from a high of 77 to a low of 29 with a mean of 57.14. On the post-test, ABC students posted a high score of 98 and a low score of 20 with a mean of 63.81. By contrast, the ten traditional biology students had a pre-test average of 68.40 with individual scores ranging from 86 to 34. On the post-test, traditional students scored from 98 to 38 with a mean score of 72.00. Overall, the ABC students had a difference score of 6.67 and the traditional students had a difference score of 3.60. Although the traditional students established a 11.26 advantage in score on the pre-test, the ABC narrowed the margin by 3.07 on the post-test. Only the ABC students recorded a significant gain in score at the $\alpha = .05$ level of significance. No significant difference between the groups was discovered at the $\alpha = .05$ level of significance.

Table XXII illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled in section II of ABC biology and traditional biology at the first metropolitan school. The fifteen ABC students had a pre-test average of 66.67 and a post-test average of 61.27 for a difference average of -5.40. ABC pre-test performance ranged from 99 to 28 and post-test scores varied from 89 to 29. Difference scores ranged from 56 to -47. ABC biology students recorded comparatively higher standard deviations on all score groups, especially on the difference scores. No significant difference in scores was found at the $\alpha = .05$ level of significance.

TABLE XXI

DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE SCIENCE ATTITUDE SURVEY FOR SECTION I ABC
BIOLOGY STUDENTS AND SECTION I TRADITIONAL BIOLOGY
STUDENTS AT THE FIRST METROPOLITAN HIGH SCHOOL

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	63	76	13	1	34	38	4
2	64	71	7	2	73	69	-4
3	78	77	-1	3	65	65	0
4	60	60	0	4	80	71	-9
5	29	20	-9	5	79	91	12
6	52	64	12	6	67	71	4
7	47	60	13	7	67	73	6
8	65	73	8	8	71	98	27
9	31	43	12	9	62	61	-1
10	76	68	-8	10	86	83	-3
11	77	98	21				
12	75	77	2				
13	57	59	2				
14	56	61	5				
15	47	53	6				
16	59	64	5				
17	63	74	11				
18	47	58	11				
19	52	70	18				
20	52	67	15				
21	50	47	-3				
Mean	57.14	63.81	6.67	Mean	68.40	72.00	3.60
S.D.	13.43	15.52	8.02	S.D.	14.24	16.65	10.10
Pre-Test versus Post-Test t = 3.81 p < .00				Pre-Test versus Post-Test t = 1.13 p < .29			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) t = 0.84 p < .41							

TABLE XXII

DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE SCIENCE ATTITUDE SURVEY FOR SECTION II ABC
BIOLOGY STUDENTS AND SECTION II TRADITIONAL BIOLOGY
STUDENTS AT THE FIRST METROPOLITAN HIGH SCHOOL

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	82	79	-3	1	66	56	-10
2	28	84	56	2	81	73	-8
3	33	89	56	3	70	71	1
4	66	39	-27	4	51	38	-13
5	63	68	5	5	70	68	-2
6	75	78	3	6	62	45	-17
7	99	82	-17	7	65	52	-13
8	46	31	-15	8	20	20	0
9	69	43	-26	9	42	75	33
10	94	73	-21	10	80	60	-20
11	61	39	-22	11	66	36	-30
12	51	43	-8	12	45	20	-25
13	96	82	-14	13	36	20	-16
14	76	29	-47	14	46	48	2
15	61	60	-1	15	28	50	22
				16	47	54	7
				17	76	78	2
				18	78	66	-12
				19	69	32	-37
				20	44	27	-17
Mean	66.67	61.27	-5.40	Mean	57.10	49.45	-7.65
S.D.	21.43	21.62	28.27	S.D.	17.90	19.24	16.60
Pre-Test versus Post-Test $t = 0.74$ $p < .47$				Pre-Test versus Post-Test $t = 2.06$ $p < .05$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 0.27$ $p < .79$							

Traditional biology students posted a -7.65 mean decrease in score. The traditional curriculum pre-test average was 57.10 for twenty students with scores ranging from 81 to 20. On the post-test, the high score was 78 and the low score was 20 with an average of 49.45. Difference scores ranged from a high of 33 to a low of -37. The traditional biology students had a significant decrease in score at the $\alpha = .05$ level of significance. Overall, there was no significant difference between the curriculum groups at the $\alpha = .05$ level of significance.

Table XXIII illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled in section III of ABC biology and traditional biology at the first metropolitan school. ABC students posted a twenty-three score average of 68.14 on the pre-test and 74.61 on the post-test which combine for a mean difference of 5.48. ABC pre-test scores ranged from a high of 87 to a low of 33 and post-test scores ranged from 99 to 34. Difference scores varied from a high of 39 to a low of -20. Seventeen traditional biology students scored an average of 63.73 on the pre-test and 55.47 on the post-test for a mean difference score of -8.27. Pre-test scores for the traditional students ranged from 77 to 50 and post-test scores ranged from 77 to 34. In terms of difference scores, the high score was 15 and the low was -37. Only four of the traditional biology students posted positive difference scores. The traditional biology group demonstrated an $\alpha = .05$ significant decrease in score. And, although the ABC biology students did not have an $\alpha = .05$ significant change in score, the ABC curriculum was superior at the $\alpha = .05$ level of significance.

TABLE XXIII

DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE SCIENCE ATTITUDE SURVEY FOR SECTION III ABC
BIOLOGY STUDENTS AND SECTION III TRADITIONAL BIOLOGY
STUDENTS AT THE FIRST METROPOLITAN HIGH SCHOOL

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	65	71	6	1	72	54	-18
2	84	79	-5	2	58	45	-13
3	44	34	-10	3	54	44	-10
4	52	70	18	4	58	49	-9
5	75	62	-13	5	64	53	-11
6	87	82	-5	6	77	58	-19
7	77	82	5	7	71	61	-10
8	71	80	9	8	72	77	5
9	79	88	9	9	53	54	1
10	82	89	7	10	50	74	24
11	76	74	-2	11	68	63	-5
12	63	85	22	12	58	73	15
13	53	57	4	13	60	35	-25
14	44	54	10	14	70	58	-12
15	67	77	10	15	71	34	-37
16	33	72	39				
17	75	74	-1				
18	84	99	15				
19	62	95	33				
20	82	62	-20				
21	76	60	-16				
Mean	68.14	74.61	5.48	Mean	63.73	55.47	-8.27
S.D.	15.21	15.17	14.97	S.D.	8.40	13.06	15.17
Pre-Test versus Post-Test $t = 1.68$ $p < .11$				Pre-Test versus Post-Test $t = 2.11$ $p < .05$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 2.69$ $p < .01$							

Table XXIV illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled in section IV of ABC biology and traditional biology at the first metropolitan school. Fifteen ABC curriculum students had a pre-test mean of 75.87 with a high score of 98 and a low score of 48. On the post-test, the ABC students had a high score of 99 and a low score of 39 with a mean of 72.07. In terms of differences, ABC scores ranged from 11 and -36 with a -3.60 mean. Twenty traditional students scored between 77 and 29 to compile a mean of 63.10 on the pre-test. Post-test results for the same group varied between 80 and 29 for a mean of 59.45. Examination of the pre-test and post-test means reveals a decline of 3.65 in student performance. Overall analysis indicates no significant difference at the $\alpha = .05$ level of significance between the pre-test and post-test scores for either group or for the group to group comparison.

Table XXV illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled in section V of ABC biology and traditional biology at the first metropolitan school. The twenty ABC students averaged 65.25 on the pre-test and 62.20 on the post-test for a mean gain of -3.05 points. Scores ranged from 98 to 32 on the pre-test and from 90 to 22 on the post-test. Difference scores varied from 37 to -32. Meanwhile, twelve traditional students had a pre-test mean of 65.25 and a post-test mean of 63.58 for an average difference score of -2.97. Pre-test scores ranged from 92 to 20 on the pre-test and from 86 to 20 on the post-test. Difference scores spanned from 18 to -13. Overall analysis indicates no significant

TABLE XXIV

**DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE SCIENCE ATTITUDE SURVEY FOR SECTION IV ABC
BIOLOGY STUDENTS AND SECTION IV TRADITIONAL BIOLOGY
STUDENTS AT THE FIRST METROPOLITAN HIGH SCHOOL**

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	78	80	2	1	44	37	-7
2	74	50	-24	2	77	60	-17
3	50	58	8	3	56	80	24
4	91	98	7	4	65	41	-24
5	82	93	11	5	76	77	1
6	78	42	-36	6	68	61	-7
7	48	39	-9	7	29	27	-2
8	79	78	-1	8	72	72	0
9	77	80	3	9	73	59	-14
10	66	80	14	10	59	46	-13
11	66	44	-22	11	77	70	-7
12	79	78	-1	12	67	76	9
13	93	96	3	13	74	60	-14
14	79	69	-10	14	63	47	-16
15	98	99	1	15	69	69	0
				16	67	75	8
				17	73	71	-2
				18	49	64	15
				19	48	68	20
				20	56	29	-27
Mean	75.87	72.07	-3.60	Mean	63.10	59.45	-3.65
S.D.	13.97	20.95	14.14	S.D.	12.80	16.21	13.85
Pre-Test versus Post-Test $t = 0.99$ $p < .34$				Pre-Test versus Post-Test $t = 1.18$ $p < .25$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 0.01$ $p < .99$							

TABLE XXV

**DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE SCIENCE ATTITUDE SURVEY FOR SECTION V ABC
BIOLOGY STUDENTS AND SECTION V TRADITIONAL BIOLOGY
STUDENTS AT THE FIRST METROPOLITAN HIGH SCHOOL**

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	98	66	-32	1	76	74	-2
2	88	90	2	2	83	76	-7
3	59	48	-11	3	53	48	-5
4	86	82	-4	4	75	82	7
5	81	74	-7	5	45	46	1
6	48	51	3	6	20	20	0
7	72	77	5	7	72	60	-12
8	51	38	-13	8	66	66	0
9	57	54	-3	9	52	45	-7
10	41	22	-19	10	92	79	-13
11	98	81	-17	11	81	69	-12
12	72	47	-25	12	68	86	18
13	45	82	37				
14	32	41	9				
15	65	53	-12				
16	53	58	5				
17	52	58	6				
18	68	72	4				
19	60	70	10				
20	79	80	1				
Mean	65.25	62.20	-3.05	Mean	65.25	63.58	-2.97
S.D.	18.77	18.00	15.02	S.D.	19.83	19.48	8.91
Pre-Test versus Post-Test t = 0.91 p < .38				Pre-Test versus Post-Test t = 1.04 p < .32			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) t = 0.09 p < .93							

difference at the $\alpha = .05$ level of significance between the pre-test and post-test scores for either group or for the group to group comparison.

Table XXVI illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled in section I of ABC biology and traditional biology at the second metropolitan school. The eight ABC students had a mean pre-test score of 63.63 and a mean post-test score of 64.88 which yielded an average difference score of 1.25. Scores ranged from 96 to 24 and from 100 to 24 on the pre-test and post-test, respectively. In contrast, six traditional students had scores ranging from 91 to 68 on the pre-test which combined for an average of 75.67. On the post-test, scores averaged 72.00 with a range from 82 to 65. The mean difference was a -3.67 with individual scores ranging from 7 to -9. No significant differences were found in pre-test and post-test score of either curriculum group at the $\alpha = .05$ level of significance. Moreover, an $\alpha = .05$ level of significance difference was not detected between groups.

Table XXVII illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled in section II of ABC biology and traditional biology at the second metropolitan school. Three ABC students posted a 59.33 average on the pre-test with scores ranging from 52 to 68. Post-test results ranged from 67 to 42 and the mean was 58.33. The pre-test and post-test means combined to yield a difference mean of -1.00. The fifteen traditional students had a pre-test and post-test average of 69.67 and 72.60, respectively. The pre-test scores varied from 86 to 51 and post-test results ranged from 100 to 48. The traditional students had a mean difference score of 2.93 with individual scores spanning from 21 to -24. In

TABLE XXVI

DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE SCORES ON THE SCIENCE ATTITUDE SURVEY FOR SECTION I ABC BIOLOGY STUDENTS AND SECTION I TRADITIONAL BIOLOGY STUDENTS AT THE SECOND METROPOLITAN HIGH SCHOOL

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	96	100	4	1	68	75	7
2	24	24	0	2	79	73	-6
3	46	75	29	3	91	82	-9
4	91	70	-21	4	68	62	-6
5	36	61	25	5	80	75	-5
6	65	76	11	6	68	65	-3
7	70	57	-13				
8	81	56	-25				
Mean	63.63	64.88	1.25	Mean	75.67	72.00	-3.67
S.D.	26.15	21.75	20.09	S.D.	9.40	7.32	5.57
Pre-Test versus Post-Test $t = 0.18$ $p < .87$				Pre-Test versus Post-Test $t = 1.61$ $p < .17$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 0.66$ $p < .53$							

TABLE XXVII

**DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE SCIENCE ATTITUDE SURVEY FOR SECTION II ABC
BIOLOGY STUDENTS AND SECTION II TRADITIONAL BIOLOGY
STUDENTS AT THE SECOND METROPOLITAN HIGH SCHOOL**

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	58	66	8	1	82	58	-24
2	68	67	-1	2	71	59	-12
3	52	42	-10	3	73	72	-1
				4	65	68	3
				5	75	78	3
				6	59	65	6
				7	55	48	-7
				8	60	75	15
				9	86	93	7
				10	81	100	19
				11	51	72	21
				12	62	57	-5
				13	82	89	7
				14	67	78	11
				15	76	77	1
Mean	59.33	58.33	-1.00	Mean	69.67	72.60	2.93
S.D.	8.08	14.15	9	S.D.	10.82	14.26	11.85
Pre-Test versus Post-Test $t = 0.19$ $p < .87$				Pre-Test versus Post-Test $t = 0.96$ $p < .35$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 0.65$ $p < .56$							

summary, no significant differences were found within each group or between groups at the $\alpha = .05$ level of significance.

Table XXVIII illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled in section III of ABC biology and traditional biology at the second metropolitan school. The fourteen ABC students recorded mean scores of 67.79 on the pre-test and 66.14 on the post-test for an average change of -1.64. Pre-test scores ranged from 99 to 43 and post-test scores ranged from 89 to 20. Difference scores varied between 25 and -40. In the fifteen student traditional group, the pre-test scores ranged from 82 to 31 and averaged 66.93. Post-test results revealed a mean of 70.60 as scores ranged from 100 to 20. Traditional curriculum students increased performance by an average of 3.67 as variations in difference scores ranged from 45 to -12. Both groups posted a no significant changes in test score at the $\alpha = .05$ level of significance. Furthermore, no significant difference between groups was found at the $\alpha = .05$ level of significance.

Table XXIX illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled in section IV of ABC biology and traditional biology at the second metropolitan school. The fourteen ABC students averaged 66.21 on the pre-test and 61.29 on the post-test. ABC pre-test scores ranged from 91 to 25 on the pre-test and from 90 to 20 on the post-test. These students posted a -4.93 mean score. Difference scores spanned from 9 to -41. In contrast, the sixteen traditional students scored an average of 70.81 on the pre-test and gained a mean of 2.06 on the post-test. Traditional curriculum pre-test scores ranged from 81 to 50 and

TABLE XXVIII

**DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE SCIENCE ATTITUDE SURVEY FOR SECTION III ABC
BIOLOGY STUDENTS AND SECTION III TRADITIONAL BIOLOGY
STUDENTS AT THE SECOND METROPOLITAN HIGH SCHOOL**

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	50	75	25	1	82	86	4
2	79	82	3	2	67	66	-1
3	60	20	-40	3	70	68	-2
4	78	65	-13	4	74	100	26
5	63	60	-3	5	34	79	45
6	77	92	15	6	77	84	7
7	74	64	-10	7	71	67	-4
8	79	80	1	8	68	64	-4
9	57	48	-9	9	79	79	0
10	60	76	16	10	78	77	-1
11	51	65	14	11	52	40	-12
12	43	34	-9	12	69	67	-2
13	79	76	-3	13	70	77	7
14	99	89	-10	14	82	85	3
				15	31	20	-11
Mean	67.79	66.14	-1.64	Mean	66.93	70.60	3.67
S.D.	15.32	20.46	16.23	S.D.	15.84	19.48	14.47
Pre-Test versus Post-Test $t = 0.38$ $p < .71$				Pre-Test versus Post-Test $t = 0.98$ $p < .34$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 0.93$ $p < .36$							

TABLE XXIX

DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE SCIENCE ATTITUDE SURVEY FOR SECTION IV ABC
BIOLOGY STUDENTS AND SECTION IV TRADITIONAL BIOLOGY
STUDENTS AT THE SECOND METROPOLITAN HIGH SCHOOL

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	72	81	9	1	81	77	-4
2	57	48	-9	2	71	74	3
3	75	73	-2	3	73	69	-4
4	76	35	-41	4	50	64	14
5	88	90	2	5	67	68	1
6	91	73	-18	6	73	80	7
7	68	64	-4	7	71	78	7
8	28	26	-2	8	69	71	2
9	66	57	-9	9	75	90	15
10	71	72	1	10	64	66	2
11	75	75	0	11	71	67	-4
12	77	79	2	12	79	62	-17
13	25	20	-5	13	67	65	-2
14	58	65	7	14	78	72	-6
				15	71	69	-2
				16	73	94	21
Mean	66.21	61.29	-4.93	Mean	70.81	72.88	2.06
S.D.	19.27	21.41	12.45	S.D.	7.15	9.07	9.28
Pre-Test versus Post-Test $t = 1.48$ $p < .16$				Pre-Test versus Post-Test $t = 0.89$ $p < .39$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 1.72$ $p < .10$							

post-test scores varied from 94 to 62. Difference scores ranged an increase of 21 to a decrease of 17. Summary analysis revealed no significant increase in score for the ABC students or traditional students at the $\alpha = .05$ level of significance. In addition, there was no difference between curriculum groups at the $\alpha = .05$ level of significance.

Table XXX illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled in section V of ABC biology and traditional biology at the second metropolitan school. Fourteen ABC students failed to record a significant change in test score at the $\alpha = .05$ level of significance. Pre-test and post-test scores averaged 68.29 and 71.29, respectively, for a mean gain of 3.00. Pre-test scores varied by 42 as scores ranged from 84 to 42. On the post-test, the score span widened with a high of 100 and a low of 45. Difference scores ranged from 18 to -28. Meanwhile, the thirteen traditional students also did not post a significant change in score at the $\alpha = .05$ level of significance. The range of pre-test scores spanned from 87 to 49 with a mean of 68.08. On the post-test, the average decreased to by -5.31 to total 63.77 with scores varying between 86 and 27. The traditional students increased scores by as much as 18 and decreased scores by as much as 28. In conclusion, there was no significant difference between the traditional and ABC curricula at the $\alpha = .05$ level of significance.

Table XXXI illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled in section I of ABC biology and traditional biology at the third metropolitan school. Twelve ABC students averaged 73.00 on the pre-test and 70.92 on the post-test for a mean decrease of 2.08. Individual scores on the pre-test averaged from 94 to 34 and from 91 to 42 on the post-

TABLE XXX

**DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE SCIENCE ATTITUDE SURVEY FOR SECTION V ABC
BIOLOGY STUDENTS AND SECTION V TRADITIONAL BIOLOGY
STUDENTS AT THE SECOND METROPOLITAN HIGH SCHOOL**

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	48	62	14	1	70	73	3
2	79	79	0	2	67	52	-15
3	64	66	2	3	78	53	-25
4	78	79	1	4	71	65	-6
5	44	66	22	5	49	67	18
6	84	80	-4	6	62	60	-2
7	61	65	4	7	50	27	-23
8	60	63	3	8	84	56	-28
9	78	61	-17	9	73	78	5
10	79	91	12	10	87	86	-1
11	81	100	19	11	54	65	11
12	74	62	-12	12	73	57	-16
13	42	45	3	13	67	77	10
14	84	79	-5				
Mean	68.29	71.29	3.00	Mean	68.08	63.77	-5.31
S.D.	15.04	14.14	11.00	S.D.	11.90	14.96	14.92
Pre-Test versus Post-Test t = 1.02 p < .33				Pre-Test versus Post-Test t = 1.28 p < .22			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) t = 1.64 p < .12							

TABLE XXXI

**DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE SCIENCE ATTITUDE SURVEY FOR SECTION I ABC
BIOLOGY STUDENTS AND SECTION I TRADITIONAL BIOLOGY
STUDENTS AT THE THIRD METROPOLITAN HIGH SCHOOL**

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	94	79	-15	1	65	65	0
2	80	81	1	2	70	68	-2
3	60	65	5	3	72	73	1
4	83	83	0	4	100	96	-4
5	78	91	13	5	79	71	-8
6	90	77	-13	6	76	88	12
7	70	66	-4	7	69	75	6
8	78	70	-8	8	72	77	5
9	34	42	8	9	93	99	6
10	73	73	0	10	74	88	14
11	67	56	-11	11	81	78	-3
12	69	68	-1	12	89	87	-2
				13	82	90	8
				14	61	65	4
				15	77	86	9
Mean	73.00	70.92	-2.08	Mean	77.33	80.40	3.07
S.D.	15.70	13.09	6.30	S.D.	10.51	10.99	8.54
Pre-Test versus Post-Test $t = 0.85$ $p < .42$				Pre-Test versus Post-Test $t = 1.90$ $p < .08$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 1.74$ $p < .10$							

test. Difference scores varied from 13 to -15. At the $\alpha = .05$ level of significance the ABC students had no significant change in score. The sixteen traditional students averaged 4.33 higher on the pre-test than the ABC students. And, the traditional students widened that margin to 9.48 by averaging 37.31 on the post-test for a mean gain in score of 3.07. Neither group had a significant change in score at the $\alpha = .05$ level of significance. In addition, there was no significant difference in performance between groups at the $\alpha = .05$ level of significance.

Table XXXII illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled in section II of ABC biology and traditional biology at the third metropolitan school. Pre-tests for eleven ABC students averaged 72.91 with scores ranging from 99 to 56. Post-tests results indicated a mean increase of 6.45 in score as the students averaged 79.36. The difference scores varied from 38 to -17. The sixteen traditional biology students experienced a similar increase in scores. The averages were 71.63 on the pre-test and 73.06 on the post-test. Pre-test scores ranged from 98 to 37 and post-test scores varied from 98 to 44. Changes in performance spanned from 24 to -13. Both ABC and traditional students had no significant change in score at the $\alpha = .05$ level of significance. Finally, no $\alpha = .05$ level of significant difference between groups was found.

Table XXXIII illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled in section I of ABC biology and traditional biology at the rural high school. Twenty ABC students recorded a pre-test average of 65.00 with scores ranging from 80 to 36. Post-test results revealed a

TABLE XXXII

**DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE SCIENCE ATTITUDE SURVEY FOR SECTION II ABC
BIOLOGY STUDENTS AND SECTION II TRADITIONAL BIOLOGY
STUDENTS AT THE THIRD METROPOLITAN HIGH SCHOOL**

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	69	70	1	1	79	79	0
2	97	80	-17	2	81	97	16
3	79	94	15	3	37	44	7
4	67	79	12	4	92	79	-13
5	62	80	18	5	61	52	-9
6	56	94	38	6	79	79	0
7	62	60	-2	7	68	68	0
8	66	66	0	8	64	69	5
9	73	73	0	9	69	69	0
10	72	79	7	10	70	71	1
11	99	98	-1	11	60	72	12
				12	54	78	24
				13	98	89	-9
				14	73	73	0
				15	98	98	0
				16	63	52	-11
Mean	72.91	79.36	6.45	Mean	71.63	73.06	1.44
S.D.	13.86	12.08	14.22	S.D.	16.16	15.00	9.90
Pre-Test versus Post-Test $t = 1.51$ $p < .16$				Pre-Test versus Post-Test $t = 0.60$ $p < .58$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 1.01$ $p < .33$							

TABLE XXXIII

**DISTRIBUTION AND ANALYSIS OF PRE-TEST, POST-TEST AND DIFFERENCE
SCORES ON THE SCIENCE ATTITUDE SURVEY FOR SECTION I ABC
BIOLOGY STUDENTS AND SECTION I TRADITIONAL BIOLOGY
STUDENTS AT THE RURAL HIGH SCHOOL**

ABC Biology Students				Traditional Biology Students			
Student	Pre-Test	Post-Test	Difference	Student	Pre-Test	Post-Test	Difference
1	77	60	-17	1	76	53	-23
2	72	69	-3	2	79	67	-12
3	69	68	-1	3	53	46	-7
4	80	90	10	4	37	64	27
5	59	61	2	5	84	77	-7
6	80	59	-21	6	74	79	5
7	62	62	0	7	86	97	11
8	63	61	-2	8	59	64	5
9	80	79	-1	9	92	94	2
10	59	83	24	10	81	90	9
11	69	76	7	11	51	72	21
12	52	53	1	12	71	79	8
13	63	58	-5	13	35	37	2
14	53	74	21	14	62	60	-2
15	70	77	7	15	50	46	-4
16	43	47	4				
17	77	77	0				
18	72	62	-10				
19	36	40	4				
20	64	77	13				
Mean	65.00	66.65	1.65	Mean	66.00	68.33	2.33
S.D.	12.23	12.57	10.85	S.D.	17.93	18.11	12.55
Pre-Test versus Post-Test $t = 0.68$ $p < .51$				Pre-Test versus Post-Test $t = 0.70$ $p < .48$			
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) $t = 0.17$ $p < .87$							

mean increase of 1.65 with an average of 66.65. Difference scores ranged from 24 to -17. These data indicated no significant change in score at the $\alpha = .05$ level of significance. Sixteen traditional students averaged 66.00 on the pre-test and 68.33 on the post-test for a mean difference of 2.33. Pre-test scores ranged from 92 to 35 and post-test results varied between 97 and 37. Difference scores spanned from 27 to -23. The traditional curriculum students also recorded no significant change in score at the $\alpha = .05$ level of significance. In summary, no significant difference between groups was found at the $\alpha = .05$ level of significance.

Table XXXIV illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled ABC biology and traditional biology at the first metropolitan high school. Ninety-two ABC biology students averaged 66.02 on the pre-test and 66.66 on the post-test for a mean difference score of 0.64. At the $\alpha = .05$ level of significance, there was no significant change in test score for the ABC biology students. Seventy-seven traditional biology students averaged 62.69 on the pre-test and 58.19 on the post-test for a difference mean of -4.49. There was no significant change in test score at the $\alpha = .05$ level of significance. In cross comparison, the ABC curriculum was superior was to the traditional curriculum at the $\alpha = .05$ level of significance.

Table XXXV illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled ABC biology and traditional biology at the second metropolitan high school. Fifty-three ABC students had a mean difference score of -0.81. The pre-test and post-test averages for these students

TABLE XXXIV

ANALYSIS OF THE SCIENCE ATTITUDE SURVEY FOR STUDENTS ENROLLED
IN ALL SECTIONS OF ABC BIOLOGY AND TRADITIONAL BIOLOGY AT THE
FIRST METROPOLITAN HIGH SCHOOL

	ABC Biology (n = 92)	Traditional Biology (n = 77)
Pre-Test Mean	66.02	62.69
Pre-Test S.D.	17.32	15.12
Post-Test Mean	66.66	58.19
Post-Test S.D.	18.38	18.10
Difference Mean	0.64	-4.49
Difference S.D.	17.02	14.06
Pre-Test versus Post-Test	t = 0.24 p < .81	t = 1.67 p < .10
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) t = 2.14 p < .03		

TABLE XXXV

ANALYSIS OF THE SCIENCE ATTITUDE SURVEY FOR STUDENTS ENROLLED
IN ALL SECTIONS OF ABC BIOLOGY AND TRADITIONAL BIOLOGY AT THE
SECOND METROPOLITAN HIGH SCHOOL

	ABC Biology (n = 53)	Traditional Biology (n = 65)
Pre-Test Mean	66.40	69.55
Pre-Test S.D.	17.55	11.48
Post-Test Mean	65.58	70.18
Post-Test S.D.	18.91	14.40
Difference Mean	-0.81	0.63
Difference S.D.	14.20	12.40
Pre-Test versus Post-Test	t = 0.23 p < .82	t = 0.28 p < .78
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) t = 0.58 p < .56		

were 66.40 and 65.58, respectively. Sixty-five traditional biology students had a mean difference score of 0.63. The pre-test and post-test averages for these students were 69.55 and 70.18, respectively. Neither the ABC biology students or the traditional biology students recorded a significant gain in test score at the $\alpha = .05$ level of significance. And, there was no difference between curricula at the $\alpha = .05$ level of significance.

Table XXXVI illustrates the distribution and analysis of the pre-test, post-test and difference scores for students enrolled ABC biology and traditional biology at the third metropolitan high school. Twenty-four ABC students recorded a pre-test average of 72.96, a post-test average of 74.96 and a corresponding difference mean of 2.00. At the $\alpha = .05$ level of significance, this gain in score was not significant. In comparison, thirty-one traditional biology students posted a pre-test average of 74.39, a post-test average of 76.61 and a corresponding difference mean of 2.23. These students also had no significant gain in score at the $\alpha = .05$ level of significance. Overall, there was no significant difference between the traditional curriculum and the ABC curriculum at the $\alpha = .05$ level of significance.

Table XXXVII illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled ABC biology and traditional biology at the rural high school. Since there was only one section of data for this school, the information contained in this table is identical to that found in Table XXXIII. The data are reported again in this summary for continuity of reading. Twenty ABC students recorded a pre-test average of 65.00. Post-test results revealed a mean

TABLE XXXVI

ANALYSIS OF THE SCIENCE ATTITUDE SURVEY FOR STUDENTS ENROLLED
IN ALL SECTIONS OF ABC BIOLOGY AND TRADITIONAL BIOLOGY AT THE
THIRD METROPOLITAN HIGH SCHOOL

	ABC Biology (n = 23)	Traditional Biology (n = 31)
Pre-Test Mean	72.96	74.39
Pre-Test S.D.	14.46	13.80
Post-Test Mean	74.96	76.61
Post-Test S.D.	13.06	13.52
Difference Mean	2.00	2.23
Difference S.D.	12.14	8.26
Pre-Test versus Post-Test	t = 0.49 p < .63	t = 0.64 p < .52
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) t = 0.08 p < .94		

TABLE XXXVII

ANALYSIS OF THE SCIENCE ATTITUDE SURVEY FOR STUDENTS ENROLLED
IN ALL SECTIONS OF ABC BIOLOGY AND TRADITIONAL BIOLOGY AT THE
RURAL HIGH SCHOOL

	ABC Biology (n = 20)	Traditional Biology (n = 15)
Pre-Test Mean	65.00	66.00
Pre-Test S.D.	12.23	17.93
Post-Test Mean	66.65	68.33
Post-Test S.D.	12.57	18.11
Difference Mean	1.65	2.33
Difference S.D.	10.85	12.55
Pre-Test versus Post-Test	t = 0.68 p < .51	t = 0.70 p < .48
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) t = 0.17 p < .87		

increase of 1.65 with an average of 66.65. These data indicated no significant gain in score at the $\alpha = .05$ level of significance. Sixteen traditional students averaged 66.00 on the pre-test and 68.33 on the post-test for a mean difference of 2.33. The traditional curriculum students also recorded no significant increase in score at the $\alpha = .05$ level of significance. No significant difference between groups was found at the $\alpha = .05$ level of significance.

Table XXXVIII illustrates the distribution and analysis of the pre-test, post-test and difference scores on the science attitude survey for students enrolled ABC biology and traditional biology at all high schools. The ABC biology students ($n = 188$) recorded a pre-test average of 66.87 and a post-test average of 67.37. These numbers dictated a difference mean of 0.51. At the $\alpha = .05$ level of significance, no significant gain in score was evident. The traditional biology students ($n = 188$) recorded a pre-test average of 67.26 and a post-test average of 66.19 for a difference mean of -1.07. These students had no significant change in score at the $\alpha = .05$ level of significance. In review, the ABC biology students had a lower pre-test, but rebounded to produce a higher post-test average than the traditional biology students. Overall, there was no significant difference between the ABC and traditional curricula at the $\alpha = .05$ level of significance.

TABLE XXXVIII

ANALYSIS OF THE SCIENCE ATTITUDE SURVEY FOR STUDENTS ENROLLED
IN ALL SECTIONS OF ABC BIOLOGY AND TRADITIONAL BIOLOGY AT ALL
HIGH SCHOOLS

	ABC Biology (n = 188)	Traditional Biology (n = 188)
Pre-Test Mean	66.87	67.26
Pre-Test S.D.	16.64	14.55
Post-Test Mean	67.37	66.19
Post-Test S.D.	17.56	17.56
Difference Mean	0.51	-1.07
Difference S.D.	15.08	12.81
Pre-Test versus Post-Test	t = 0.29 p < .77	t = 0.64 p < .52
ABC Biology Students versus Traditional Biology Students (Difference Score Analysis) t = 1.09 p < .27		

Chapter V

Summary, Conclusions, Recommendations and Implications

Summary

Fifty percent of all careers require a functional knowledge of fundamental biology and chemistry. Therefore, it is of vital importance that all people entering the job force possess a working framework of the biological and chemical sciences. Furthermore, it should be noted that the labor market continually requires expanded and diversified skills from new entrants. This is especially true for those in technological fields like biology and chemistry (United States Department of Commerce, 1991).

Unfortunately, secondary students in the United States are typically underachievers in science. This has led many education experts to question whether the typical instructional methodologies used in science are effective (Johnson and Johnson, 1987). Science instruction has traditionally focused on developing theoretical knowledge through memorization of information. Limited emphasis has been placed on practical application of memorized data. In addition, little effort has been directed toward fostering a positive student attitude toward science.

Increased interest has recently surfaced concerning the use of applied instructional techniques for disseminating scientific instruction. Harvey (1991) referenced the need for

applied curricula which will make academic concepts relevant to the workplace.

Furthermore, he contended that students enrolled in applied curriculum courses exhibit a more positive subject attitude than their traditional curriculum peers. If students do truly develop an enhanced perspective of the subject due to more practical instruction, then it is reasonable to assume that their subject competence would improve as well.

Problem

Traditional science teaching methods may be an ineffective preparation venue for students assuming careers in a technologically advanced labor market. Most science based occupations require the active application of information commonly found in public school science curricula. However, traditional science curricula utilize instruction techniques such as rote memorization which do not focus on pragmatic occupational preparation. It has been indicated that instruction which mirrors the environment where it will be used is most effective. Therefore, it is arguable that a curriculum which stresses an applied approach employing the cooperative learning method may be a more effective means of teaching a diverse base of scientific information. For this reason, the relative effectiveness of an applied science curriculum needs to be evaluated.

Purpose

The purpose of this study was to compare the Applied Biology/Chemistry (ABC) curriculum taught using the cooperative learning method with the traditional biology curriculum taught using more typical instruction by means of student scores on a standardized biology test and science attitude survey.

Objectives

Six objectives were established in efforts to achieve the purpose of the study.

The objectives of this study were:

1. To compare pre-test and post-test scores on the National Association of Biology Teachers/National Science Teachers Association (NABT/NSTA) biology test of those students taught the ABC curriculum using the cooperative learning method in selected Oklahoma schools.
2. To compare pre-test and post-test scores on the NABT/NSTA biology test of those students taught the traditional biology curriculum using typical teaching methods in selected Oklahoma schools.
3. To compare pre-test and post-test difference scores on the NABT/NSTA biology test of those students taught the ABC curriculum using the cooperative learning method with those taught the traditional biology curriculum using typical teaching methods in selected Oklahoma schools.
4. To compare pre-test and post-test scores on the science attitude survey of those students taught the ABC curriculum using the cooperative learning method in selected Oklahoma schools.
5. To compare pre-test and post-test scores on the science attitude survey of those students taught the traditional biology curriculum using typical teaching methods in selected Oklahoma schools.
6. To compare pre-test and post-test scores on the science attitude survey of those students taught the ABC curriculum using the cooperative learning method with those

taught the traditional biology curriculum using typical teaching methods in selected Oklahoma schools.

Hypotheses

Listed below are the hypotheses which were constructed to achieve the objectives of the study. Hypotheses are categorized by related assessment instrument.

NABT/NSTA Biology Test Hypotheses

- **Ho₁-** There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in ABC Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- **Ho₂-** There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- **Ho₃-** There is no significant difference between the pre-test and post-test difference scores on the NABT/NSTA biology test of students enrolled in ABC Biology I and students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- **Ho₄-** There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in ABC Biology I at the First

- Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- H_{05} - There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
 - H_{06} - There is no significant difference between the pre-test and post-test difference scores on the NABT/NSTA biology test of students enrolled in ABC Biology I and students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
 - H_{07} - There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in ABC Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
 - H_{08} - There is no significant difference between the pre-test and post-test scores on the NABT/NSTA biology test of students enrolled in traditional Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
 - H_{09} - There is no significant difference between the pre-test and post-test difference scores on the NABT/NSTA biology test of students enrolled in ABC Biology I and students enrolled in traditional Biology I in each section at the First Metropolitan High

School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.

Science Attitude Survey Hypotheses

- H_{010} - There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in ABC Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- H_{011} - There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- H_{012} - There is no significant difference between the pre-test and post-test difference scores on the science attitude survey of students enrolled in ABC Biology I and students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School and the Rural High School.
- H_{013} - There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in ABC Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.

- Ho₁₄- There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₁₅- There is no significant difference between the pre-test and post-test difference scores on the science attitude survey of students enrolled in ABC Biology I and students enrolled in traditional Biology I at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₁₆- There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in ABC Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₁₇- There is no significant difference between the pre-test and post-test scores on the science attitude survey of students enrolled in traditional Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.
- Ho₁₈- There is no significant difference between the pre-test and post-test difference scores on the science attitude survey of students enrolled in ABC Biology I and students enrolled in traditional Biology I in each section at the First Metropolitan High School, the Second Metropolitan High School, the Third Metropolitan High School or the Rural High School.

Hypothesis Testing

A t-test analysis was used to determine whether significant differences existed for each of the null hypotheses. An alpha level of $\alpha = .05$ was used to determine statistical significance. The use of t-tests was explained by Popham (1973) as follows:

The t-test is used to determine just how great the difference between two means must be for it to be judged significant, that is, a significant departure from differences, which might be expected from chance alone. Another way of stating the function of the t-test is to assert that, through its use, we test the null hypothesis that two group means are not significantly different, that is, the means are so similar that the same groups can be considered to have been drawn from the same population (pp. 124-125).

All data were analyzed by the researcher using Microsoft Excel for Windows 5.0. Specifically, the t-tests were conducted using the t-test for two samples assuming unequal variances contained in the Analysis Tools of the spreadsheet program. Raw scores, means, and standard deviations are also presented in the analysis.

Scope

The scope of the study consisted of students enrolled in either a traditional biology course or an ABC biology course at four Oklahoma high schools. Three of the locations were in metropolitan areas and the other was in an area classified as rural. The first metropolitan school had a total of 79 and 77 traditional students record scores on the

NABT/NSTA biology test and the science attitude survey, respectively. In contrast, the ABC biology students posted 93 NABT/NSTA biology test scores and 92 science attitude survey scores. At the second metropolitan school, the ABC students had 54 scores on the NABT/NSTA biology test and 53 scores on the science attitude survey. In contrast, 65 traditional biology scores were recorded for both the test and the survey. The third metropolitan school had a total of 32 and 31 traditional biology scores on the NABT/NSTA biology test and science attitude survey, respectively. In contrast, there were 23 ABC biology scores for both instruments. At the rural school, ABC biology scores were collected from 20 students on the NABT/NSTA biology test and the science attitude survey. In contrast, traditional biology scores were garnered from 16 students on the NABT/NSTA biology test and from 15 students on the science attitude survey.

Measurement Instruments

The 1990 version of the National Association of Biology Teachers/National Science Teachers Association (NABT/NSTA) Biology examination was used as a pre-test and post-test for all biology students. The test was composed by the High School Biology Examination Development Committee of the (NABT/NSTA). This committee has eight members of equal gender distribution representing all geographic regions of the United States. The examination was developed to ascertain skills and understanding in eight science areas: 1) bioenergetics, 2) genetics, 3) ecology, 4) behavior, 5) STS (Science, Technology and Society), 6) systems and 7) technology. It was normed on 889 students with a mean of 45.092, standard deviation of 13.771 and a standard error of .462.

The science attitude survey uses responses to 20 statements to accomplish its purpose. It was focused toward determining biology attitude. Students could either strongly agree, agree, neither agree or disagree, disagree or strongly disagree to each of the statements. Constant increment point values were assigned to each possible response. Values from question to question were consistent. Thirteen of the items were positive attitude statements; seven were negative attitude statements. On the negative attitude items, the point values were reversed. Higher scores were associated with a more positive attitude. The instrument was administered as a pre-test and post-test to all biology students.

Measurement Procedures

The pre-tests were administered to students within the first four weeks of the 1993-94 academic year. One of two versions of the NABT/NSTA biology test, differing in only in item order, was randomly administered to each student. All of the science attitude surveys were identical in content and form. Both the ABC and traditional students were provided identical instructions. During the last three weeks of the school year, the post-tests were given. The alternative version of the achievement test was given to each student.

Findings

Since the hypotheses were multifaceted, it would obscure the findings to address each one individually. Therefore, the major results of the study are presented in a school-by-school and entire group format. Summary tables are provided enhance the narrative.

First Metropolitan High School

Table XXXIX summarizes the findings for the first metropolitan high school. Data for both the NABT/NSTA biology test and the attitude survey are included. At this school, a total of five sections of both ABC and traditional biology were taught. On the NABT/NSTA biology test, data was obtained from ninety-three ABC biology students and seventy-nine traditional biology students. Attitude survey data was garnered from ninety-two ABC biology students and seventy-seven traditional biology students.

The ABC biology students recorded significant gains on the NABT/NSTA biology test in three of the five sections of the course at the $\alpha = .05$ level of significance. An $\alpha = .05$ significant gain was also evident when all scores for the ABC biology students were combined. No significant changes in NABT/NSTA scores were posted for any section or for the entire group of traditional biology students at the $\alpha = .05$ level of significance. In comparison, the ABC curriculum produced significantly higher gains in achievement test score than the traditional biology curriculum at the $\alpha = .05$ level of significance.

The ABC biology students in the first section posted a significant gain in score on the attitude survey at the $\alpha = .05$ level of significance. However, no significant differences were found for any other section or the entire group of ABC biology students. The traditional biology students produced a significant decrease in score on the attitude survey in section II and section III. No additional significant changes in score were found for any other section or for the entire group of traditional biology students. In contrast, the ABC biology students recorded a significantly higher difference score on the attitude survey than the traditional students at the $\alpha = .05$ level of significance.

Table XXXIX

**SUMMARY OF NABT/NSTA BIOLOGY TEST AND ATTITUDE SURVEY RESULTS FOR STUDENTS ENROLLED IN ABC
BIOLOGY AND TRADITIONAL BIOLOGY AT THE FIRST METROPOLITAN HIGH SCHOOL**

		NABT/NSTA Test						Attitude Survey					
		N	pre-test mean	post-test mean	difference mean	t-statistic	p-value	N	pre-test mean	post-test mean	difference mean	t-statistic	p-value
First Metropolitan High School													
Section I	ABC	20	24.95	31.40	6.45	3.66	.00	21	57.14	63.81	6.67	3.81	.00
	Traditional	9	26.89	28.78	1.89	0.66	.53	10	68.40	72.00	3.60	1.13	.29
	Comparison	-	-	-	-	1.36	.19	-	-	-	-	0.84	.41
Section II	ABC	15	25.13	28.53	3.40	1.61	.13	15	66.67	61.27	-5.40	0.74	.47
	Traditional	20	21.80	22.50	0.70	0.34	.37	20	57.10	49.45	-7.65	2.06	.05
	Comparison	-	-	-	-	0.91	.37	-	-	-	-	0.27	.79
Section III	ABC	23	25.09	30.35	5.26	3.28	.00	21	68.14	74.61	5.48	1.68	.11
	Traditional	17	21.64	23.76	2.12	1.18	.26	15	63.73	55.47	-8.27	2.11	.05
	Comparison	-	-	-	-	1.35	.20	-	-	-	-	2.69	.01
Section IV	ABC	15	24.80	29.13	4.33	1.85	.09	15	75.87	72.07	-3.60	0.99	.34
	Traditional	21	25.19	23.67	-1.52	0.78	.44	20	63.10	59.45	-3.65	1.18	.25
	Comparison	-	-	-	-	1.92	.06	-	-	-	-	0.01	.99
Section V	ABC	20	22.00	30.00	8.00	4.10	.00	20	65.25	62.20	-3.05	0.91	.38
	Traditional	12	20.08	23.75	3.67	2.50	.03	12	65.25	63.58	-2.97	1.04	.32
	Comparison	-	-	-	-	1.77	.09	-	-	-	-	0.09	.93
Combined	ABC	93	24.35	30.01	5.66	4.59	.00	92	66.02	66.66	0.64	0.24	.81
	Traditional	79	22.99	23.99	1.00	0.81	.42	77	62.69	58.19	-4.49	1.67	.10
	Comparison	-	-	-	-	3.71	.00	-	-	-	-	2.14	.03

Note: Shaded areas indicate an $\alpha = .05$ significant difference.

Second Metropolitan High School

Table XL summarizes the findings for the second metropolitan high school. Data for both the NABT/NSTA biology test and the attitude survey are included. At this school, a total of five sections of both ABC and traditional biology were taught. On the NABT/NSTA biology test, data was obtained from fifty-four ABC biology students and sixty-five traditional biology students. Attitude survey data was garnered from fifty-three ABC biology students and sixty-five traditional biology students.

The ABC biology students posted significant increases in NABT/NSTA test score in Section III and Section V at the $\alpha = .05$ level of significance. Moreover, these students also demonstrated an $\alpha = .05$ significant increase when all sections were combined. The traditional students recorded significant advances in NABT/NSTA score in all five sections at the $\alpha = .05$ level of significance. Logically, these students also posted an $\alpha = .05$ significant increase in score when all scores were combined. Comparatively, the traditional curriculum was found to be superior to the ABC curriculum at the $\alpha = .05$ level of significance.

Analysis of the science attitude survey revealed no significant differences for either the ABC biology students or the traditional biology students at the $\alpha = .05$ level of significance. The two groups failed to distinguish themselves in cross comparison at the $\alpha = .05$ level of significance.

Third Metropolitan High School

Table XLI summarizes the findings for the third metropolitan high school. Data

Table XL

**SUMMARY OF NABT/NSTA BIOLOGY TEST AND ATTITUDE SURVEY RESULTS FOR STUDENTS ENROLLED IN ABC
BIOLOGY AND TRADITIONAL BIOLOGY AT THE SECOND METROPOLITAN HIGH SCHOOL**

		NABT/NSTA Test						Attitude Survey					
		N	pre-test mean	post-test mean	difference mean	t-statistic	p-value	N	pre-test mean	post-test mean	difference mean	t-statistic	p-value
Second Metropolitan High School													
Section I	ABC	8	21.50	24.00	2.50	0.80	.45	8	63.63	64.88	1.25	0.18	.87
	Traditional	6	24.67	37.00	12.33	3.00	.03	6	75.67	72.00	-3.67	1.61	.17
	Comparison	-	-	-	-	1.90	.09	-	-	-	-	0.66	.53
Section II	ABC	4	21.40	31.40	10.00	0.81	.48	3	29.33	58.33	-1.00	0.19	.87
	Traditional	15	17.50	23.50	6.00	3.49	.00	15	69.67	72.60	2.93	0.96	.35
	Comparison	-	-	-	-	0.50	.65	-	-	-	-	0.65	.56
Section III	ABC	14	19.14	29.07	9.93	4.49	.00	14	67.79	66.14	-1.64	0.38	.71
	Traditional	15	19.33	32.20	12.87	5.02	.00	15	66.93	70.60	3.67	0.98	.34
	Comparison	-	-	-	-	0.87	.39	-	-	-	-	0.93	.36
Section IV	ABC	14	25.86	26.50	0.64	0.44	.67	14	66.21	61.29	-4.93	1.48	.16
	Traditional	16	22.13	32.13	10.00	5.12	.00	16	70.81	72.88	2.06	0.89	.39
	Comparison	-	-	-	-	3.83	.00	-	-	-	-	1.72	.10
Section V	ABC	14	24.57	31.00	6.43	2.71	.02	14	68.29	71.29	3.00	1.02	.33
	Traditional	13	21.84	29.38	7.54	3.18	.01	13	68.08	63.77	-5.31	1.28	.22
	Comparison	-	-	-	-	0.38	.71	-	-	-	-	1.64	.12
Combined	ABC	54	22.51	27.74	5.19	2.95	.00	53	66.40	65.58	-0.81	0.23	.82
	Traditional	65	21.49	31.88	10.38	3.98	.00	65	69.55	70.18	0.63	0.28	.78
	Comparison	-	-	-	-	3.11	.00	-	-	-	-	0.58	.56

Note: Shaded areas indicate an $\alpha = .05$ significant difference.

Table XLI

SUMMARY OF NABT/NSTA BIOLOGY TEST AND ATTITUDE SURVEY RESULTS FOR STUDENTS ENROLLED IN ABC BIOLOGY AND TRADITIONAL BIOLOGY AT THE THIRD METROPOLITAN HIGH SCHOOL

		NABT/NSTA Test					Attitude Survey						
		N	pre-test mean	post-test mean	difference mean	t-statistic	p-value	N	pre-test mean	post-test mean	difference mean	t-statistic	p-value
Third Metropolitan High School													
Section I	ABC	12	22.92	27.67	4.75	2.18	.05	12	73.00	70.92	-2.08	0.85	.42
	Traditional	16	21.63	37.31	15.69	11.39	.00	15	77.33	80.40	3.07	1.90	.08
	Comparison	-	-	-	-	4.25	.00	-	-	-	-	1.74	.10
Section II	ABC	11	22.91	29.91	7.00	2.76	.02	11	72.91	79.36	6.45	1.51	.16
	Traditional	16	21.63	28.88	7.25	2.92	.01	16	71.63	73.06	1.44	0.60	.58
	Comparison	-	-	-	-	0.07	.95	-	-	-	-	1.01	.33
Combined	ABC	23	22.91	28.74	5.83	2.55	.01	23	72.96	74.96	2.00	0.49	.63
	Traditional	32	21.63	33.09	11.47	5.93	.00	31	74.39	76.61	2.23	0.64	.52
	Comparison	-	-	-	-	2.47	.02	-	-	-	-	0.08	.94

Note: Shaded areas indicate an $\alpha = .05$ significant difference.

for both the NABT/NSTA biology test and the attitude survey are included. At this school, two sections of both ABC and traditional biology were taught. On the NABT/NSTA biology test, data was obtained from twenty-three ABC biology students and thirty-two traditional biology students. Attitude survey data was garnered from twenty-three ABC biology students and thirty-one traditional biology students.

Both sections of both curriculum groups had significant post-test verses pre-test gains on the NABT/NSTA biology test at the $\alpha = .05$ level of significance. The traditional biology students produced an $\alpha = .05$ significant advantage over the ABC biology students in the first section and the combined comparisons when the difference scores were analyzed.

Analysis of the science attitude survey revealed no significant differences for either the ABC biology students or the traditional biology students at the $\alpha = .05$ level of significance. The two groups failed to distinguish themselves in cross comparison at the $\alpha = .05$ level of significance.

Rural High School

Table XLII summarizes the findings for the rural high school. Data for both the NABT/NSTA biology test and the attitude survey are included. At this school, one section of both ABC and traditional biology was taught. On the NABT/NSTA biology test, data was obtained from twenty ABC biology students and sixteen traditional biology students. Attitude survey data was garnered from twenty ABC biology students and fifteen traditional biology students.

Table XLII

SUMMARY OF NABT/NSTA BIOLOGY TEST AND ATTITUDE SURVEY RESULTS FOR STUDENTS ENROLLED IN ABC BIOLOGY AND TRADITIONAL BIOLOGY AT THE RURAL HIGH SCHOOL

		NABT/NSTA Test					Attitude Survey						
		N	pre-test mean	post-test mean	difference mean	t-statistic	p-value	N	pre-test mean	post-test mean	difference mean	t-statistic	p-value
Rural High School													
Section I/Combined	ABC	20	24.95	29.65	4.70	5.24	.00	20	65.00	66.65	1.65	0.68	.51
	Traditional	16	27.38	31.81	4.44	2.66	.01	15	66.00	68.33	2.33	0.70	.48
	Comparison	-	-	-	-	0.01	.98	-	-	-	-	0.17	.87

Note: Shaded areas indicate an $\alpha = .05$ significant difference.

On the NABT/NSTA, both curriculum groups produced a significant post-test versus pre-test gain in score at the $\alpha = .05$ level of significance. In cross comparison, the groups failed to distinguish themselves at the $\alpha = .05$ level of significance.

Analysis of the science attitude survey revealed no significant differences for either the ABC biology students or the traditional biology students at the $\alpha = .05$ level of significance. The two groups failed to distinguish themselves in cross comparison at the $\alpha = .05$ level of significance.

All High Schools

Table XLIII summarizes the findings for all high schools. Data for both the NABT/NSTA biology test and the attitude survey are included. On the NABT/NSTA biology test, data was obtained from one hundred ninety ABC biology students and one hundred ninety-two traditional biology students. Science attitude survey data was garnered from one hundred eighty-eight ABC biology students and one hundred eighty-eight traditional biology students.

Use of the ABC biology and traditional biology curricula produced $\alpha = .05$ significant gains in post-test versus pre-test on the NABT/NSTA biology test. In comparison, data analysis revealed no significant differences between the groups at the $\alpha = .05$ level of significance.

Analysis of the science attitude survey revealed no significant differences for either the ABC biology students or the traditional biology students at the $\alpha = .05$ level

Table XLIII

**SUMMARY OF NABT/NSTA BIOLOGY TEST AND ATTITUDE SURVEY RESULTS FOR STUDENTS ENROLLED IN ABC
BIOLOGY AND TRADITIONAL BIOLOGY AT ALL HIGH SCHOOLS**

		NABT/NSTA Test						Attitude Survey					
		N	pre-test mean	post-test mean	difference mean	t-statistic	p-value	N	pre-test mean	post-test mean	difference mean	t-statistic	p-value
All High Schools													
Combined	ABC	190	23.72	29.17	5.44	6.29	.00	188	66.87	67.37	0.51	0.29	.77
	Traditional	192	22.62	28.82	6.20	7.01	.01	188	67.26	66.19	-1.07	0.64	.52
	Comparison	-	-	-	-	0.84	.40	-	-	-	-	1.09	.27

Note: Shaded areas indicate an $\alpha = .05$ significant difference.

of significance. The two groups failed to distinguish themselves in cross comparison at the $\alpha = .05$ level of significance.

Conclusions

The following section identifies the conclusions of the study as related to the objectives:

1. The analysis of data revealed that nine of thirteen sections of ABC biology exhibited a significant increase at the $\alpha = .05$ level of significance in post-test score verses the pre-test score on the NABT/NSTA biology test. In addition, the composite comparison for each school and for the entire group demonstrated an $\alpha = .05$ significant increase in score. *Therefore, it was concluded that the use of the ABC curriculum was an effective means of increasing biology knowledge.*
2. The analysis of data revealed that nine of thirteen sections of ABC biology exhibited a significant increase at the $\alpha = .05$ level of significance in post-test score verses the pre-test score on the NABT/NSTA biology test. In addition, the composite comparison for three of the four schools and for the entire group demonstrated an $\alpha = .05$ significant increase in score. *Therefore, it was concluded that the use of the traditional curriculum was an effective means of increasing biology knowledge.*
3. The analysis of data indicated that the ABC curriculum was superior to the traditional curriculum at the first metropolitan school at the $\alpha = .05$ level of significance. In contrast, at the same significance level, the traditional curriculum was superior to the ABC curriculum at the other two metropolitan schools. At the rural school, there was

no $\alpha = .05$ significant difference between the curricula. Finally, there was no $\alpha = .05$ significant difference between curricula for the entire group. Obviously, neither curriculum demonstrated consistent superiority. *Therefore, it was concluded that the curricula were equivalent in their ability to increase biology knowledge.*

4. The ABC biology group had only one section to record an $\alpha = .05$ significant increase on post-test score versus pre-test score on the science attitude survey. There were no significant changes at the $\alpha = .05$ in score for any school or for the entire group. *For this reason, it was concluded that the use of the ABC curriculum had no effect on the attitude of students toward science.*
5. The traditional biology group had two sections at one school record an $\alpha = .05$ significant decrease on post-test score versus pre-test score on the science attitude survey. There were no significant changes at the $\alpha = .05$ in score for any school or for the entire group. *For this reason, it was concluded that the use of the traditional curriculum had no effect on the attitude of students toward science.*
6. In direct comparison of difference scores on the science attitude survey, an $\alpha = .05$ level of significant difference was found at the first metropolitan school. At that school, the ABC students had significantly higher difference scores than the traditional students. However, no other significant differences were found at the $\alpha = .05$ level of significance. *Therefore, it was concluded that the use of either curriculum produced similar effects on the attitudes of students toward science.*

Recommendations

The following list of recommendations is provided in relation to the outcomes of the study.

1. Students should be offered secondary biology which uses the ABC biology curriculum.

Although it was concluded the curricula were equivalent in their ability to increase biology knowledge and modify science attitude, the ABC curricula is more relevant and contemporary. Furthermore, its presence in an academic program should entice a larger student clientele to procure biology credit.

2. Students should receive identical recognition for successful completion of either ABC biology or traditional biology in efforts to fulfill high school graduation requirements.

It was concluded the curricula were equivalent in their ability to increase biology knowledge and modify science attitude.

3. Students should receive identical recognition for successful completion of either ABC biology or traditional biology in efforts to fulfill college entrance requirements. It was concluded the curricula were equivalent in their ability to increase biology knowledge and modify science attitude.

4. Students should be offered either ABC biology or traditional biology. The presence of both alternatives will provide for the matching of learning style to teaching approach.

5. Teachers should be provided in-service training focused on effectively utilizing applied curricula and alternative instruction approaches. An increased store of teaching skills and materials will undoubtedly elevate the quality of teacher instruction.

6. More applied curricula should be developed for use in other disciplines of the general academic arena. The ABC biology curriculum was concluded to be a viable alternative to the traditional biology curriculum. Therefore, it is reasonable to assume that applied curricula developed in other areas would produce similar results.
7. Alternative methods of evaluating applied curricula should be developed and adopted. Traditional methods of student knowledge assessment may not be appropriate for evaluating applied curricula. Alternative curricula may require alternative assessment.

Implications

If secondary students are not provided appealing options in biology curriculum, many of those students may not be motivated to pursue the study of biology. This assumption might also be extended to all scientific instruction. Literature cited in this study related the increased need of students to acquire science knowledge to adequately prepare for the careers of the next century. For this reason, it is the charge of all educators and administrators to utilize the highest quality instructional methods and materials available.

The ABC curriculum provides instruction which fosters a wider acquaintance and broader outlook than traditional methods of furnishing science instruction. It is the intent of this curriculum to not only instill science knowledge, but also to present material in a useful and exciting manner. If more educators and administrators incorporate this type of innovative instruction, then the requirements of tomorrow's workforce may be more successfully met.

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APPENDIXES

APPENDIX A

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
FOR
HUMAN SUBJECTS RESEARCH

**OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW**

Date: 12-21-94

IRB#: AG-95-007

Proposal Title: ASSESSMENT OF THE APPLIED BIOLOGY/CHEMISTRY CURRICULUM

Principal Investigator(s): James Key, Jaye Hamby

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

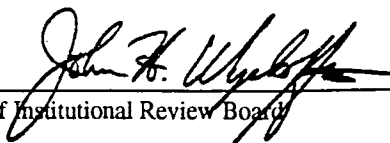
APPROVAL STATUS SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.

APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.

ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

Signature:



Chair of Institutional Review Board

Date: December 22, 1994

APPENDIX B

SCIENCE ATTITUDE SURVEY

ATTITUDE TOWARD SCIENCE AND BIOLOGY

Please use the following scale to answer the following questions:

- SA -- Strongly Agree
- A -- Agree
- N -- Neither Agree nor Disagree
- D -- Disagree
- SD -- Strongly Disagree

(Circle one choice)

- (1) SA A N D SD Science is fun.
- (2) SA A N D SD I do not like science and it bothers me to have to study it.
- (3) SA A N D SD During science class, I usually am interested.
- (4) SA A N D SD I would like to learn more about science.
- (5) SA A N D SD If I knew I would never go to science class again, I would feel sad.
- (6) SA A N D SD Science is interesting to me and I enjoy it.
- (7) SA A N D SD Science makes me feel uncomfortable, restless, irritable, and impatient.
- (8) SA A N D SD Science is fascinating and fun.
- (9) SA A N D SD The feeling that I have towards science is a good feeling.
- (10) SA A N D SD When I hear the word science, I have a feeling of dislike.
- (11) SA A N D SD Science is a topic which I enjoy studying.
- (12) SA A N D SD I feel at ease with science and I like it very much.
- (13) SA A N D SD I feel a definite positive reaction to science.
- (14) SA A N D SD Science is boring.
- (15) SA A N D SD Biology is interesting to me and I enjoy it.
- (16) SA A N D SD I do not like Biology and it bothers me to study it.
- (17) SA A N D SD I would like to learn more about Biology.
- (18) SA A N D SD Biology is boring.
- (19) SA A N D SD When I hear the word Biology, I have a feeling of dislike.
- (20) SA A N D SD During Biology class, I usually am interested.

APPENDIX C

1990 NABT/NSTA BIOLOGY TEST CONCEPTS AND DISTRIBUTIONS

1990 NABT/NSTA BIOLOGY TEST CONCEPTS AND DISTRIBUTIONS

Cell Structure- 8 questions

Bioenergetics- 7 questions

Genetics- 12 questions

Ecology- 8 questions

Evolution- 12 questions

Behavior- 11 questions

Science, Technology and Society- 8 questions

Systems- 8 questions

Taxonomy- 6 questions

APPENDIX D

APPLIED BIOLOGY/CHEMISTRY TEACHER QUESTIONNAIRE

Please answer the following questions concerning the entire course.

1. How well did you feel this curriculum met the learner outcomes for Biology I?

2. Do you believe that this course changed students' attitudes toward science? If so, how?

3. What do you think your students' perceptions of this course were?

4. What do you think parents' perceptions of this course were?

5. How do you think your principal perceived this course?

6. How do you think your superintendent perceived this course?

7. Should students be given science credit for this course?

8. What is your overall perception of the course?

9. Do you see the need for a graduate level course aimed at teaching AB/C? If so briefly describe this course (no. of hours, when taught, what covered, etc.)

10. What advice would you offer to someone who is planning to teach this course next year?

VITA 

Julian LeRon (Jaye) Hamby

Candidate for the Degree of

Doctor of Education

Thesis: AN ASSESSMENT OF THE APPLIED BIOLOGY/CHEMISTRY
CURRICULUM IN SELECTED OKLAHOMA SCHOOLS

Major Field: Agricultural Education

Biographical:

Personal Data: Born in Cleveland, Tennessee, March 1, 1968.

Education: Attended Benton Elementary School, Benton, Tennessee;
graduated from Polk County High School, Benton, Tennessee, in May, 1986;
received Bachelor of Science degree in Agricultural Education from the
University of Tennessee, Knoxville in December, 1991; received Master of
Agriculture degree in Agricultural Education from Oklahoma State University,
Stillwater in May, 1993; completed requirements for the Doctor of Education
degree in Agricultural Education in May, 1995.

Professional Experience: State President, Tennessee FFA Association,
Nashville, Tennessee, 1986-87; National Vice President, National FFA
Organization, Alexandria, Virginia, 1988-89; Director, Washington Conference
Program, National FFA Organization, Alexandria, Virginia, 1991-93; Team
Leader, Made For Excellence Conferences, National FFA Organization,
Alexandria, Virginia, 1990-93; Graduate Research Associate, Department of
Agricultural Education, Communications and 4-H Youth Development,
Oklahoma State University, Stillwater, Oklahoma.