The Effect of a Zoo-Based Experiential Academic Science Program on High School Students' Math and Science Achievement and Perceptions of School Climate

Elizabeth A. Mulkerrin

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The Effect of a Zoo-Based Experiential Academic Science Program on High School Students’ Math and Science Achievement and Perceptions of School Climate

By

Elizabeth A. Mulkerrin

A DISSERTATION
Presented to the Faculty of
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For the Degree of Doctor of Education
Major: Educational Administration
Under the Supervision of Dr. John W. Hill
Omaha, Nebraska
May, 2012

Supervisory Committee
Dr. John W. Hill, Chair
Dr. Kay A. Keiser
Dr. Neal F. Grandgenett
Dr. Larry L. Dlugosh
Abstract

THE EFFECT OF A ZOO-BASED EXPERIENTIAL ACADEMIC SCIENCE PROGRAM ON HIGH SCHOOL STUDENTS’ MATH AND SCIENCE ACHIEVEMENT AND PERCEPTIONS OF SCHOOL CLIMATE

Elizabeth A. Mulkerrin, Ed.D.
University of Nebraska, 2012
Advisor: Dr. John W. Hill

The purpose of this study was to determine the effect of an 11th-grade and 12th-grade zoo-based academic high school experiential science program compared to a same school-district school-based academic high school experiential science program on students’ pretest and posttest science, math, and reading achievement, and student perceptions of program relevance, rigor, and relationships. Science coursework delivery site served as the study’s independent variable for the two naturally formed groups representing students (n = 18) who completed a zoo-based experiential academic high school science program and students (n = 18) who completed a school-based experiential academic high school science program. Students in the first group, a zoo-based experiential academic high school science program, completed real world, hands-on projects at the zoo while students in the second group, those students who completed a school-based experiential academic high school science program, completed real world, simulated projects in the classroom. These groups comprised the two research arms of the study. Both groups of students were selected from the same school district. The study’s two dependent variables were achievement and school climate. Achievement was analyzed using norm-referenced 11th-grade pretest PLAN and 12th-grade posttest ACT
test composite scores. Null hypotheses were rejected in the direction of improved test scores for both science program groups--students who completed the zoo-based experiential academic high school science program ($p < .001$) and students who completed the school-based experiential academic high school science program ($p < .001$). The posttest-posttest ACT test composite score comparison was not statistically different ($p = .93$) indicating program equipoise for students enrolled in both science programs. No overall weighted grade point average score improvement was observed for students in either science group, however, null hypotheses were rejected in the direction of improved science grade point average scores for 11th-grade ($p < .01$) and 12th-grade ($p = .01$) students who completed the zoo-based experiential academic high school science program. Null hypotheses were not rejected for between group posttest science grade point average scores and school district criterion reference math and reading test scores. Finally, students who completed the zoo-based experiential academic high school science program had statistically improved pretest-posttest perceptions of program relationship scores ($p < .05$) and compared to students who completed the school-based experiential academic high school science program had statistically greater posttest perceptions of program relevance ($p < .001$), perceptions of program rigor ($p < .001$), and perceptions of program relationships ($p < .001$).
Acknowledgements

"Every accomplishment starts with the decision to try" -author unknown.

For many years, family, friends, and colleagues have been encouraging me to pursue a doctoral degree. Finally, I made the decision to try and started an incredible adventure and new chapter in my life. I am proud and humble to say I have accomplished a life-long goal. I would not have been able to close this chapter in my doctoral adventure without acknowledging all of the individuals who encouraged me to start this adventure and were there to support me to the end. It is amazing to think about how many individuals have been standing behind me and nudging me forward until I completed the doctoral process.

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CHAPTER ONE

Introduction

National and International Assessment Score

America’s students are neither mastering nor are they being adequately taught science and mathematics content as demonstrated by their Third International Mathematics and Science Study (TIMSS) scores, National Assessment of Educational Programs (NAEP) scores, or Program for International Student Assessment (PISA) test scores (Conley, 2001; Gonzales, Williams, Jocelyn, Roey, Kastberg, & Brenwald, 2008; Grigg, Lauko, & Brockway, 2006; Mourshed, Chijioke, & Barber, 2010; Peterson, 2010; Pittman, 2005) which ranks them average compared to students from other participating countries. International and national assessments are designed to test mastery of content, knowledge, reasoning, and understanding of science and mathematics at grades four, eight, and eleven (Gonzales et al., 2008; Grigg et al., 2006; Mourshed et al., 2010; Sawchuk, 2010). It has been asserted that students’ average scores on these high stakes assessments are unfortunate predictors of why the United States may be falling behind in its competitive edge in math and science careers--made all the more poignant when the goal is for America’s students to score and be ranked in the top five globally (National Academies, 2007; Peterson, 2010).

TIMSS Achievement Scores

Math. Of significant concern to educators, policy makers, and politicians alike is that TIMSS math achievement test scores trend lower over time as students are evaluated in the fourth-grade and eighth-grade. For example, in the most recent TIMSS (2007) math report, students in the fourth grade scored 11th out of 36 countries with an average
score of 529, and students in the eighth grade scored 9th out of 48 countries on math with an average score of 508. Furthermore, both males and females at all evaluated grade levels scored within the intermediate level of math knowledge where male students’ scores were marginally higher than female students’ math scores. For example, fourth-grade males on average scored 532, which is 32 points above the average TIMSS scale of 500 where fourth-grade females on average scored 526, which is 26 points above the average TIMSS scale of 500. Eighth-grade males on average scored 510, which is 10 points above the average TIMSS scale of 500 where eighth-grade females on average scored 507, which is 7 points above the average TIMSS scale of 500.

The math TIMSS results for fourth-grade students’ show how both males and females on average are scoring at the intermediate level of the international benchmark, and only 10% are scoring at or above the advanced international benchmark level. The TIMSS results for eighth-grade students show a similar picture, where both males and females on average are scoring at the intermediate level of the international benchmark, and only 6% are scoring at or above the international benchmark advance level (Gonzales et al., 2008; Peterson, 2010). When comparing the math results of U.S. students to other countries, in both cases, seven countries had a higher percentage of students at or above advanced international benchmark level. The results show U.S. students are not mastering mathematical content and are falling further behind as they progress through the educational system.

Science. Also of concern to educators, policy makers, and politicians is that TIMSS science achievement test scores also follow the math achievement scores and trend lower over time as students are evaluated in the fourth-grade and eighth-grade. For
example, in the most recent TIMSS (2007) science report, students in the fourth-grade scored 8th out of 36 countries with an average score of 539, and students in the eighth-grade scored 11th out of 48 countries on science with an average score of 520. Furthermore, both males and females at all evaluated grade levels scored within the intermediate level of science knowledge where male students’ scores were marginally higher than female students’ science scores. For example, fourth-grade males on average scored 541, which is 41 points above the average TIMSS scale of 500 where fourth-grade females on average scored 536, which is 36 points above the average TIMSS scale of 500. Eighth-grade males on average scored 526, which is 26 points above the average TIMSS scale of 500 where eighth-grade females on average scored 514, which is 14 points above the average TIMSS scale of 500.

The science TIMSS results for fourth-grade students show both males and females on average are scoring at the intermediate level of the international benchmark and only 15% of U.S. fourth-graders are scoring at or above the advance international benchmark level. The TIMSS results for eighth-grade students show both males and females on average are scoring at the intermediate level of the international benchmark and only 10% of U.S. eighth-graders are scoring at or above the advance international benchmark level (Gonzales et al., 2008; Peterson, 2010). The science test results indicate U.S. students are not mastering science content and are falling behind students from other nations at all grade levels.

The TIMSS assessment is one of many indicators demonstrating how our students are either not mastering math and science curriculum or are not receiving a level of math and science instruction and activities sufficient to raise their knowledge base and
therefore test scores. The apparent trend extent in international and national assessments is the fact that as our students progress through the U.S. education system they fare worse on these assessments over time. Instead of our students moving ahead in math and science by the time they are in the 12th grade, they lag behind students from many countries with fewer advantages and opportunities for learning. Moreover, decreasing math and science National Assessment of Educational Programs (NAEP) assessment scores are observed through high school. For example, by the time students have completed the 11th grade, their science NAEP (2009) test scores on average have decreased 13 percentage points compared to their fourth-grade scores. The same holds true in math scores where by the time students have completed the 11th grade, their math NAEP (2009) test scores on average have decreased 13 percentage points compared to their fourth-grade scores (National Center for Education, 2011a, 2011b, & 2011c). Alarming trends like the decrease of math and science proficiency in content knowledge from fourth-grade to the 12th-grade sends a message that the U.S. educational system needs to find a solution to the problem so our country can keep its competitive edge in math and science careers.

**Seeking Math and Science Education Reform**

Recent education reforms call for addressing the math and science instructional needs of high school students in order to better prepare them for math and science examinations as well as true success in and beyond the classroom (Achieve, Inc., 2009; Silverstein, Dubner, Miller, Glied, & Loike, 2009). For example, academy reform models are designing specialized programs and schools that focus on the rigor and relevance of math and science curriculum where students are completing their core
curricular courses during their freshman and sophomore years and opening up science and math electives and unique opportunities for students to explore a variety of career pathways (Achieve, Inc., 2005). It is theorized that creating an educational environment that has a balanced and rigorous curriculum while providing experiential learning in real-world science and math environments will better prepare students to be competitive in today’s global work force which demands these skills (Achieve, Inc., 2009; Kemple, 2004; Kemple & Willner, 2008; Pittman, 2005).

**Purpose of the Study**

The purpose of this study is to determine the effect of an 11th-grade and 12th-grade zoo-based academic high school experiential science program compared to a same school-district school-based academic high school experiential science program on students’ pretest and posttest science, math, and reading achievement, and student perceptions of program relevance, rigor, and relationships.

**Research Questions**

The following pretest-posttest research questions were used to analyze the effect of zoo-based academic high school experiential science program completion and same school district’s school-based academic high school experiential science program completion on students’ norm referenced achievement test composite scores.

**Overarching Pretest-Posttest Norm-Referenced Achievement Research**

**Question #1.** Did students who completed a zoo-based academic high school experiential science program lose, maintain, or improve their 11th-grade pretest PLAN normal curve equivalent test composite scores compared to their 12th-grade posttest ACT normal curve equivalent test composite scores?
Overarching Pretest-Posttest Norm-Referenced Achievement Research

**Question #2.** Did students who completed a school-based experiential academic high school science program lose, maintain, or improve their 11th-grade PLAN normal curve equivalent composite scores compared to their 12th-grade ACT normal curve equivalent composite scores?

Overarching Posttest Norm-Referenced Achievement Research **Question #3.**

Did students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program have congruent or different 12th-grade posttest ACT normal curve equivalent test composite scores?

Overarching Pretest-Posttest Overall Grade Point Average Research

**Question #4.** Did students who completed a zoo-based academic high school experiential science program lose, maintain, or improve their beginning 11th-grade overall grade point average compared to their ending 11th-grade overall grade point average?

**Question #5.** Did students who completed a school-based academic high school experiential science program lose, maintain, or improve their beginning 11th-grade overall grade point average compared to their ending 11th-grade overall grade point average?

**Question #6.** Did students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school
experiential science program have congruent or different 11th-grade ending overall grade point average scores?

**Overarching Pretest-Posttest Overall Grade Point Average Research**

**Question #7.** Did students who completed a zoo-based academic high school experiential science program lose, maintain, or improve their beginning 12th-grade overall grade point average compared to their ending 12th-grade overall grade point average?

**Overarching Pretest-Posttest Overall Grade Point Average Research**

**Question #8.** Did students who completed a school-based academic high school experiential science program lose, maintain, or improve their beginning 12th-grade overall grade point average compared to their ending 12th-grade overall grade point average?

**Overarching Posttest Overall Grade Point Average Research Question #9.**

Did students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program have congruent or different 12th-grade ending overall grade point average scores?

**Overarching Pretest-Posttest Science Grade Point Average Research**

**Question #10.** Did students who completed a zoo-based academic high school experiential science program lose, maintain, or improve their beginning 11th-grade pretest science grade point average compared to their ending 11th-grade posttest science grade point average scores?
Overarching Pretest-Posttest Science Grade Point Average Research

**Question #11.** Did students who completed a school-based academic high school experiential science program lose, maintain, or improve their beginning 11th-grade pretest science grade point average compared to their ending 11th-grade posttest science grade point average scores?

**Overarching Posttest Science Grade Point Average Research Question #12.**

Did students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program have congruent or different 11th-grade posttest science grade point average score?

**Overarching Pretest-Posttest Science Grade Point Average Research**

**Question #13.** Did students who completed a zoo-based academic high school experiential science program lose, maintain, or improve their beginning 12th-grade pretest science grade point average compared to their ending 12th-grade posttest science grade point average scores?

**Overarching Pretest-Posttest Science Grade Point Average Research**

**Question #14.** Did students who completed a school-based academic high school experiential science program lose, maintain, or improve their beginning 12th-grade pretest science grade point average compared to their ending 12th-grade posttest science grade point average scores?

**Overarching Posttest Science Grade Point Average Research Question #15.**

Did students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school
experiential science program have congruent or different 12th-grade posttest science
grade point average score?

**Overarching Posttest Criterion-Reference Test Research Question #16.** Did
11th-grade students who completed a zoo-based academic high school experiential
science program compared to 11th-grade students who completed a school-based
academic high school experiential science program have congruent or different 11th-
grade school district criterion reference (a) math and (b) reading test scores?

**Sub-Question 16a.** Were posttest (a) math school district criterion
reference test scores congruent or different for 11th-grade students who completed a zoo-
based academic high school experiential science program compared to 11th-grade
students who completed a school-based academic high school experiential science
program?

**Sub-Question 16b.** Were posttest (b) reading school district criterion
reference test scores congruent or different for 11th-grade students who completed a zoo-
based academic high school experiential science program compared to 11th-grade
students who completed a school-based academic high school experiential science
program?

**Overarching Posttest Criterion-Reference Test Research Question #17.** Did
12th-grade students who completed a zoo-based academic high school experiential
science program compared to 12th-grade students who completed a school-based
academic high school experiential science program have congruent or different 12th-
grade school district criterion reference (a) math and (b) reading test scores?
**Sub-Question 17a.** Were posttest (a) math school district criterion reference test scores congruent or different for 12th-grade students who completed a zoo-based academic high school experiential science program compared to 12th-grade students who completed a school-based academic high school experiential science program?

**Sub-Question 17b.** Were posttest (b) reading school district criterion reference test scores congruent or different for 12th-grade students who completed a zoo-based academic high school experiential science program compared to 12th-grade students who completed a school-based academic high school experiential science program?

The following pretest-posttest research questions were used to analyze the effect of a zoo-based academic high school experiential science program students’ school perception and same school-district’s school-based academic high school experiential science program students’ school perception of relevance, rigor, and relationships.

**Overarching Pretest-Posttest Student School Perception Research Question #18.** Did students who completed a zoo-based academic high school experiential science program lose, maintain, or improve their perception of school climate compared to their end of the year posttest perception of school climate (a) relevance, (b) rigor, and (c) relationships survey results?

**Sub-Question 18a.** Was there a significant difference between students’ beginning of the year school perceptions compared to their ending of the year school perceptions survey results (a) relevance after completing a zoo-based academic high school experiential science program?
Sub-Question 18b. Was there a significant difference between students’ beginning of the year school perceptions compared to their ending of the year school perceptions survey results (b) rigor after completing a zoo-based academic high school experiential science program?

Sub-Question 18c. Was there a significant difference between students’ beginning of the year school perceptions compared to their ending of the year school perceptions survey results (c) relationships after completing a zoo-based academic high school experiential science program?

Overarching Pretest-Posttest Student School Perception Research Question #19. Did students who completed a school-based academic high school experiential science program lose, maintain, or improve their perception of school climate compared to their end of the year posttest perception of school climate (a) relevance, (b) rigor, and (c) relationships survey results?

Sub-Question 19a. Was there a significant difference between students’ beginning of the year school perceptions compared to their ending of the year school perceptions survey results (a) relevance after completing a school-based academic high school experiential science program?

Sub-Question 19b. Was there a significant difference between students’ beginning of the year school perceptions compared to their ending of the year school perceptions survey results (b) rigor after completing a school-based academic high school experiential science program?

Sub-Question 19c. Was there a significant difference between students’ beginning of the year school perceptions compared to their ending of the year school
perceptions survey results (c) relationships after completing a school-based academic high school experiential science program?

**Overarching Posttest-Posttest Student School Perception Research Question #20.** Did students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program have congruent or different perceptions of school climate (a) relevance, (b) rigor, and (c) relationships?

**Sub-Question 20a.** Were posttest (a) relevance school perceptions results congruent or different for students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program?

**Sub-Question 20b.** Were posttest (b) rigor school perceptions results congruent or different for students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program?

**Sub-Question 20c.** Were posttest (c) relationships school perceptions results congruent or different for students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program?
Assumptions of the Study

The study has several strong features. The 11th-grade and 12th-grade science programs of this study, the zoo-based academic high school experiential science program and the school-based academic high school experiential science program were developed by curriculum experts, teachers, and administrators to have equivalent rigor and relevance. Only the delivery sites, the Zoo Academy or the traditional high school, differ in this study. Furthermore, the research school district supports equally the zoo-based academic high school experiential science program and the school-based academic high school experiential science program.

Delimitations of the Study

This study will be delimited to the 11th-grade and 12th-grade students participating in the zoo-based academic high school experiential science program and the school-based academic high school experiential science program in attendance from the fall of 2009 to the spring of 2010. All 10th-grade and 11th-grade students in 2008-2009 were required to be on track for graduation by the spring of 2009. Data on grade point average and student perceptions was collected routinely throughout the 2009-2010, school year and included in the study. Study findings were limited to the students participating in the zoo-based academic high school experiential science program and the school-based academic high school experiential science program.

Limitations of the Study

This exploratory study was confined to 11th-grade and 12th-grade students (N = 36) participation in a yearlong zoo-based academic high school experiential science program and the school-based academic high school experiential science program. Study
participants in the first arm \((n = 18)\) spent their 11th-grade and 12th-grade school year in the non-traditional zoo-based academic high school experiential science program. Study participants in the second arm \((n = 18)\) spent their 11th-grade and 12th-grade school year in the comprehensive school-based academic high school experiential science program. The limited sample size and newly developed academic program may limit the utility and generalizing of the study results and findings.

**Definition of Terms**

**21st Century Skills.** Skills learned through interdisciplinary, integrated, problem-based curriculum. These skills include: critical thinking and problem solving, collaboration across networks and leading by influence, agility and adaptability, initiative and entrepreneurialism, effective oral and written communication, accessing and analyzing information, and curiosity and imagination (Wagner, 2010).

**American College Testing (ACT) test.** Standardized test for high school achievement and college entrance exam. This exam covers four core curricular areas: English, math, reading, and science reasoning.

**Applied learning.** Type of learning that empowers and motivates students to develop skills and knowledge needed for employment and post-secondary education (Harrison, 2005).

**Career Academy.** A small learning community that offers a career framework which combines academic and career courses. Career academies are organized around themes in response to students’ academic and vocational interests and guide instruction in both core-subject and elective courses along with engaging the interest and motivation of students (Kemple, 2004; Kemple & Willner, 2008; Quint, 2006; Smith, 2008).
**Challenge-based learning.** Instructional method that provides students with global and real-world challenges that require technology, application of 21st century skills, and knowledge to solve real-world problems (Johnson, Smith, Smythe, & Varon, 2009).

**District criterion reference test (CRT).** Is a standardized assessment developed by school districts to evaluate the content knowledge and skills students are expected to master while in school.

**District level math content standard objectives.** The research school district offers the following math courses at the Zoo Academy and district high schools: Algebra I, Geometry, and Algebra II.

**Algebra I Objectives.** *Objective 1:* Students will acquire number sense and perform operations with real numbers. 1.1: Students will be able to solve linear equations and inequalities. 1.2: Students will be able to solve problems using mathematical operations. 1.3: Students will be able to understand and apply laws of exponents. *Objective 2:* Students will use patterns, relations, and functions to represent and analyze mathematical situations using algebraic symbols. 2.1: Students will be able to use and identify linear patterns. 2.2: Students will be able to identify and apply properties. 2.3: Students will be able to use and apply absolute values. 2.4: Students will be able to understand and solve systems of equations and inequalities. 2.5: Students will be able to identify and apply factoring. 2.6: Students will be able to solve equations by using radicals. 2.7: Students will be able to understand rational expressions. *Objective 3:* Students will recognize, describe, and identify geometric shapes, and solve problems using spatial and logical reasoning, applications of geometric principles, and modeling.
3.1: Students will be able to graph functions. 3.2: Students will be able to identify and apply various forms of linear equations. **Objective 4:** Students will understand and apply measurement tools, formulas, and techniques. 4.1: Students will be able to identify and solve problems using proportional reasoning. 4.2: Students will be able to identify and apply appropriate formulas to solve problems. 4.3: Students will be able to use formulas and equations. 4.4: Students will be able to identify and solve problems using direct and indirect variation. 4.5: Students will formulate questions that can be addressed with data, and then organize, display, and analyze the relevant data to answer their questions. 4.6: Students will apply and interpret basic concepts of probability.

**Geometry Objectives.**  
**Objective 1:** There will be no number system or number operations concepts introduced in Geometry.  
**Objective 2:** Students will represent and analyze mathematical situations and properties using patterns, relations, functions, and algebraic symbols.  
2.1: Use patterns, relations, and functions to represent mathematical situations.  
2.2: Evaluate, solve, and analyze mathematical situations using algebraic properties, formulas and symbols.  
**Objective 3a:** Students will solve problems using spatial and logical reasoning.  
3a.1: Develop mathematical arguments about geometric relationships.  
**Objective 3b:** Students will solve problems using applications of geometric principles and modeling.  
3b.1: Identify characteristics and properties of two and three-dimensional shapes.  
3b.2: Specify locations and describe spatial relationships using coordinate geometry.  
3b.3: Use visualization, spatial reasoning, and geometric modeling to solve problems.  
**Objective 4:** Students will understand and apply measurement tools, formulas, and techniques.  
4.1: Apply basic construction techniques to solve problems.  
4.2: Determine measurements using appropriate techniques, tools, and formulas.  
4.3:
Perform basic transformations using construction tools. **Objective 5:** There will be no probability or data analysis concepts introduced in Geometry.

**Algebra II Objectives.** **Objective 1:** Students will acquire number sense and perform operations with real and complex numbers. 1.1: Solve linear equations and inequalities. 1.2: Represent complex numbers in a variety of ways. 1.3: Simplify problems using mathematical operations. **Objective 2:** Students will represent and analyze mathematical situations and properties using patterns, relations, functions, and algebraic symbols. 2.1: Use patterns, relations, and functions to represent mathematical situations. 2.2: Evaluate, solve, and analyze mathematical situations using algebraic properties and symbols. 2.3: Represent quantitative relationships using mathematical models and symbols. 2.4: Understand the relationship between exponents and logarithms. 2.5: Apply the steps of factoring. **Objective 3:** Students will solve problems using spatial and logical reasoning, applications of geometric principles, and modeling. 3.1: Specify locations and describe spatial relationships using coordinate geometry. **Objective 4:** Students will understand and apply measurement tools, formulas, and techniques. 4.1: Evaluate the exact values of the sine, cosine, and tangent functions. 4.2: Solve triangles. 4.3: The units and processes of measurement of rotational angles. **Objective 5:** Students will draw conclusions using concepts of probability after collecting, organizing, and analyzing a data set. 5.1: Students will formulate a question and design a survey or an experiment in which data is collected and displayed in a variety of formats, then select and use appropriate statistical methods to analyze the data. 5.2: Students will develop and evaluate inferences to make predictions. 5.3: Students will apply and analyze concepts of probability.
**District level science content standard objectives.** The local school district represented offers the following science courses at the Zoo Academy and district high schools: comparative anatomy, honors research, and zoology.

**Comparative Anatomy Objectives.** *Objective 11.1:* Students will describe the structure and function of the skeletal system and how it is integrated with other systems of the body. *Objective 11.2:* Students will describe the structure and function of the muscular system and how it is integrated with other systems of the body. *Objective 11.3:* Students will describe the structure and function of the integumentary system and how it is integrated with other systems of the body. *Objective 11.4:* Students will describe the structure and function of the nervous system and how it is integrated with other systems of the body. *Objective 11.5:* Students will describe the structure and function of the endocrine system and how it is integrated with other systems of the body. *Objective 11.6:* Students will describe the structure and function of the blood. *Objective 11.7:* Students will describe the structure and function of the heart and blood vessels. *Objective 11.8:* Students will describe the structure and function of the lymphatic system and how it is integrated with other systems of the body. *Objective 11.9:* Students will describe the structure and function of the respiratory system and how it is integrated with other systems of the body. *Objective 11.10:* Students will describe the structure and function of the digestive system and how it is integrated with other systems of the body. *Objective 11.11:* Students will describe the structure and function of the urinary system and how it is integrated with other systems of the body. *Objective 11.12:* Students will describe the structure and function of the reproductive system and how it is integrated with other systems of the body.
Honors Research Objectives. Objective 1: Students will apply the nature of scientific knowledge to their own investigations and in the evaluation of scientific explanations. 1.1: Recognize that scientific explanations must be open to questions, possible modifications, and must be based upon historical and current scientific knowledge. 1.2: Analyze how society influences the work of scientists and how science, technology, and current scientific discoveries influence and change society. 1.3: Understand that the work of science results in incremental advances, almost always building on prior knowledge, in our understanding. Objective 2: Students will design and conduct investigations that lead to the use of logic and evidence in the formulation of scientific explanations and models. 2.1: Formulate a coherent testable hypothesis supported by prior knowledge to guide an investigation. 2.2: Design and conduct logical and sequential scientific investigations with repeated trials and apply findings to new investigations. 2.3: Identify and manage variables and constraints objectively. 2.4: Select and safely use lab equipment, technology, and mathematical concepts appropriately and accurately. 2.5: Use tools and technology to make detailed qualitative and quantitative observations. 2.6: Evaluate and represent data collected in an systematic, accurate, and objective manner.

Zoology Objectives. Objective 1: Students will apply the nature of scientific knowledge to their own investigations and in the evaluation of scientific explanations. 1.1: Recognize that scientific explanations must be open to questions, possible modifications, and must be based upon historical and current scientific knowledge. 1.2: Analyze how society influences the work of scientists and how science, technology, and current scientific discoveries influence and change society. 1.3: Understand that the work
of science results in incremental advances, almost always building on prior knowledge, in our understanding. **Objective 2:** Students will design and conduct investigations that lead to the use of logic and evidence in the formulation of scientific explanations and models. 2.1: Formulate a coherent testable hypothesis supported by prior knowledge to guide an investigation. 2.2: Design and conduct logical and sequential scientific investigations with repeated trials and apply findings to new investigations. 2.3: Identify and manage variables and constraints objectively. 2.4: Select and safely use lab equipment, technology, and mathematical concepts appropriately and accurately. 2.5: Use tools and technology to make detailed qualitative and quantitative observations. 2.6: Evaluate and represent data collected in a systematic, accurate, and objective manner. **Objective 3:** Students will analyze data, interpret diagrams, and use analogies to develop an understanding of how the information in DNA is used to direct protein synthesis and influence an organism’s characteristics. 3.1: Explain the three key roles of DNA. 3.2: Describe how information flows from DNA to RNA to direct the synthesis of proteins. 3.3: Identify the types, causes, and effects of mutations. **Objective 4:** Students will describe the theory of biological evolution. 4.1: Predict how a particular species might adapt to changes on Earth. 4.2: Illustrate how evolution leads to diversity of life through speciation. 4.3: Demonstrate understanding of modern evolutionary classification of organisms. 4.4: Predict the distribution of fossils based on organisms that exist today. **Objective 5:** Students will understand how the existence of life on Earth depends on interactions among organisms and between organisms and their environment. 5.1: Describe the role predation and herbivory play in shaping communities. 5.2: Identify the three types of symbiotic relationships in nature. 5.3: Describe how ecosystems recover
from a disturbance. 5.4: Explain the values of biodiversity and how it can be preserved. 5.5: Explain the concept of ecological footprint. 5.6: Identify the role of ecology in a sustainable future. Objective 6: Students will describe the structures and functions that enable animals to carry out basic life processes and maintain homeostasis. 6.1: Identify the characteristics and traits that define animals. 6.2: Explain how animals descended from earlier forms through the process of evolution. 6.3: Recognize the structures of animals that allow them to obtain essential materials and eliminate wastes. 6.4: Describe how the body systems of animals allow them to collect information about their environments and respond appropriately. 6.5: Explain how animals interact with one another and their environments.

Differentiate Instruction. Instructional model that allows flexibility in the teaching approach to adjust curriculum to learners’ needs, which gives students multiple opportunities to learn content and make sense of ideas. The students do not have to adjust and adapt to the curriculum (Hall, Strangman, & Meyer, 2003; Tomlinson, 2001).

Engagement. The active involvement, commitment, and concentrated attention of students in school. These students are intellectually immersed, socially connected, and emotionally centered. The students take an active role in shaping programs and activities around them (Joselowsky, 2007; Pittman, 2005).

Experiential Learning. Experiential learning is an instructional model where student learning is centered on real-world problems that can have multiple solutions to the problem. The teacher is seen as a facilitator guiding the students through the process of collaboratively solving the problem by applying knowledge and skills learned (Cleary & English, 2005; Hoachlander, 2008; Hmelo-Silver, 2004; Visconti, 2010).
**Grade point average (GPA).** Is a 4.0 scale of grades received in core curricular areas by the student throughout the academic school year.

**Immersed experience.** Placing the students’ educational experiences into real-world situations. The Zoo Academy immerses students into zoological career fields.

**Integrated curriculum.** Composed of lessons to help students make connections across curricula.

**Multiple pathways.** Combination of academic and technical study program that integrates classroom and real world learning centered on sectors of industry such as environmental studies, health science, financial, and business. These programs combine college preparatory courses with career and technical education (Conley, 2001; Hoachlander, 2008; Jones, Yonezawa, Ballesteros, & Mehan, 2002).

**National Assessment of Educational Programs (NAEP).** Assessment designed to measure the knowledge and abilities of U.S. students in math, science, and reading (National Center for Education Statistics, 2011a).

**Norm-referenced test (NRT).** Is a test or instrument that allows for comparing individual scores to a group score on the same test or instrument. The Norm-referenced tests used in this study are the PLAN and ACT tests.

**Program for International Student Assessment (PISA) test.** International comparison designed to measure math and science literacy of students in upper grades (National Center for Education Statistics, 2011a).

**PLAN test.** Norm-referenced assessment given to tenth-graders. This assessment focuses on both career preparation and improving academic achievement.
**Problem-based learning.** Instructional method that provides students with real-world problems to engage them in the content and develop the skills needed to be able to apply the knowledge (Hmelo-Silver, 2004; Visconti, 2010).

**Proficient.** Solid academic performance, where students demonstrate subject-matter knowledge, application of knowledge to real-world situations, and analytical skills (National Center for Education Statistics, 2011a, 2011b, & 2011c).

**Project-based learning.** Instructional method that provides students with projects found in the real world to engage them in the content and develop the skills needed to be able to apply the knowledge.

**Relationships.** Establishing a personalized positive school climate where the students and adults are able to express care and concern for students’ wellbeing, intellectual growth, and educational success (Dryer, 1996; McLeod & Kilpatrick, 2001; Quint, 2006). This is key to the motivational element in the learning process of adolescents (Quint, 2006).

**Relevance.** Relevant curriculum which gives students the opportunity to apply what they have learned to relevant, real-world problems and develop the academic connections needed to prepare them for success in the global world (Conley, 2001; Daggett, 2005; Hoachlander, 2008).

**Rigor.** Challenging curriculum that prepares students for both college and career (Daggett, 2005; Hoachlander, 2008; Mehan, 2006).

**Small learning community.** Graves (1992) defines community as “an inherently cooperative, cohesive, and self-reflective group entity whose members work on a regular
face-to-face basis toward common goals while respecting a variety of perspectives, values, and life styles” (Dryer, 1996; Manning, & Saddlemire, 1996).

**Third International Mathematics and Science Study (TIMSS).** International achievement tool used to assess math and science achievement of fourth and eighth-grade students in the U.S. compared to other countries (National Center for Education Statistics, 2011a).

**Work-based experience.** Students in 11th-grade and 12th-grade engaged in internships, working with professionals who assess the students’ work based on industry standards (Hoachlander, 2008).

**Significance of the Study**

This study contributes to the body of research on the effect of a non-traditional experiential academic science program on high school students’ math and science achievement and school climate perceptions. The research is of significant interest to educators, administrators, business leaders, community members, and policy makers who are seeking ways to increase the preparedness of students to compete globally for scientific careers.

**Contribution to research.** Current research answers the significance of career academies. Few studies have offered conclusions about the effectiveness of work-based academies located outside of traditional high schools. This study examined the effect of a zoo-based experiential academic science program on high school students’ math and science achievement and perceptions of school climate. This study gives insight and supporting evidence of the impact of academies located in non-traditional settings on math and science achievement and student perceptions of high school.
**Contribution to practice.** This study offers suggestions needed to establish an effective non-traditional work-based career academy offered outside of the traditional high school. Based on the results of this study, the research school district may decide whether to continue the development of small learning communities and the expansion of additional career academy programs.

**Contribution to policy.** The educational system must address the instructional needs of students while preparing them for work experiences of the future. Changes in both the classroom and the workplace are necessary in order to penetrate the barriers between classroom community of practice and the workplace community of practice. Local policy will be impacted by this study if results show that modifying learning environments to motivate and meet individual learner needs can positively impact academic achievement; a discussion should be generated to consider the expansion of the program to other school districts.

**Organization of the Study**

The literature review relevant to this study is presented in Chapter 2. This chapter reviews professional literature on rigor, relevance, relationships, experiential learning, small learning communities, and career academies. Chapter 3 describes the research design, methodology, and procedures used to gather and analyze the data of the study. Chapter 4 reports the research results and findings--including inferential data analysis, tables, and descriptive statistics. Chapter 5 provides conclusions and a discussion of the research findings.
CHAPTER TWO

Review of Literature

Recent findings of how students in the United States rank on international math and science exams suggest that our students, while receiving a breadth of content knowledge, may not be receiving the depth of knowledge they need to keep a competitive edge in math and science careers (Bybee, 2010; Grigg, Lauko, & Brockway, 2006; Mourshed et al., 2010; Sawchuk, 2010). The main, educational systems throughout the country are working to develop programs that will inspire students to be innovative, creative, active learners able to think critically and envision a future filled with success and service to others (Bybee, 2010).

To better prepare our students for success in the global economy, several innovative high school reforms have been established to increase the number of students who graduate and successfully transition into postsecondary education or the global work force (Achieve, Inc., 2005; Kemple, 2004; Kemple & Willner, 2008; Quint, 2006). For over a decade, educators have seen the impact of school reform changes in high schools across the country decrease the number of students dropping out, improving school climate, strengthening curriculum and instruction, decreasing the achievement gap between majority and minority students, and preparing students for transition to postsecondary programs or employment after graduation (Kemple, 2004; Kemple & Willner, 2008; Quint, 2006).

The goal of high school has changed from only preparing a few students for postsecondary education to preparing all students for living successfully in an interdependent world (Conley, 2001; Pittman, 2005). To prepare students with 21st
century skills needed to be both college and career ready, high schools are creating educational environments filled with rigor, relevance, and relationships; these conditions are needed to ensure that all students may be economically and personally successful (Achieve, Inc., 2009; Conley, 2001; Hawkins, Oesterle, & Hill, 2004; Johnson & McElroy, 2010; Manning & Saddlemire, 1996; Quint, 2006). In order to ensure rigor, relevance, and relationships, school goals now clearly focus on components of change capacity such as improved school climate, a strengthened curriculum, hands-on active experiential learning opportunities, and personalized relationships (Breunlin, Mann, Kelly, Cimmarusti, Dunne, & Lieber, 2005; Dryer, 1996; Toch, Jerald, & Dillon, 2007). Thus, developing student competencies, skills, and social behaviors are all thought to be beneficial to self and society (Hawkins, Oesterle, & Hill, 2004).

Nationally, the trend in science education is to move away from general to more in-depth content knowledge. Leaders in science education are creating standards, guidelines, and assessments to prepare our students to become more competitive globally. The National Science Education Standards (NSES) were established in 1996 to be used as guidelines by educators to create rigorous and relevant curriculum that will be used to improve our students’ understanding of and ability to master science and math concepts (National Research Council, 1996). Instead of United States educators utilizing standards and assessments as guidelines and tools to determine the mastery of science and math in our students, they are using standards to create prescriptive curricula and pedagogical methods to ensure consistency in all classrooms and for all students to achieve basic mastery of content knowledge (Sawchuk, 2010). In reality, current science and math learning activities are more likely to reflect local learning goals that not only adhere to
NSES standards (1996) but go beyond a prescribed curriculum to a creative curriculum that gives teachers and local schools more latitude over pedagogy and curricula and greater accountability for student content mastery and success (Mourshed, Chijioke, & Barber, 2010; National Academies, 2007; Sawchuk, 2010).

Leaders in science education are demanding school systems to require students to spend more time doing science as the best way to understand science (National Academies, 2007). Taking active learning into account, educators must evaluate how to incorporate more in-depth content rigor into a curriculum that is already overwhelming in its scope and sequence. For example, recommendations by the National Academies of Science Committee, as set forth in their blueprint for science education, Rising Above the Gathering Storm (2007), suggests education systems should establish specialty schools to immerse students in science, technology, and mathematical education as a way to test the relevance and rigor of science curriculum (Mourshed, Chijioke, & Barber, 2010; National Academies, 2007; Sawchuk, 2010). The rich combination of specialty schools and rigorous curriculum that is relevant may create a nation of students who are competitive in today’s global market (Achieve Inc., 2009; Conley, 2001; Mourshed, Chijioke, & Barber, 2010; National Academies, 2007; Sawchuk, 2010).

Learning Environment

Positive learning environments where educators know their students, develop a concern for their well-being, and provide a curriculum that is both rigorous and relevant is the key to motivating adolescents (Cleary & English, 2005; Keefe, Kelley, & Miller, 1985; Quint, 2006). To create positive learning environments, the school and the community must establish a new culture of personalized learning where students feel
confident to become effective team players and intellectual decision-makers (Conley, 2001; Dryer, 1996; Hugh, Taylor, Chin, & Hutchinson, 2006; Mackin, 1996). To effectively establish positive learning environments within schools is to develop a culture for learning. In order for a school to develop a culture for learning, it must develop new content knowledge and skills, establish small learning communities, have access to new resources, and develop leadership (Dryer, 1996; Fullan, 2006; Manning & Saddlemire, 1996; Sergiovanni, 1994). Effective science and math learning activities create an environment where teachers can freely guide students through experiential curriculum supported by ready access to professional resources that will place students in environments where they may demonstrate leadership, collaboration, communication, and self-governance in real-world situations (Hugh et al., 2006).

Finally, the business community must come together with the school to complete the new culture of learning needed to raise academic standards and connect students to their lives outside of school (Toch, Jerald, & Dillon, 2007). Together, business leaders and educators must develop an understanding of the educational experiences that occur in all community organizations (Senge, Cambron-McCabe, Lucas, Smith, Dutton, & Kleiner, 2000) and establish alternative learning environments where students can explore careers. Establishing these partnerships will give students the opportunity to learn the necessary workplace skills and knowledge needed to transition between school and work (Hugh et al., 2006). Everyone working together as a community--business leaders, teachers, scientists, and students--are more likely to create successful change that better prepares students for successful transition into global careers (Achieve Inc., 2009; Kemple, 2004; Quint, 2006). Science classrooms often emphasize the kind of
collaborative practices found in the workplace. The social learning environments found in science classrooms are very similar to the communities of practice found in science (Hugh, Taylor, Chin, & Hutchinson, 2006).

Creating a sense of community within schools where all students know that they are valued, belong, and can succeed is an essential ingredient of implementing communities of practice found in science environments and brought to life in schools both large and small (Breunlin et al., 2005; Manning & Saddlemire, 1996). The development of communities in schools gives administrators, teachers, and students the ability to share ideas and leadership roles forming authentic relationships, wanting to better know oneself and community members, and being receptive to new ideas (Cleary & English, 2005; Sergiovanni, 1994). The basic human need is to belong and feel part of a group that works towards common goals, common interests, shared values, conceptions, and ideas (Graves, 1992; Hugh et al., 2006; Manning & Saddlemire, 1996; Sergiovanni, 1994).

**Small Learning Communities**

The most common reform we see today is implementing small learning communities within high schools, such as the creation of career academies. The philosophy behind small learning communities, schools-within-schools, or career academies is to develop relationships between the students and teachers, increase rigor, and increase relevance (Cleary & English, 2005; Conley, 2001). Rigor, relevance, and relationships reform efforts focus on raising academic standards, connecting student studies to their lives outside of school, and preparing students for the ever-changing global workforce. Research shows students who participate in small learning
communities feel more accepted and part of the school culture. Students who feel they belong and are safe are likely to succeed academically and move into postsecondary degree programs or professions (Conley, 2001; Dryer, 1996).

The rational for establishing small learning communities is to satisfy the basic human need to feel part of a group that works towards a common goal, common interests, shared values, and ideas, for schools and classrooms to be interdependent, cooperative communities where students and teachers learn and work in more comfortable and inspiring environments (Cleary & English, 2005; Dryer, 1996; Graves, 1992; Manning & Saddlemire, 1996; Sergiovanni, 1994). The development of communities in schools give administrators, teachers and students the ability to share ideas and leadership roles forming authentic relationships, wanting to better know oneself and community members, and being receptive to new ideas (Dryer, 1996; Keefe et al., 1985; Sergiovanni, 1994). School programs that emphasize small learning communities develop personalized environments where student-teacher relationships develop to increase the academic and social needs of the students (Adelman & Taylor, 2009; Breunlin et al., 2005; Dryer, 1996).

Small learning communities take on several different formats in high schools across the country. When establishing small learning communities, school leaders need to make sure professional learning communities are established where the focus is on what will successfully support every student in their high school experience, provide every student with meaningful adult relationships, and insure a personalized learning experience where students are able to see the relevance in their learning task (Cleary & English, 2005; National Association of Secondary School Principals, 2005). It is very
important that these key points are well established in order for the school climate to become successful.

Small learning communities come in a variety of forms within a high school, such as career academies, theme-based academies, or schools-within-schools. All three types of small learning communities have shown positive educational benefits for the students who they serve (Cleary & English, 2005; Kemple, 2004; Quint, 2008).

The talent development small learning communities’ model is made up of the positive components seen in learning communities around the country. This model provides a personalized and orderly learning environment, assists students who enter with poor academic skills, improves instructional content and practice through professional learning communities, and prepares students for the world beyond high school (Cleary & English, 2005; Quint, 2008). The talent development model creates small learning community components starting with a 9th-grade success academy that becomes 10th-grade through 12th-grade career academies (Quint, 2008).

Ninth-graders enter into a success academy where they are guided through the transition into high school, provided the extra academic assistance needed to succeed in high school, and are part of a small community made up of students and educators working together as a family unit (Quint, 2008). Tenth-grade through 12th-grade students are provided with multiple career academies or pathways to keep them engaged through career exploration that creates a linkage to the world they will enter after graduation (Conley, 2001; Hoachlander, 2008). These career academies are community partnerships where students and educators are given the opportunity to work with local
professionals to continue to develop integrated problem-based curriculum, critical thinking skills, and communication skills.

**Career Academy High School Science Models**

Currently there are over 2,500 career academies nationally that are operating as a single program, such as Omaha’s Henry Doorly Zoo’s Zoo Academy program that operates inclusively on the zoo property (Kemple, 2004; Quint, 2006). Career academies are geared to blend academic rigor, specialized college preparatory curriculum, workplace knowledge, and relevant engaging experience within the workplace (Cleary & English, 2005; Smith, 2008). Across the nation, career academies have different structures and learning environments. Some academies are housed within the high school, where students take a series of career themed courses. Other academies are located outside of the high school within partnering businesses. These academies provide very authentic learning environments where the school and partnering businesses work together to provide rigorous curriculum and relevant experiences. All career academies have three distinguishing characteristics: (1) develops personalized learning environments through small learning communities; (2) combines the relevance and rigor of academic and career curricula around a career related theme; (3) establishes partnerships with local community businesses to provide work-based learning opportunities for students (Hugh et al., 2006; Kemple, 2004; Smith, 2008).

Findings show the rigor incorporated into the career academies demonstrates the feasibility of accomplishing goals of school-to-career without compromising academic goals. Career academy and business partners provide students with a broad array of career awareness and development experiences both in and outside of school including
multiple pathways and work-based learning experiences (Hoachlander, 2008; Kemple, 2004; Pittman, 2005; Quint, 2006). The basic model used in career academies is composed of a team of teachers who are linked with a group of students, block scheduling of classes, common planning time for teachers, and an occupational focus. In this model, the teachers, students, and business partners work together as a cohesive group to create a learning environment that provides a safe place for students to explore and experience the relevance of courses through the workplace (Elliott, Hanser, & Gilroy, 2002).

Career academies provide students with explicit introductions to the world of work and furnish them with skills and connections to help them transition from high school to successful employment (Kemple, 2004). Students commonly believe and feel school is irrelevant to the real world. The intent of career academies is to affiliate career-related education with local businesses so students can see the connection between school and work (Elliott et al., 2002).

**Exemplary Zoo Academy high school models.** Exemplary models of successful Zoo Academies in the country are Asheboro High School Zoo School, Cabrillo High School Aquarium, Cincinnati Zoo Academy, Lincoln Zoo School, Millbrook School, Minnesota Zoo School, Omaha’s Henry Doorly Zoo’s Zoo Academy, and Zoo Magnet Center. All of these models have a unique structure that provides various experiences based on the commitment and partnerships developed between the school districts and the zoos.

For example, the Omaha’s Henry Doorly Zoo’s Zoo Academy--serving as the research academy for this study--is one example of an effective career academy model.
for science education. The academy has become an excellent work-based learning model and demonstrates how to successfully collaborate and form partnerships between school districts and informal science education organizations.

The Zoo Academy model is a prime example of science education reform in action. This program places both teachers and students into a non-traditional science-learning environment where all participants observe, learn, and apply scientific knowledge to real-world situations. The Zoo Academy becomes a safe environment where the teacher is given the opportunity to freely guide students through active scientific inquiry, establish a community-learning environment, and emphasize student understanding. The combination of these components leads to the establishment of a perfect learning environment for students to demonstrate their understanding of scientific concepts, and to freely investigate, to research, analyze, and communicate science explanations to peers and professionals. Selected Zoo Academy teachers spent three months interning at the zoo to develop current curriculum, develop conceptual connections between science, math, social studies, and English courses, and zoo business. Teachers strive to develop an understanding of conservation issues facing zoos and the community while establishing a working relationship with zoo employees. By fostering this small learning community goal, learning will take place in an atmosphere of adult cohesion and acceptance. Building this relationship with animal area supervisors and animal curators is a key component to assure the experiences the students receive are positive, educational, and relevant.

The academy teachers teaming up with the expertise of the zoo staff provides a very rich inquiry-based learning environment for students. The teachers plan the
curriculum goals around inquiry problem-based experiences. In doing this, the teachers constantly evaluate their own knowledge and expertise, and determine where they need assistants to meet the needs of the students. The zoo staff becomes the resource needed to help the teacher guide the students through scientific investigations and experiences with zoo conservation scientists. This experience establishes a relationship between the students and zoo staff by giving everyone the opportunity to communicate their findings and discuss the impact of new discoveries and how it relates to current conservation issues.

The Zoo Academy model is a combination of three major educational components: career exploration, classroom experiences, and scientific research opportunities. Career exploration allows for students to freely explore their career goals through internships. The internships give students the opportunity to work directly with horticulturists, nutritionists, veterinarian staff, and animal management teams, giving the students a chance to discover new scientific careers and start the career decision process.

The Zoo Academy course work is developed to give students a variety of learning opportunities and daily experiences by taking advantage of access to zoo professionals, research laboratories, animal exhibits, and behind-the-scenes areas. All of these opportunities are used to establish a living laboratory setting. This concept of a living laboratory is very successful and important to the whole concept of the program. The interaction between the teachers and zoo staff allows for more opportunities to apply scientific concepts and to see real-world examples.
Community Partnerships

Education research on school reform shows that the development of partnerships through multiple contexts, including, universities, professionals, community, and informal science organizations, promotes change in school structure and climate, increases the number of students’ prepared for postsecondary and global work force (Jones et al., 2002; National Research Council, 1996). The business community has a natural interest in preparing high school students to become college and career ready because they know the demands of the workforce and the necessity of preparing for economic competitiveness (Achieve Inc., 2009). Partnerships between school districts, business community and informal science centers, like zoos and museums, can provide programs and opportunities that interest students and guide them onto a path of career readiness and lifelong learning (McLeod & Kilpatrick, 2001; National Research Council, 1996).

Community of practice is a variety of workplace settings where there is common enterprise and knowledge (Lave & Wenger, 1991). Schools and workplaces are very different communities of practice that have come together to produce unique opportunities for students to belong to both communities of practices at the same time (Hugh et al., 2006). These unique community partnerships where schools and organizations create a curriculum that provides students with extended periods of time in a workplace while being enrolled as a full-time student results in engaging classroom sessions based on the real-world knowledge necessary for success in the workplace (Cleary & English, 2005; Hugh et al., 2006).
Through the relationships developed between the community and schools, teachers must be provided opportunities to spend time in the community to develop an understanding for a variety of career opportunities and relevant problem-based questions that can be integrated into the curriculum. This strong community support for teacher professional development and expertise from the professionals in the community helps the school establish the importance of much-needed rigor and relevance in the curriculum (Conley, 2001). Studies show that teachers with practical experiences outside of the classroom improve the quality and authenticity of teaching that increases the interest and achievement of the students (Cleary & English, 2005; Conley, 2001; Johnson & McElroy, 2010; Silverstein et al., 2009). The expertise of the teacher is limited to their educational background and experience. It is crucial for the teacher to utilize the zoo staff as a resource and incorporate their expertise into the curriculum. The combination of teacher and zoo staff expertise can be seen as simple presentations in the classroom, elaborate laboratory experiences, or behind-the-scenes guidance through an inquiry experience. Evidence shows student achievement is enhanced when teachers are given professional development activities that involve reviewing assignments for rigor and making classroom activities more engaging (Conley, 2001; Quint, 2006).

Increasing business-education partnerships and unique co-op programs is a priority in education. Students benefit by being given the opportunity to apply content knowledge in the classroom to real-world experiences that will develop the skills students need to be competitive in the global work-force (Hugh et al., 2006). Interestingly, the workplace partner also benefits from providing these unique learning environments while
ultimately contributing to a skilled workforce based on opportunities to develop new projects using fresh ideas from the students and building future community partners.

**Experiential Learning**

There are many terms to describe high school students’ practical, hands-on learning experiences in sciences. School programs that emphasize practical experienced-based science curriculum are referred to as focus schools, schools-within-a-school, career academies, work-based experiences, and co-op learning programs (Breunlin et al., 2005; Conley, 2001; Kemple, 2004; Quint, 2006). However, all of these programs rely on a connected learning theory where students complete assignments that are hands-on, applied, and relevant (Breunlin et al., 2005; Conley, 2001; Hoachlander, 2008; Silverstein et al., 2009) and are thought to be of greater learning value than co-occurring traditional classroom activities. The goal of many programs that emphasize practical experienced-based connected science curriculum is to assist students in becoming good science consumers. From the students’ perspective, these programs are dynamic, relevant, and not only popular, but successful.

Experiential learning instructional models centers students learning about real-world problems that can have multiple solutions (Hmelo-Silver, 2004; Visconti, 2010). Experiential curriculum is designed to have several integrated theme-based units for the students to develop the skills they need to complete real-world experiences in the community through projects and internships (Hmelo-Silver, 2004; Visconti, 2010). This approach to experiential learning helps students develop lifelong learning skills (Hmelo-Silver, 2004). Each curriculum framework leads to the same outcome--to create rigorous and relevant opportunities for students to apply their knowledge.
Experiential learning instruction can be called problem-based, challenge-based, or project-based learning. All three experiential learning styles are composed of the same basic framework including a big idea, essential questions, the challenge, solutions-action, and finally an assessment of outcomes (Johnson et al., 2009). The process starts with a big idea of local or global importance. The teacher can come up with this big idea or work in collaboration with a community partner to find a relevant global idea that affects the workplace. The students proceed to research the big idea by bringing in the concepts and processes learned through course work that starts to strengthen the connections between what students are learning in the classroom and what they perceive to be the problem in the real world (Downing, Kwong, Chan, Lam, & Downing, 2009; Johnson et al., 2009). Once the students develop an understanding of the scope of the big idea, they are challenged to solve the problem. At this point in time, the teacher becomes the facilitator and guides the students to work as a collaborative team. It is important for the students to have access to business partners and community members to work with professionals and gain the information and knowledge needed to complete the challenge. The final product and assessment is presented to the community involved in the problem. This community consists of the business partners, teachers, students, and community members (Johnson et al., 2009).

The experiential learning process provides opportunities for students to learn content and thinking strategies through the experience of solving real-world problems (Hmelo-Silver, 2004). Together, community leaders and educators work to provide the necessary guidance and experiences needed for the students to master the skills they need to become successful post high-school-educated citizenry (Hawkins et al., 2004).
Rigor, Relevance, and Relationships in Science and Math Programs

The key to motivate and engage students in science and math programs is to establish a positive atmosphere for teachers to build student relationships and focus on taking rigorous curriculum and making it relevant. When students are engaged in the learning process, real achievement takes place and their chances to excel in the global world increases (Daggett, 2005). Evidence shows low-achieving students who are taking a combination of college prep courses filled with rigor, relevance, and good instruction leads to high student achievement (Conley, 2001; Toch et al., 2007). The students’ ability to apply high-rigor knowledge in relevant, real-world situations is the true assessment of achieving academic excellence (Daggett, 2005).

Rigor. Challenging rigorous curriculum that provides a balance in content breadth and depth in order for students to gain understanding and knowledge is necessary to create an environment of academic excellence (Daggett, 2005; Hirsch, 2001; Hoachlander, 2008; Mehan, 2006).

The development of rigorous curriculum is very challenging and requires balancing the correct breadth and relevance of content areas to enter into a deep knowledge of the subject (Daggett, 2005; Hirsch, 2001). The best way to learn and build upon general principles is through multiple examples and hands-on experiences solving real-world problems (Hirsch, 2001). For example, the 11th graders entering the Zoo Academy are required to complete the following science courses: zoology, zoo orientation, and comparative anatomy to gain the knowledge and experiences needed to develop a deep understanding of life science concepts. These students take their learning process deeper by applying knowledge and prior experiences to real-world situations in
animal management, one of many careers at the research Zoo Academy. By the 12th grade, students continue to build on and expand their breadth and depth of knowledge of life science content by applying content knowledge from multiple disciplines, math, English, and social studies, to the scientific process of developing and conducting a scientific research project. This rigorous scope and sequence of science courses is a nice balance between breadth, depth, and relevance of the science curriculum. The true indicator of academic excellence through rigorous curriculum is the ability of the students to apply what they learn in school to a variety of situations in the real world (Daggett, 2005; Hugh et al., 2006).

**Relevance.** Quality relevant learning experiences deepen the understanding and the connections students make between content knowledge gained in an academic setting and the knowledge needed to solve real-world problems (Conley, 2001; Daggett, 2005; Hugh et al., 2006; Hirsch, 2001). Engaging students in relevant community service projects, internships, and academy programs help students understand why the content learned in core classes is important (Conley, 2001; Hugh et al., 2006; Hoachlander, 2008). These students are able to make in-depth connections between the curriculum and relevant experience needed to become a scientifically literate community member. Students who are engaged in the learning process are less distracted and spend more time focused on the learning process that leads to active participation and academic success (Deutsch, 2003).

The goal of many programs that emphasize experienced-based science curriculum is to assist students in becoming responsible and scientifically literate citizens. To achieve this goal, schools are increasing diversifying programs to expand new and
interesting ways for students to explore their interest through the 11th-grade and 12th-grade years by collaborating with community organizations (Conley, 2001). Educators and organizations are sharing content information the students must learn and the opportunities that naturally occur in daily work routines. This joint collaboration helps students make the connections needed to dig deeper into the knowledge and skills they gained from their experiences (Hugh et al., 2006).

**Relationships.** Personalized relationships and a positive school climate where the students and adults are able to express care and concern for students’ well-being, intellectual growth, and educational success (Cleary & English, 2005; Dryer, 1996; McLeod & Kilpatrick, 2001; Quint, 2006) is essential for creating a holistic environment where students are developing the basic knowledge, strong personal and interpersonal skills, and ability required to compete globally in the 21st century (Mackin, 1996).

Personalizing the school environment to establish positive relationships between students and teachers requires establishing personal adult advocates, personal learning plans, differentiated teaching, and the creation of small learning communities (Cleary & English, 2005; Dryer, 1996). The development of the student-teacher relationship becomes apparent when instructional learning styles are incorporated into lesson plans. Research clearly shows it is important to organize lessons to meet the needs of various learning styles (Dryer, 1996; Mackin, 1996). From the students’ perspective, the attitude towards students and presentation style are as important as class content (Dryer, 1996).

These findings demonstrate teachers must understand different student learning styles, build rapport, develop mutual respect, and effectively communicate in order to convey their subject matter (Dryer, 1996). It is believed that teachers should act as
personal adult advocates serving in the role of supporting students academically, able to adapt and teach to all types of learning styles, deal with the social tribulations of adolescence, and assist students as needed (Cleary & English, 2005; Cresswell & Rasmussen, 1996). Through the advice and direction of the teacher, the students will have individualized personal learning plans to make sure that their individual goals and expectations of high school are clearly defined and understood (Dryer, 1996); this is key to the motivational element in the learning process of adolescents (Quint, 2006).

Establishing a learning environment where students feel trusted, respected, and encouraged leads to students learning how to think, try out ideas, express their views, interact in teams, and become part of a dynamic learning process within an environment (Cresswell & Rasmussen, 1996; Mackin, 1996). Research shows that students in academies report high levels of interpersonal support and high expectations from teachers and peers (Breunlin et al., 2005; Kemple, 2004). Career academies provide students with explicit introductions to the world of work and furnish them with skills and connections to help them transition from high school to successful employment (Kemple, 2004).

**Structure of Omaha’s Henry Doorly Zoo’s Zoo Academy**

Eleventh and 12th-grade students complete all of the core curricular courses required for graduation from the research project Zoo Academy. The Zoo Academy course work is developed to give students a variety of learning opportunities and daily experiences by taking advantage of access to zoo professionals, research laboratories, animal exhibits, and behind-the-scenes areas. All of these opportunities are used to establish a living laboratory setting. This concept of a living laboratory is very successful and important to the whole concept of the program. The interaction between the teachers
and zoo staff allows for multiple opportunities to apply content knowledge to daily real-world situations.

The students follow a four-hour academic block schedule which has the flexibility for the teachers (science, math, English, and social studies) and students to work as a collaborative team and complete problem-based experiences throughout the school year including:

**Science.** Science coursework includes: (a) Zoology, (b) Comparative Anatomy, (c) Honors Research, (d) Animal Externship, (e) Zoo Orientation, and (f) Horticulture.

**Math.** Math coursework includes: (a) Algebra 1, (b) Algebra 2, (c) Honors Algebra 2, (d) Pre-Calculus, (e) Trigonometry, and (f) Geometry.

**English.** English coursework includes: (a) English 11, (b) Honors English 11, (c) Contemporary Literature, and (d) Honors World Literature.

**Social Studies.** Social Studies coursework includes: (a) Sociology, (b) Psychology, (c) U.S. Foreign Relations, (d) American Government, (e) Honors American Government, and (f) Issues in Geography.

Courses are offered during a four-hour academic block A (Monday and Wednesday) and B (Tuesday and Thursday) schedule. Friday is a service learning day. The service-learning day is designed to give students the flexibility to continue their individual projects with zoo staff, make up classes missed during the week or work in teams on challenge-based projects. This flexible day is very valuable for both the students and teachers because it provides additional time to build the relationships needed to make a program like the Zoo Academy successful. During the week, students are pulled out of classes to participate in a variety of unique educational experiences that
occur at the zoo on a daily basis. The flexibility to pull students out of classes gives the students more opportunities to build their experiences and prior knowledge to deepen their understanding of the curriculum content.

School knowledge is organized in a way that will teach the skills and abilities required for performance inside as well as outside of school. Modifying schooling to better enable it to promote skills for learning outside school may simultaneously renew its academic value (Hugh et al., 2006).

**Conclusion**

Educators, community partners and business leaders know we need to address the issue of better preparing our students for success, whether it be preparing them to be globally competitive on science and math examinations, successful in the classroom, or become competitive for careers of today (Achieve, Inc., 2009). The educational system must address the instructional needs of students while preparing them for work experiences of the future. Changes in both the classroom and the workplace are necessary in order to penetrate the barriers between classroom community of practice and the workplace community of practice (Hugh et al., 2006). Traditional educational systems and instructional methodologies must be composed of three key elements: rigor, relevance, and relationships. The composition of these three elements and establishment of non-traditional learning environments is the perfect equation for setting students up for success in science and math careers and the development of a scientifically literate citizenry (Achieve, Inc., 2009).
CHAPTER THREE

Methodology

Participants

**Number of participants.** The maximum accrual for this study was \( N = 36 \) including a naturally formed group of 11th-grade and 12th-grade students who participated in a zoo-based experiential academic high school science program \( n = 18 \) and a randomly selected group of 11th-grade and 12th-grade students who participated in a school-based experiential academic high school science program \( n = 18 \). Students \( n = 18 \) who attended the zoo-based experiential academic high school science program spent the school day at the zoo immersed in experiential science opportunities and academic course work for 11th-grade and 12th-grade school year. Students \( n = 18 \) who attended the same school districts’ school-based experiential academic high school science program spent the school day at their home high school immersed in experiential science opportunities and academic course work for 11th-grade and 12th-grade school year.

**Gender of participants.** Of the total number of selected subjects identified as 11th-grade and 12th-grade students participating in a zoo-based experiential academic high school science program \( n = 18 \), the gender ratio was 6 males (33%) and 12 females (67%). Of the total number of selected subjects identified as 11th-grade and 12th-grade students participating in a school-based experiential academic high school science program \( n = 18 \), the gender ratio was 14 males (78%) and 4 females (22%). The gender of the study participants was congruent with the research school districts’ gender demographics for 11th-grade and 12th-grade students.
Age range of participants. The age range for all study participants was from 16 years to 18 years. All participants were in 11th-grade and 12th-grade. The age range of the study participants was congruent with the research school districts’ age range of demographics for 11th-grade and 12th-grade students.

Racial and ethnic origin of participants. Of the total number of students who participated in the zoo-based experiential academic high school science program \( n = 18 \), the ethnic and racial origin of participants was 18 Caucasian (100%). Of the total number of selected students who participated in the school-based experiential academic high school science program \( n = 18 \), the ethnic and racial origin of participants was 16 Caucasian (89%), 1 African American (5.5%), and 1 Asian (5.5%). The racial and ethnic origin of the study participants was congruent with the research school districts racial and ethnic demographics of 11th-grade and 12th-grade students.

Inclusion criteria of participants. Eleventh-grade and 12th-grade students who attended the research school district, met the course requirements to be classified as 11th-grade students, and completed all of the core class requirements for graduation.

Method of participant identification. Eleventh-grade and 12th-grade students who completed all of the core class requirements for graduation and have met the course requirements to be classified as 11th-grade students. No individual identifiers were attached to the achievement or school perception data of the 36 participating students in the two naturally formed groups.

Description of Procedures

Research design. The pretest-posttest two-group comparative efficacy design was displayed in the following notation:
Group 1  X₁  O₁  Y₁  O₂
Group 2  X₁  O₁  Y₂  O₂

**Group 1 = study participants #1.** Naturally formed group of students \(n = 18\) completing the 11th-grade and 12th-grade.

**Group 2 = study participants #2.** Randomly selected group of students \(n = 18\) completing the 11th-grade and 12th-grade.

**X₁ = study constant.** All research study students \(N = 36\) were enrolled in the same public school district and completed the 11th-grade and 12th-grade school years.

**Y₁ = study independent variable, science coursework delivery site, condition #1.** Students completed a zoo-based experiential academic high school science program.

**Y₂ = study independent variable, science coursework delivery site, condition #2.** Students completed a school-based experiential academic high school science program.

**O₁ = study pretest dependent measures.** (1) Achievement as measured by: (a) beginning of program PLAN Normal Curve Equivalent test composite scores, (b) beginning of program weighted Grade Point Average scores, (c) beginning of program science Grade Point Average scores, and (d) beginning of program School District Criterion Reference Achievement Test proficiency scores for (i) math and (ii) reading. (2) School climate as measured by: beginning of program School Perception Survey results for (i) Relevance, (ii) Rigor, and (iii) Relationships.

**O₂ = study posttest dependent measures.** (1) Achievement as measured by: (a) ending of program ACT Normal Curve Equivalent test composite scores, (b) ending of program weighted Grade Point Average scores, (c) ending of program science Grade
Point Average scores, and (d) ending of program School District Criterion Referenced Achievement Test proficiency scores for (i) math and (ii) reading. (2) School climate as measured by: ending of program School Perception Survey results for (i) Relevance, (ii) Rigor, and (iii) Relationships.

**Implementation of the Independent Variables**

The independent variables for this study were the two naturally formed groups representing students who completed a zoo-based experiential academic high school science program and students who completed a school-based experiential academic high school science program. The students in the first group, a zoo-based experiential academic high school science program, completed real world, hands-on projects at the zoo. The second group, those students who completed a school-based experiential academic high school science program, completed real world, simulated projects in the classroom. These groups comprised the two research arms of the study. Both groups of students were selected from the same school district.

The purpose of this study is to determine the effect of 11th-grade and 12th-grade zoo-based experiential academic high school science program compared to a same school-district school-based experiential academic high school science program on students’ 11th-grade pretest and 12th-grade posttest science achievement and school perceptions.

**Dependent Measures**

The study’s two dependent variables were (1) achievement data and (2) school climate data. The first of these, achievement, was analyzed using beginning program PLAN and ending program ACT test results. Beginning and ending of program weighted
Grade Point Average scores, beginning and ending of program science Grade Point Average scores, and beginning and ending of program School District Criterion Referenced Achievement Test proficiency scores for (i) math and (ii) reading were also utilized to evaluate student achievement gain and program effectiveness. (2) School climate as measured by: ending of program School Perception Survey results for (i) Relevance, (ii) Rigor, and (iii) Relationships. Permission to use the school climate survey was granted by the publisher Eye on Education. The school climate survey was proven to be reliable and valid (Bernhardt, 2004; Easton, 2008).

Research Questions and Data Analysis

The following pretest-posttest research questions were used to analyze the effect of zoo-based academic high school experiential science program completion and same school district’s school-based academic high school experiential science program completion on students’ norm referenced achievement test composite scores.

Overarching Pretest-Posttest Norm-Referenced Achievement Research

Question #1. Did students who completed a zoo-based academic high school experiential science program lose, maintain, or improve their 11th-grade pretest PLAN normal curve equivalent test composite scores compared to their 12th-grade posttest ACT normal curve equivalent test composite scores?

Analysis. Research Question #1 was analyzed using dependent t test to examine the significance of the difference between students’ PLAN norm curve equivalent composite score compared to ending ACT posttest norm curve equivalent composite score following participation in a zoo-based experiential high school science program. Since multiple statistical tests were conducted, a one-tailed .01 alpha level was employed
to help control for Type 1 errors. Means and standard deviations were displayed in tables.

**Overarching Pretest-Posttest Norm-Referenced Achievement Research**

**Question #2.** Did students who completed a school-based experiential academic high school science program lose, maintain, or improve their 11th-grade PLAN normal curve equivalent composite scores compared to their 12th-grade ACT normal curve equivalent composite scores?

**Analysis.** Research Question #2 was analyzed using dependent t test to examine the significance of the difference between students’ PLAN normal curve equivalent composite scores compared to ACT normal curve equivalent composite scores following participation in a school-based experiential high school science program. Since multiple statistical tests were conducted, a one-tailed .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

The following posttest research question was used to analyze the effect of zoo-based academic high school experiential science program completion compared to the same school district’s school-based academic high school experiential science program completion on students’ norm referenced achievement test composite scores.

**Overarching Posttest-Posttest Norm-Referenced Achievement Research**

**Question #3.** Did students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program have congruent or different 12th-grade posttest ACT normal curve equivalent test composite scores?
**Analysis.** Research Question #3 was analyzed using analysis of variance (ANOVA) to examine the significance of the difference between students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program and their 12th-grade ACT normal equivalent test composite scores. Since multiple statistical tests were conducted, a single classification ANOVA with a .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

The following pretest-posttest research questions were used to analyze the effect of zoo-based academic high school experiential science program completion and same school district’s school-based academic high school experiential science program completion on students’ 11th-grade overall grade point average.

**Overarching Pretest-Posttest Overall Grade Point Average Research Question #4.** Did students who completed a zoo-based academic high school experiential science program lose, maintain, or improve their beginning 11th-grade overall grade point average compared to their ending 11th-grade overall grade point average?

**Analysis.** Research Question #4 was analyzed using dependent t test to examine the significance of the difference between students’ beginning 11th-grade overall grade point average compared to their ending 11th-grade overall grade point average after completing a zoo-based academic high school experiential science program. Since multiple statistical tests were conducted, a one-tailed .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.
Overarching Pretest-Posttest Overall Grade Point Average Research

Question #5. Did students who completed a school-based academic high school experiential science program lose, maintain, or improve their beginning 11th-grade overall grade point average compared to their ending 11th-grade overall grade point average?

Analysis. Research Question #5 was analyzed using dependent $t$ test to examine the significance of the difference between students’ beginning 11th-grade overall grade point average compared to their ending 11th-grade overall grade point average after completing a school-based academic high school experiential science program. Since multiple statistical tests were conducted, a one-tailed .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

The following posttest research question was used to analyze the effect of zoo-based academic high school experiential science program completion compared to the same school district’s school-based academic high school experiential science program completion on overall grade point average.

Overarching Posttest-Posttest Overall Grade Point Average Research

Question #6. Did students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program have congruent or different 11th-grade ending overall grade point average scores?

Analysis. Research Question #6 was analyzed using analysis of variance (ANOVA) to examine the significance of the difference between students who completed a zoo-based academic high school experiential science program compared to students
who completed a school-based academic high school experiential science program 11th-grade overall grade point average. Since multiple statistical tests were conducted, a single classification ANOVA with a .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

The following pretest-posttest research questions were used to analyze the effect of zoo-based academic high school experiential science program completion and same school districts school-based academic high school experiential science program completion on students’ 12th-grade overall grade point average.

**Overarching Pretest-Posttest Overall Grade Point Average Research**

**Question #7.** Did students who completed a zoo-based academic high school experiential science program lose, maintain, or improve their beginning 12th-grade overall grade point average compared to their ending 12th-grade overall grade point average?

**Analysis.** Research Question #7 was analyzed using dependent *t* test to examine the significance of the difference between students’ beginning 12th-grade overall grade point average compared to their ending 12th-grade overall grade point average after completing a zoo-based academic high school experiential science program. Since multiple statistical tests were conducted, a one-tailed .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

**Overarching Pretest-Posttest Overall Grade Point Average Research**

**Question #8.** Did students who completed a school-based academic high school experiential science program lose, maintain, or improve their beginning 12th-grade
overall grade point average compared to their ending 12th-grade overall grade point average?

**Analysis.** Research Question #8 was analyzed using dependent $t$ test to examine the significance of the difference between students’ beginning 12th-grade overall grade point average compared to their ending 12th-grade overall grade point average after completing a school-based academic high school experiential science program. Since multiple statistical tests were conducted, a one-tailed .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

The following posttest research question was used to analyze the effect of zoo-based academic high school experiential science program completion compared to the same school district’s school-based academic high school experiential science program completion on 12th-grade overall grade point average.

**Overarching Posttest-Posttest Overall Grade Point Average Research Question #9.** Did students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program have congruent or different 12th-grade ending overall grade point average scores?

**Analysis.** Research Question #9 was analyzed using analysis of variance (ANOVA) to examine the significance of the difference between students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program 12th-grade overall grade point average. Since multiple statistical tests were conducted, a
single classification ANOVA with a .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

The following pretest-posttest research questions were used to analyze the effect of zoo-based academic high school experiential science program completion and same school districts school-based academic high school experiential science program completion on students’ science grade point average scores.

**Overarching Pretest-Posttest Science Grade Point Average Research**

**Question #10.** Did students who completed a zoo-based academic high school experiential science program lose, maintain, or improve their beginning 11th-grade pretest science grade point average compared to their ending 11th-grade posttest science grade point average scores?

**Analysis.** Research Question #10 was analyzed using dependent t test to examine the significance of the difference between students’ beginning 11th-grade science grade point average scores compared to their ending 11th-grade science grade point average scores after completing a zoo-based academic high school experiential science program. Since multiple statistical tests were conducted, a one-tailed .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

**Overarching Pretest-Posttest Science Grade Point Average Research**

**Question #11.** Did students who completed a school-based academic high school experiential science program lose, maintain, or improve their beginning 11th-grade pretest science grade point average compared to their ending 11th-grade posttest science grade point average scores?
**Analysis.** Research Question #11 was analyzed using dependent t test to examine the significance of the difference between students’ beginning 11th-grade science grade point average scores compared to their ending 11th-grade science grade point average scores after completing a school-based academic high school experiential science program. Since multiple statistical tests were conducted, a one-tailed .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

The following posttest research question was used to analyze the effect of zoo-based academic high school experiential science program completion compared to the same school district’s school-based academic high school experiential science program completion on 11th-grade science grade point average scores.

**Overarching Posttest-Posttest Science Grade Point Average Research Question #12.** Did students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program have congruent or different 11th-grade posttest science grade point average scores?

**Analysis.** Research Question #12 was analyzed using analysis of variance (ANOVA) to examine the significance of the difference between students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program 11th-grade science grade point average scores. Since multiple statistical tests were conducted, a single classification ANOVA with a .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.
The following pretest-posttest research questions were used to analyze the effect of zoo-based academic high school experiential science program completion and same school district’s school-based academic high school experiential science program completion on students’ science grade point average scores.

**Overarching Pretest-Posttest Science Grade Point Average Research**

**Question #13.** Did students who completed a zoo-based academic high school experiential science program lose, maintain, or improve their beginning 12th-grade pretest science grade point average compared to their ending 12th-grade posttest science grade point average scores?

**Analysis.** Research Question #13 was analyzed using dependent t test to examine the significance of the difference between students’ beginning 12th-grade science grade point average scores compared to their ending 12th-grade science grade point average scores after completing a zoo-based academic high school experiential science program. Since multiple statistical tests were conducted, a one-tailed .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

**Overarching Pretest-Posttest Science Grade Point Average Research**

**Question #14.** Did students who completed a school-based academic high school experiential science program lose, maintain, or improve their beginning 12th-grade pretest science grade point average compared to their ending 12th-grade posttest science grade point average scores?

**Analysis.** Research Question #14 was analyzed using dependent t test to examine the significance of the difference between students’ beginning 12th-grade science grade
point average scores compared to their ending 12th-grade science grade point average scores after completing a school-based academic high school experiential science program. Since multiple statistical tests were conducted, a one-tailed .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

The following posttest research question was used to analyze the effect of zoo-based academic high school experiential science program completion compared to the same school district’s school-based academic high school experiential science program completion on 12th-grade science grade point average scores.

**Overarching Posttest-Posttest Science Grade Point Average Research**

**Question #15.** Did students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program have congruent or different 12th-grade posttest science grade point average scores?

**Analysis.** Research Question #15 was analyzed using analysis of variance (ANOVA) to examine the significance of the difference between students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program 12th-grade science grade point average. Since multiple statistical tests were conducted, a single classification ANOVA with a .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

The following posttest research questions were used to analyze the effect of zoo-based academic high school experiential science program completion compared to same
school district’s school-based academic high school experiential science program completion on school district criterion referenced (a) math and (b) reading achievement proficiency test scores.

**Overarching Posttest-Posttest Criterion-Referenced Test Research Question #16.** Did 11th-grade students who completed a zoo-based academic high school experiential science program compared to 11th-grade students who completed a school-based academic high school experiential science program have congruent or different 11th-grade school district criterion referenced (a) math and (b) reading test scores?

**Sub-Question 16a.** Were posttest (a) math school district criterion referenced test scores congruent or different for 11th-grade students who completed a zoo-based academic high school experiential science program compared to 11th-grade students who completed a school-based academic high school experiential science program?

**Sub-Question 16b.** Were posttest (b) reading school district criterion referenced test scores congruent or different for 11th-grade students who completed a zoo-based academic high school experiential science program compared to 11th-grade students who completed a school-based academic high school experiential science program?

**Analysis.** Research Sub-Questions #16a and 16b were analyzed using analysis of variance (ANOVA) to examine the significance of the difference between 11th-grade students who completed a zoo-based academic high school experiential science program compared to 11th-grade students who completed a school-based academic high school experiential science program 11th-grade school district criterion referenced (a) math and
(b) reading test scores. Since multiple statistical tests were conducted, a single classification ANOVA with a .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

**Overarching Posttest-Posttest Criterion-Reference Test Research Question #17.** Did 12th-grade students who completed a zoo-based academic high school experiential science program compared to 12th-grade students who completed a school-based academic high school experiential science program have congruent or different 12th-grade school district criterion reference (a) math and (b) reading test scores?

**Sub-Question 17a.** Were posttest (a) math school district criterion reference test scores congruent or different for 12th-grade students who completed a zoo-based academic high school experiential science program compared to 12th-grade students who completed a school-based academic high school experiential science program?

**Sub-Question 17b.** Were posttest (b) reading school district criterion reference test scores congruent or different for 12th-grade students who completed a zoo-based academic high school experiential science program compared to 12th-grade students who completed a school-based academic high school experiential science program?

**Analysis.** Research Sub-Questions #17a and 17b were analyzed using analysis of variance (ANOVA) to examine the significance of the difference between 12th-grade students who completed a zoo-based academic high school experiential science program compared to 12th-grade students who completed a school-based academic high school experiential science program 12th-grade school district criterion reference (a) math and
(b) reading test scores. Since multiple statistical tests were conducted, a single
classification ANOVA with a .01 alpha level was employed to help control for Type 1
errors. Means and standard deviations were displayed in tables.

The following pretest-posttest research questions were used to analyze the effect
of zoo-based academic high school experiential science program school perception and
same school district’s school-based academic high school experiential science program
on students’ school climate perception of relevance, rigor, and relationships.

**Overarching Pretest-Posttest Student School Perception Research Question**

#18. Did students who completed a zoo-based academic high school experiential science
program lose, maintain, or improve their perception of school climate compared to their
end of the year posttest perception of school climate (a) relevance, (b) rigor, and (c)
relationships survey results?

**Sub-Question 18a.** Was there a significant difference between students’
beginning of the year school perceptions compared to their ending of the year school
perceptions survey results (a) relevance after completing a zoo-based academic high
school experiential science program?

**Sub-Question 18b.** Was there a significant difference between students’
beginning of the year school perceptions compared to their ending of the year school
perceptions survey results (b) rigor after completing a zoo-based academic high school
experiential science program?

**Sub-Question 18c.** Was there a significant difference between students’
beginning of the year school perceptions compared to their ending of the year school
perceptions survey results (c) relationships after completing a zoo-based academic high
school experiential science program?
perceptions survey results (c) relationships after completing a zoo-based academic high school experiential science program?

**Analysis.** Research Sub-Questions #18a, 18b, and 18c were analyzed using dependent $t$ tests to examine the significance of the difference between students’ beginning pretest compared to ending posttest school perception survey (a) relevance, (b) rigor, and (c) relationships survey results following completion in a zoo-based academic experiential high school science program. Since multiple statistical tests were conducted, a one-tailed .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

**Overarching Pretest-Posttest Student School Perception Research Question #19.** Did students who completed a school-based academic high school experiential science program lose, maintain, or improve their perception of school climate compared to their end of the year posttest perception of school climate (a) relevance, (b) rigor, and (c) relationships survey results?

**Sub-Question 19a.** Was there a significant difference between students’ beginning of the year school perceptions compared to their ending of the year school perceptions survey results (a) relevance after completing a school-based academic high school experiential science program?

**Sub-Question 19b.** Was there a significant difference between students’ beginning of the year school perceptions compared to their ending of the year school perceptions survey results (b) rigor after completing a school-based academic high school experiential science program?
**Sub-Question 19c.** Was there a significant difference between students’ beginning of the year school perceptions compared to their ending of the year school perceptions survey results (c) relationships after completing a school-based academic high school experiential science program?

**Analysis.** Research Sub-Questions #19a, 19b, and 19c were analyzed using dependent *t* tests to examine the significance of the difference between students’ beginning pretest compared to ending posttest school perception survey (a) relevance, (b) rigor, and (c) relationships survey results following completion in a school-based academic experiential high school science program. Since multiple statistical tests were conducted, a one-tailed .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

The following posttest-posttest research questions were used to analyze the effect of zoo-based academic high school experiential science program school perception and same school district’s school-based academic high school experiential science program students’ school climate perception of relevance, rigor, and relationship.

**Overarching Posttest-Posttest Student School Perception Research Question #20.** Did students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program have congruent or different perceptions of school climate (a) relevance, (b) rigor, and (c) relationships?

**Sub-Question 20a.** Were posttest (a) relevance school perceptions results congruent or different for students who completed a zoo-based academic high school
experiential science program compared to students who completed a school-based academic high school experiential science program?

**Sub-Question 20b.** Were posttest (b) rigor school perceptions results congruent or different for students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program?

**Sub-Question 20c.** Were posttest (c) relationships school perceptions results congruent or different for students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program?

**Analysis.** Research Sub-Questions #20a, 20b, and 20c were analyzed using analysis of variance (ANOVA) to examine the significance of the difference between students who completed a zoo-based academic high school experiential science program compared to students who completed a school-based academic high school experiential science program school climate perceptions (a) relevance, (b) rigor, and (c) relationships. Since multiple statistical tests were conducted, a single classification ANOVA with a .01 alpha level was employed to help control for Type 1 errors. Means and standard deviations were displayed in tables.

**Data Collection Procedures**

All study achievement and school perception data were retrospective, archival, and routinely collected school information. Permission from the appropriate school research personnel was obtained. Naturally formed groups of 18 students in one arm and 18 in the other were obtained to include achievement and school perception data. Non-
coded numbers were used to display individual de-identified achievement and school perception data. Aggregated group data, descriptive statistics, and parametric statistical analysis were utilized and reported with means and standard deviations on tables.

**Performance site.** The research was conducted in the public school setting through normal educational practices. The study procedures did not interfere with the normal educational practices of the public school and did not involve coercion or discomfort of any kind. Data were stored on spreadsheets and computer flash drives for statistical analysis in the office of the primary researcher and the dissertation chair. Data and computer files were kept in locked file cabinets. No individual identifiers were attached to the data.

**Institutional Review Board (IRB) for the protection of Human Subjects**

**Approval Category.** The exemption categories for this study were provided under 45CFR.101 (b) categories 1 and 4. The research was conducted using routinely collected archival data. A letter of support from the district was provided for IRB review.
CHAPTER FOUR

Results

Purpose of the Study

The purpose of this study was to determine the effect of an 11th-grade and 12th-grade zoo-based academic high school experiential science program compared to a same school-district school-based academic high school experiential science program on students’ pretest and posttest science, math and reading achievement, and student perceptions of program relevance, rigor, and relationships.

Implementation of the Independent Variables

The independent variables for this study were two naturally formed groups representing students who completed a zoo-based experiential academic high school science program and students who completed a school-based experiential academic high school science program. The students in the first group, a zoo-based experiential academic high school science program, completed real world, hands-on projects at the zoo. The second group, those students who completed a school-based experiential academic high school science program, completed real world, simulated projects in the classroom. These groups comprised the two research arms of the study. Both groups of students were selected from the same school district.

Dependent Measures

The study’s two dependent variables were (1) achievement and (2) school climate. Achievement, was analyzed using the following dependent measures (a) norm-referenced test composite scores; these scores were derived from the PLAN test and American College Testing (ACT) test, (b) school district criteria reference test, which included
math and reading scores, (c) course grade point average for science, and (d) overall weighted grade point average as determined by the district information management system. The second dependent variable was school climate data. The participating 11th-grade and 12th-grade students’ perception of school climate in regard to (a) rigor, (b) relevance, and (c) relationships were obtained from surveys.

All study achievement data related to each of the dependent variables were retrospective, archival, and routinely collected school information. Permission from the appropriate school research personnel was obtained before data were collected and analyzed.

Table 1 displays demographic information of individual 11th-grade and 12th-grade students who participated in a zoo-based experiential academic high school science program. Table 2 displays demographic information of individual 11th-grade and 12th-grade students who participated in a school-based experiential academic high school science program.

**Research Question #1**

Table 3 displays students \(n = 18\) who completed a Zoo-Based Academic High School Experiential Science Program 11th-grade pretest PLAN normal curve equivalent test composite scores compared to their 12th-grade posttest ACT normal curve equivalent test composite scores. The first pretest-posttest hypothesis was tested using the dependent \(t\) test. As seen in Table 3, the null hypothesis for test scores over time was rejected in the direction of improvement for the end of 11th-grade pretest PLAN normal curve equivalent test composite scores compared to ending 12th-grade posttest ACT
normal curve equivalent test composite scores: pretest $M = 18.39$, $SD = 3.05$; posttest $M = 20.83$, $SD = 4.53$; $t(17) = 4.65$, $p < .001$ (one-tailed), $d = 1.432$.

Research Question #2

Table 4 displays students ($n = 18$) who completed a School-Based Academic High School Experiential Science Program 11th-grade pretest PLAN normal curve equivalent test composite scores compared to their 12th-grade posttest ACT normal curve equivalent test composite scores. The second pretest-posttest hypothesis was tested using the dependent $t$ test. As seen in Table 4, the null hypothesis for test scores over time was rejected in the direction of improvement for the end of 11th-grade pretest PLAN normal curve equivalent test composite scores compared to ending 12th-grade posttest ACT normal curve equivalent test composite scores: pretest $M = 17.72$, $SD = 2.74$; posttest $M = 20.72$, $SD = 3.39$; $t(17) = 7.42$, $p < .001$ (one-tailed), $d = 1.700$.

Research Question #3

Table 5 displays Analysis of Variance (ANOVA) of students ($n = 18$) who completed a Zoo-Based Academic High School Experiential Science Program compared to students ($n = 18$) who completed a School-Based Academic High School Experiential Science Program 12th-grade posttest ACT normal curve equivalent test composite scores. The third posttest-posttest hypothesis was tested using a single classification ANOVA. As seen in Table 5, the null hypothesis for the posttest-posttest comparison of students who completed a Zoo-Based Academic High School Experiential Science Program ($M = 20.83$, $SD = 4.53$) compared to students who completed a School-Based Academic High School Experiential Science Program ($M = 20.72$, $SD = 3.39$) end of 12th-grade posttest
ACT normal curve equivalent test composite scores was not rejected where the overall main effect of the comparison was not statistically different, \( F(1, 34) = 0.01, p = .93 \).

**Research Question #4**

Table 6 displays students \( (n = 10) \) who completed a Zoo-Based Academic High School Experiential Science Program beginning 11th-grade overall grade point average compared to ending 11th-grade overall grade point average scores. The fourth pretest-posttest hypothesis was tested using the dependent \( t \) test. As seen in Table 6, the null hypothesis for overall grade point average over time was not rejected in the direction of improvement for the beginning of 11th-grade pretest overall grade point average scores compared to ending 11th-grade overall grade point average scores: pretest \( M = 3.34, SD = 0.71 \); posttest \( M = 3.36, SD = 0.69 \); \( t(9) = 1.19, p = .13 \) (one-tailed), \( d = 0.202 \).

**Research Question #5**

Table 7 displays students \( (n = 8) \) who completed a School-Based Academic High School Experiential Science Program beginning 11th-grade overall grade point average compared to ending 11th-grade overall grade point average scores. The fifth pretest-posttest hypothesis was tested using the dependent \( t \) test. As seen in Table 7, the null hypothesis for overall grade point average over time was not rejected in the direction of lower scores for the beginning of 11th-grade pretest overall grade point average scores compared to ending 11th-grade overall grade point average scores: pretest \( M = 3.34, SD = 0.49 \); posttest \( M = 3.33, SD = 0.51 \); \( t(7) = -0.68, p = .26 \) (one-tailed), \( d = -0.140 \).

**Research Question #6**

Table 8 displays Analysis of Variance (ANOVA) of students \( (n = 10) \) who completed a Zoo-Based Academic High School Experiential Science Program compared
to students ($n = 8$) who completed a School-Based Academic High School Experiential Science Program 11th-grade overall grade point average scores. The sixth posttest-posttest hypothesis was tested using a single classification ANOVA. As seen in Table 8, the null hypothesis for the posttest-posttest comparison of students who completed a Zoo-Based Academic High School Experiential Science Program ($M = 3.36, SD = 0.69$) compared to students who completed a School-Based Academic High School Experiential Science Program ($M = 3.33, SD = 0.51$) ending 11th-grade posttest overall grade point average scores was not rejected where the overall main effect of the comparison was not statistically different, ($F(1, 16) = 0.01, p = .92$).

**Research Question #7**

Table 9 displays students ($n = 8$) who completed a Zoo-Based Academic High School Experiential Science Program beginning 12th-grade overall grade point average compared to ending 12th-grade overall grade point average scores. The seventh pretest-posttest hypothesis was tested using the dependent $t$ test. As seen in Table 9, the null hypothesis for overall grade point average over time was not rejected in the direction of improvement for the beginning of 12th-grade pretest overall grade point average scores compared to ending 12th-grade overall grade point average scores: pretest $M = 3.09, SD = 0.75$; posttest $M = 3.11, SD = 0.73$; $t(7) = 1.76, p = .06$ (one-tailed), $d = 0.000$.

**Research Question #8**

Table 10 displays students ($n = 10$) who completed a School-Based Academic High School Experiential Science Program beginning 12th-grade overall grade point average compared to ending 12th-grade overall grade point average scores. The eighth pretest-posttest hypothesis was tested using the dependent $t$ test. As seen in Table 10, the
null hypothesis for overall grade point average over time was rejected in the direction of lower scores for the beginning of 12th-grade pretest overall grade point average scores compared to ending 12th-grade overall grade point average scores: pretest $M = 3.29$, $SD = 0.68$; posttest $M = 3.23$, $SD = 0.70$; $t(9) = -3.12$, $p = .01$ (one-tailed), $d = -0.606$.

**Research Question #9**

Table 11 displays Analysis of Variance (ANOVA) of students ($n = 8$) who completed a Zoo-Based Academic High School Experiential Science Program compared to students ($n = 10$) who completed a School-Based Academic High School Experiential Science Program 12th-grade overall grade point average scores. The ninth posttest-posttest hypothesis was tested using a single classification ANOVA. As seen in Table 11, the null hypothesis for the posttest-posttest comparison of students who completed a Zoo-Based Academic High School Experiential Science Program ($M = 3.11$, $SD = 0.73$) compared to students who completed a School-Based Academic High School Experiential Science Program ($M = 3.23$, $SD = 0.70$) ending 12th-grade posttest overall grade point average scores was not rejected where the overall main effect of the comparison was not statistically different, ($F(1, 16) = 0.13$, $p = .72$).

**Research Question #10**

Table 12 displays students ($n = 10$) who completed a Zoo-Based Academic High School Experiential Science Program beginning 11th-grade science grade point average scores compared to ending 11th-grade science grade point average scores. The tenth pretest-posttest hypothesis was tested using the dependent $t$ test. As seen in Table 12, the null hypothesis for science grade point average scores over time was rejected in the direction of lower scores for the beginning of 11th-grade pretest science grade point
average scores compared to ending 11th-grade science grade point average scores: pretest $M = 3.75, SD = 0.77$; posttest $M = 3.43, SD = 0.61$; $t(9) = -2.96, p = .008$ (one-tailed), $d = -1.037$.

**Research Question #11**

Table 13 displays students ($n = 8$) who completed a School-Based Academic High School Experiential Science Program beginning 11th-grade science grade point average scores compared to ending 11th-grade science grade point average scores. The eleventh pretest-posttest hypothesis was tested using the dependent $t$ test. As seen in Table 13, the null hypothesis for science grade point average scores over time was not rejected in the direction of improvement for the beginning of 11th-grade pretest science grade point average scores compared to ending 11th-grade science grade point average scores: pretest $M = 3.47, SD = 0.90$; posttest $M = 3.48, SD = 0.84$; $t(7) = 0.25, p = .40$ (one-tailed), $d = 0.081$.

**Research Question #12**

Table 14 displays Analysis of Variance (ANOVA) of students ($n = 10$) who completed a Zoo-Based Academic High School Experiential Science Program compared to students ($n = 8$) who completed a School-Based Academic High School Experiential Science Program 11th-grade science grade point average scores. The twelfth posttest-posttest hypothesis was tested using a single classification ANOVA. As seen in Table 14, the null hypothesis for the posttest-posttest comparison of students who completed a Zoo-Based Academic High School Experiential Science Program ($M = 3.43, SD = 0.61$) compared to students who completed a School-Based Academic High School Experiential Science Program ($M = 3.48, SD = 0.90$) ending 11th-grade posttest science
grade point average scores was not rejected where the overall main effect of the comparison was not statistically different, \( F(1, 16) = 0.02, p = .89 \).

**Research Question #13**

Table 15 displays students \((n = 8)\) who completed a Zoo-Based Academic High School Experiential Science Program beginning 12th-grade science grade point average scores compared to ending 12th-grade science grade point average scores. The thirteenth pretest-posttest hypothesis was tested using the dependent \( t \) test. As seen in Table 15, the null hypothesis for science grade point average scores over time was rejected in the direction of improvement for the beginning of 12th-grade pretest science grade point average scores compared to ending 12th-grade science grade point average scores: pretest \( M = 2.91, SD = 0.95 \); posttest \( M = 3.18, SD = 0.76 \); \( t(7) = 2.73, p = .01 \) (one-tailed), \( d = 1.289 \).

**Research Question #14**

Table 16 displays students \((n = 10)\) who completed a School-Based Academic High School Experiential Science Program beginning 12th-grade science grade point average scores compared to ending 12th-grade science grade point average scores. The fourteenth pretest-posttest hypothesis was tested using the dependent \( t \) test. As seen in Table 16, the null hypothesis for science grade point average scores over time was not rejected in the direction of lower scores for the beginning of 12th-grade pretest science grade point average scores compared to ending 12th-grade science grade point average scores: pretest \( M = 3.61, SD = 0.98 \); posttest \( M = 3.39, SD = 0.99 \); \( t(9) = -1.42, p = .09 \) (one-tailed), \( d = -0.438 \).
Research Question #15

Table 17 displays Analysis of Variance (ANOVA) of students \((n = 8)\) who completed a Zoo-Based Academic High School Experiential Science Program compared to students \((n = 10)\) who completed a School-Based Academic High School Experiential Science Program 12th-grade posttest science grade point average scores. The fifteenth posttest-posttest hypothesis was tested using a single classification ANOVA. As seen in Table 17, the null hypothesis for the posttest-posttest comparison of students who completed a Zoo-Based Academic High School Experiential Science Program \((M = 3.18, SD = 0.76)\) compared to students who completed a School-Based Academic High School Experiential Science Program \((M = 3.39, SD = 0.99)\) ending 12th-grade posttest science grade point average scores was not rejected where the overall main effect of the comparison was not statistically different, \((F(1, 16) = 0.25, p = .63)\).

Research Question #16a

Table 18 displays Analysis of Variance (ANOVA) of students \((n = 10)\) who completed a Zoo-Based Academic High School Experiential Science Program compared to students \((n = 8)\) who completed a School-Based Academic High School Experiential Science Program 11th-grade posttest school district math criterion reference test scores. The sixteenth posttest-posttest hypothesis sub-question (a) was tested using a single classification ANOVA. As seen in Table 18, the null hypothesis for the posttest-posttest comparison of students who completed a Zoo-Based Academic High School Experiential Science Program \((M = 18.20, SD = 2.10)\) compared to students who completed a School-Based Academic High School Experiential Science Program \((M = 17.13, SD = 2.47)\) ending 11th-grade posttest school district math criterion reference test scores was not
rejected where the overall main effect of the comparison was not statistically different, 
\((F(1, 16) = 1.00, p = .33)\).

**Research Question #16b**

Table 19 displays Analysis of Variance (ANOVA) of students \((n = 10)\) who completed a Zoo-Based Academic High School Experiential Science Program compared to students \((n = 8)\) who completed a School-Based Academic High School Experiential Science Program 11th-grade posttest school district reading criterion reference test scores. The sixteenth posttest-posttest hypothesis sub-question (b) was tested using a single classification ANOVA. As seen in Table 19, the null hypothesis for the posttest-posttest comparison of students who completed a Zoo-Based Academic High School Experiential Science Program \((M = 2.80, SD = 0.79)\) compared to students who completed a School-Based Academic High School Experiential Science Program \((M = 3.38, SD = 0.74)\) ending 11th-grade posttest school district reading criterion reference test scores was not rejected where the overall main effect of the comparison was not statistically different, \((F(1, 16) = 2.48, p = .13)\).

**Research Question #17a**

Table 20 displays Analysis of Variance (ANOVA) of students \((n = 8)\) who completed a Zoo-Based Academic High School Experiential Science Program compared to students \((n = 10)\) who completed a School-Based Academic High School Experiential Science Program 12th-grade posttest school district math criterion reference test scores. The seventeenth posttest-posttest hypothesis sub-question (a) was tested using a single classification ANOVA. As seen in Table 20, the null hypothesis for the posttest-posttest comparison of students who completed a Zoo-Based Academic High School Experiential
Science Program \( (M = 18.38, SD = 2.72) \) compared to students who completed a School-Based Academic High School Experiential Science Program \( (M = 18.50, SD = 1.71) \) ending 12th-grade posttest school district math criterion reference test scores was not rejected where the overall main effect of the comparison was not statistically different, \( (F(1, 16) = 0.01, p = .91) \).

**Research Question #17b**

Table 21 displays Analysis of Variance (ANOVA) of students \( (n = 8) \) who completed a Zoo-Based Academic High School Experiential Science Program compared to students \( (n = 10) \) who completed a School-Based Academic High School Experiential Science Program 12th-grade posttest school district reading criterion reference test scores. The seventeenth posttest-posttest hypothesis sub-question (b) was tested using a single classification ANOVA. As seen in Table 21, the null hypothesis for the posttest-posttest comparison of students who completed a Zoo-Based Academic High School Experiential Science Program \( (M = 3.38, SD = 0.74) \) compared to students who completed a School-Based Academic High School Experiential Science Program \( (M = 2.95, SD = 0.76) \) ending 12th-grade posttest school district reading criterion reference test scores was not rejected where the overall main effect of the comparison was not statistically different, \( (F(1, 16) = 1.41, p = .25) \).

**Research Question #18a**

Table 22 displays students \( (n = 18) \) who completed a Zoo-Based Academic High School Experiential Science Program beginning of the school year compared to ending of the school year perception of program relevance. The eighteenth pretest-posttest hypothesis sub-question (a) was tested using the dependent \( t \) test. As seen in Table 22,
the null hypothesis for ending of the school year perception of program relevance was not rejected in the direction of lower scores for the beginning of the school year pretest scores compared to ending of the school year posttest scores: pretest $M = 4.30$, $SD = 0.54$; posttest $M = 4.17$, $SD = 0.35$; $t(17) = -0.85$, $p = .20$ (one-tailed), $d = -0.202$.

**Research Question #18b**

Table 23 displays students ($n = 18$) who completed a Zoo-Based Academic High School Experiential Science Program beginning of the school year compared to ending of the school year perception of program rigor. The eighteenth pretest-posttest hypothesis sub-question (b) was tested using the dependent $t$ test. As seen in Table 23, the null hypothesis for ending of the school year perception of program rigor was not rejected in the direction of improvement for the beginning of the school year pretest scores compared to ending of the school year posttest scores: pretest $M = 4.02$, $SD = 0.57$; posttest $M = 4.26$, $SD = 0.36$; $t(17) = 1.58$, $p = .07$ (one-tailed), $d = 0.371$.

**Research Question #18c**

Table 24 displays students ($n = 18$) who completed a Zoo-Based Academic High School Experiential Science Program beginning of the school year compared to ending of the school year perception of program relationships. The eighteenth pretest-posttest hypothesis sub-question (c) was tested using the dependent $t$ test. As seen in Table 24, the null hypothesis for ending of the school year perception of program relationships was rejected in the direction of improvement for the beginning of the school year pretest scores compared to ending of the school year posttest scores: pretest $M = 4.09$, $SD = 0.49$; posttest $M = 4.40$, $SD = 0.36$; $t(17) = 1.82$, $p = .04$ (one-tailed), $d = 0.422$. 
Research Question #19a

Table 25 displays students \( (n = 18) \) who completed a School-Based Academic High School Experiential Science Program beginning of the school year compared to ending of the school year perception of program relevance. The nineteenth pretest-posttest hypothesis sub-question (a) was tested using the dependent \( t \) test. As seen in Table 25, the null hypothesis for ending of the school year perception of program relevance was not rejected in the direction of improvement for the beginning of the school year pretest scores compared to ending of the school year posttest scores: pretest \( M = 3.34, SD = 0.48 \); posttest \( M = 3.55, SD = 0.53 \); \( t(17) = 1.08, p = .15 \) (one-tailed), \( d = 0.255 \).

Research Question #19b

Table 26 displays students \( (n = 18) \) who completed a School-Based Academic High School Experiential Science Program beginning of the school year compared to ending of the school year perception of program rigor. The nineteenth pretest-posttest hypothesis sub-question (b) was tested using the dependent \( t \) test. As seen in Table 26, the null hypothesis for ending of the school year perception of program rigor was not rejected in the direction of lower scores for the beginning of the school year pretest scores compared to ending of the school year posttest scores: pretest \( M = 3.75, SD = 0.49 \); posttest \( M = 3.73, SD = 0.51 \); \( t(17) = -0.19, p = .42 \) (one-tailed), \( d = -0.033 \).

Research Question #19c

Table 27 displays students \( (n = 18) \) who completed a School-Based Academic High School Experiential Science Program beginning of the school year compared to ending of the school year perception of program relationships. The nineteenth pretest-
posttest hypothesis sub-question (c) was tested using the dependent $t$ test. As seen in Table 27, the null hypothesis for ending of the school year perception of program relationships was not rejected in the direction of improvement for the beginning of the school year pretest scores compared to ending of the school year posttest scores: pretest $M = 3.60, SD = 0.52$; posttest $M = 3.61, SD = 0.56$; $t(17) = 0.06, p = .48$ (one-tailed), $d = 0.014$.

**Research Question #20a**

Table 28 displays Analysis of Variance (ANOVA) of students ($n = 18$) who completed a Zoo-Based Academic High School Experiential Science Program compared to students ($n = 18$) who completed a School-Based Academic High School Experiential Science Program ending of the school year perception of program relevance. The twentieth posttest-posttest hypothesis sub-question (a) was tested using a single classification ANOVA. As seen in Table 28, the null hypothesis for the posttest-posttest comparison of students who completed a Zoo-Based Academic High School Experiential Science Program ($M = 4.17, SD = 0.35$) compared to students who completed a School-Based Academic High School Experiential Science Program ($M = 3.55, SD = 0.53$) was rejected where the overall main effect of the comparison was statistically different, ($F(1, 34) = 17.05, p = .0002$).

**Research Question #20b**

Table 29 displays Analysis of Variance (ANOVA) of students ($n = 18$) who completed a Zoo-Based Academic High School Experiential Science Program compared to students ($n = 18$) who completed a School-Based Academic High School Experiential Science Program ending of the school year perception of program rigor. The twentieth
posttest-posttest hypothesis sub-question (b) was tested using a single classification ANOVA. As seen in Table 29, the null hypothesis for the posttest-posttest comparison of students who completed a Zoo-Based Academic High School Experiential Science Program ($M = 4.26, SD = 0.36$) compared to students who completed a School-Based Academic High School Experiential Science Program ($M = 3.73, SD = 0.51$) was rejected where the overall main effect of the comparison was statistically different, ($F(1, 34) = 13.37, p = .001$).

**Research Question #20c**

Table 30 displays Analysis of Variance (ANOVA) of students ($n = 18$) who completed a Zoo-Based Academic High School Experiential Science Program compared to students ($n = 18$) who completed a School-Based Academic High School Experiential Science Program ending of the school year perception of program relationships. The twentieth posttest-posttest hypothesis sub-question (c) was tested using a single classification ANOVA. As seen in Table 30, the null hypothesis for the posttest-posttest comparison of students who completed a Zoo-Based Academic High School Experiential Science Program ($M = 4.40, SD = 0.36$) compared to students who completed a School-Based Academic High School Experiential Science Program ($M = 3.61, SD = 0.56$) was rejected where the overall main effect of the comparison was statistically different, ($F(1, 34) = 24.84, p < .001$).
Table 1

Demographic Information of Individual 11th-Grade and 12th-Grade Students Who Participated in a Zoo-Based Experiential Academic High School Science Program

<table>
<thead>
<tr>
<th>Student Number</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Grade&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Male</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>2.</td>
<td>Male</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>3.</td>
<td>Female</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>4.</td>
<td>Female</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>5.</td>
<td>Male</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>6.</td>
<td>Female</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>7.</td>
<td>Female</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>8.</td>
<td>Female</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>9.</td>
<td>Male</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>10.</td>
<td>Male</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>11.</td>
<td>Female</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>12.</td>
<td>Female</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>13.</td>
<td>Female</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>14.</td>
<td>Female</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>15.</td>
<td>Male</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>16.</td>
<td>Female</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>17.</td>
<td>Female</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>18.</td>
<td>Female</td>
<td>Caucasian</td>
<td>11</td>
</tr>
</tbody>
</table>

<sup>Note</sup>. Students attended the Zoo-Based Experiential Academic High School Science Program were eligible to complete all Junior and Senior year district-level academic coursework in this program returning to their home high school for extracurricular and elective course participation.

<sup>a</sup>All study statistical comparisons were grade-to-grade except for the (a) ACT results where students completed the exam in both Junior and Senior high school years and the (b) school climate survey analysis where the results were aggregated by school year.
Table 2

Demographic Information of Individual 11th-Grade and 12th-Grade Students Who Participated in a School-Based Experiential Academic High School Science Program

<table>
<thead>
<tr>
<th>Student Number</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Grade&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Male</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>2.</td>
<td>Male</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>3.</td>
<td>Male</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>4.</td>
<td>Male</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>5.</td>
<td>Male</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>6.</td>
<td>Male</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>7.</td>
<td>Male</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>8.</td>
<td>Female</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>9.</td>
<td>Male</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>10.</td>
<td>Male</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>11.</td>
<td>Male</td>
<td>Asian</td>
<td>12</td>
</tr>
<tr>
<td>12.</td>
<td>Male</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>13.</td>
<td>Female</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>14.</td>
<td>Female</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>15.</td>
<td>Male</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>16.</td>
<td>Male</td>
<td>Caucasian</td>
<td>12</td>
</tr>
<tr>
<td>17.</td>
<td>Male</td>
<td>Caucasian</td>
<td>11</td>
</tr>
<tr>
<td>18.</td>
<td>Female</td>
<td>African American</td>
<td>12</td>
</tr>
</tbody>
</table>

<sup>Note.</sup> Students attended the School-Based Experiential Academic High School Science Program completed all Junior and Senior year district-level academic coursework in this program.
<sup>a</sup>All study statistical comparisons were grade-to-grade except for the (a) ACT results where students completed the exam in both Junior and Senior high school years and the (b) school climate survey analysis where the results were aggregated by school year.
Table 3

Students (n = 18) Who Completed a Zoo-Based Academic High School Experiential Science Program 11th-Grade Pretest PLAN Normal Curve Equivalent Test Composite Scores Compared To Their 12th-Grade Posttest ACT Normal Curve Equivalent Test Composite Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest M (SD)</th>
<th>Posttest M (SD)</th>
<th>d</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>18.39 (3.05)</td>
<td>20.83 (4.53)</td>
<td>1.432</td>
<td>4.65</td>
<td>.000***</td>
</tr>
</tbody>
</table>

Note. A = Students in this analysis attended the Zoo-Based Experiential Academic High School Science Program for their Junior and Senior high school years. ***p < .001.
Table 4

Students (n = 18) Who Completed a School-Based Academic High School Experiential Science Program 11th-Grade Pretest PLAN Normal Curve Equivalent Test Composite Scores Compared To Their 12th-Grade Posttest ACT Normal Curve Equivalent Test Composite Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest M (SD)</th>
<th>Posttest M (SD)</th>
<th>d</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>17.72 (2.74)</td>
<td>20.72 (3.39)</td>
<td>1.700</td>
<td>7.42</td>
<td>.000***</td>
</tr>
</tbody>
</table>

Note. B = Students in this analysis attended the School-Based High School Experiential Academic Science Program for their Junior and Senior high school years. **p < .001.
Table 5

*Analysis of Variance of Students (n = 18) Who Completed a Zoo-Based Academic High School Experiential Science Program Compared to Students (n = 18) Who Completed a School-Based Academic High School Experiential Science Program 12th-Grade Posttest ACT Normal Curve Equivalent Test Composite Scores*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>0.11</td>
<td>0.11</td>
<td>1</td>
<td>0.01</td>
<td>.93†</td>
</tr>
<tr>
<td>Within Groups</td>
<td>544.11</td>
<td>16.00</td>
<td>34</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ACT Composite Scores

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20.83 (4.53)</td>
</tr>
<tr>
<td>B</td>
<td>20.72 (3.39)</td>
</tr>
</tbody>
</table>

*Note. A = Students attending the Zoo-Based Experiential Academic High School Science Program; B = Students attending the School-Based Experiential Academic High School Science Program.*

†*ns.*
Table 6

*Students (n = 10) Who Completed a Zoo-Based Academic High School Experiential Science Program Beginning 11th-Grade Overall Grade Point Average Scores Compared to Ending 11th-Grade Overall Grade Point Average Scores*

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>A</td>
<td>3.34 (0.71)</td>
<td></td>
</tr>
</tbody>
</table>

*Note. A = Students in this analysis attended the Zoo-Based Experiential Academic High School Science Program for their Junior and Senior high school years. This analysis was based on 11th-grade beginning and ending overall grade point average scores. $^*$ns.*
Table 7

*Students (n = 8) Who Completed a School-Based Academic High School Experiential Science Program Beginning 11th-Grade Overall Grade Point Average Scores Compared to Ending 11th-Grade Overall Grade Point Average Scores*

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest M (SD)</th>
<th>Posttest M (SD)</th>
<th>d</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>3.34 (0.49)</td>
<td>3.33 (0.51)</td>
<td>-0.140</td>
<td>-0.68</td>
<td>.26⁺</td>
</tr>
</tbody>
</table>

*Note. B = Students in this analysis attended the School-Based Experiential Academic High School Science Program for their Junior and Senior high school years. This analysis was based on 11th-grade beginning and ending overall grade point average scores.  
⁺ns.*
Table 8

*Analysis of Variance of Students (n = 10) Who Completed a Zoo-Based Academic High School Experiential Science Program Compared to Students (n = 8) Who Completed a School-Based Academic High School Experiential Science Program 11th-Grade Posttest Overall Grade Point Average Scores*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>0.00</td>
<td>0.00</td>
<td>1</td>
<td>0.01</td>
<td>.92*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>6.11</td>
<td>0.38</td>
<td>16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Overall Grade Point Average Scores**  
Mean (SD)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.36 (0.69)</td>
</tr>
<tr>
<td>B</td>
<td>3.33 (0.51)</td>
</tr>
</tbody>
</table>

*Note. A = Students attending the Zoo-Based Experiential Academic High School Science Program; B = Students attending the School-Based Experiential Academic High School Science Program.  
*ns.*
Table 9

Students (n = 8) Who Completed a Zoo-Based Academic High School Experiential Science Program Beginning 12th-Grade Overall Grade Point Average Compared to Ending 12th-Grade Overall Grade Point Average Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
<th>d</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>3.09 (0.75)</td>
<td>3.11 (0.73)</td>
<td>0.000</td>
<td>1.76</td>
<td>.06⁺</td>
</tr>
</tbody>
</table>

Note. A = Students in this analysis attended the Zoo-Based Experiential Academic High School Science Program for their Junior and Senior high school years. This analysis was based on 12th-grade beginning and ending overall grade point average scores. ⁺ns.
Table 10

*Students (n = 10) Who Completed a School-Based Academic High School Experiential Science Program Beginning 12th-Grade Overall Grade Point Average Compared to Ending 12th-Grade Overall Grade Point Average Scores*


<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest M</th>
<th>Pretest SD</th>
<th>Posttest M</th>
<th>Posttest SD</th>
<th>d</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>3.29 (0.68)</td>
<td>3.23 (0.70)</td>
<td>-0.606</td>
<td>-3.12</td>
<td>.01**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. B = Students in this analysis attended the School-Based Experiential Academic High School Science Program for their Junior and Senior high school years. This analysis was based on 12th-grade beginning and ending overall grade point average scores.**p = .01.
Table 11

*Analysis of Variance of Students (n = 8) Who Completed a Zoo-Based Academic High School Experiential Science Program Compared to Students (n = 10) Who Completed a School-Based Academic High School Experiential Science Program 12th-Grade Posttest Overall Grade Point Average Scores*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>df</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>0.07</td>
<td>0.07</td>
<td>1</td>
<td>0.13</td>
<td>.72†</td>
</tr>
<tr>
<td>Within Groups</td>
<td>8.12</td>
<td>0.51</td>
<td>16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overall Grade Point Average Scores</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.11 (0.73)</td>
</tr>
<tr>
<td>B</td>
<td>3.23 (0.70)</td>
</tr>
</tbody>
</table>

*Note. A = Students attending the Zoo-Based Experiential Academic High School Science Program; B = Students attending the School-Based Experiential Academic High School Science Program.  
†ns.*
Table 12

*Students (n = 10) Who Completed a Zoo-Based Academic High School Experiential Science Program Beginning 11th-Grade Science Grade Point Average Compared to Ending 11th-Grade Science Grade Point Average Scores*

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>A</td>
<td>3.75 (0.77)</td>
<td>3.43 (0.61)</td>
</tr>
</tbody>
</table>

*Note.* A = Students in this analysis attended the Zoo-Based Experiential Academic High School Science Program for their Junior and Senior high school years. This analysis was based on 11th-grade beginning and 11th-grade ending science grade point average scores. **p < .01.
Table 13

Students (n = 8) Who Completed a School-Based Academic High School Experiential Science Program Beginning 11th-Grade Science Grade Point Average Compared to Ending 11th-Grade Science Grade Point Average Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>d</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>3.47</td>
<td>0.90</td>
<td>3.48</td>
<td>0.84</td>
<td>0.081</td>
<td>0.25</td>
<td>.40†</td>
</tr>
</tbody>
</table>

Note. B = Students in this analysis attended the School-Based Experiential Academic High School Science Program for their Junior and Senior high school years. This analysis was based on 11th-grade beginning and 11th-grade ending science grade point average scores. The average science grade point average score was not available for one student. Because the missing value was preceded and followed by non-missing values it was replaced by the average of the preceded and following values. †ns.
Table 14

*Analysis of Variance of Students (n = 10) Who Completed a Zoo-Based Academic High School Experiential Science Program Compared to Students (n = 8) Who Completed a School-Based Academic High School Experiential Science Program 11th-Grade Posttest Science Grade Point Average Scores*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>0.01</td>
<td>0.01</td>
<td>1</td>
<td>0.02</td>
<td>.89†</td>
</tr>
<tr>
<td>Within Groups</td>
<td>8.97</td>
<td>0.56</td>
<td>16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Science Grade Point Average Scores</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.43 (0.61)</td>
</tr>
<tr>
<td>B</td>
<td>3.48 (0.90)</td>
</tr>
</tbody>
</table>

*Note.* A = Students attending the Zoo-Based Experiential Academic High School Science Program; B = Students attending the School-Based Experiential Academic High School Science Program.

†*ns.*
Table 15

*Students (n = 8) Who Completed a Zoo-Based Academic High School Experiential Science Program Beginning 12th-Grade Science Grade Point Average Compared to Ending 12th-Grade Science Grade Point Average Scores*

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
<th>d</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>2.91 (0.95)</td>
<td>3.18 (0.76)</td>
<td>1.289</td>
<td>2.73</td>
<td>.01**</td>
</tr>
</tbody>
</table>

*Note. A = Students in this analysis attended the Zoo-Based Experiential Academic High School Science Program for their Junior and Senior high school years. This analysis was based on 12th-grade beginning and 12th-grade ending non-honors-based science grade point average scores.  
**p = .01.*
Table 16

Students (n = 10) Who Completed a School-Based Academic High School Experiential Science Program Beginning 12th-Grade Science Grade Point Average Compared to Ending 12th-Grade Science Grade Point Average Scores

<table>
<thead>
<tr>
<th></th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>B</td>
<td>3.61 (0.98)</td>
<td>3.39 (0.99)</td>
</tr>
</tbody>
</table>

Note. B = Students in this analysis attended the School-Based Experiential Academic High School Science Program for their Junior and Senior high school years. This analysis was based on 12th-grade beginning and 12th-grade ending honors-based credit science grade point average scores. The average science grade point average score was not available for three students. Because the missing values were preceded and followed by non-missing values they were replaced by the averages of the preceded and following values.

$^+$ns.
Table 17

*Analysis of Variance of Students (n = 8) Who Completed a Zoo-Based Academic High School Experiential Science Program Compared to Students (n = 10) Who Completed a School-Based Academic High School Experiential Science Program 12th-Grade Posttest Science Grade Point Average Scores*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>0.20</td>
<td>0.20</td>
<td>1</td>
<td>0.25</td>
<td>.63(^t)</td>
</tr>
<tr>
<td>Within Groups</td>
<td>12.76</td>
<td>0.80</td>
<td>16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Science Grade Point Average Scores*  

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>3.18 (0.76)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>3.39 (0.99)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* A = Students attending the Zoo-Based Experiential Academic High School Science Program; B = Students attending the School-Based Experiential Academic High School Science Program.  
\(^t\)ns.
Table 18

*Analysis of Variance of Students (n = 10) Who Completed a Zoo-Based Academic High School Experiential Science Program Compared to Students (n = 8) Who Completed a School-Based Academic High School Experiential Science Program 11th-Grade Posttest School District Math Criterion Reference Test Scores*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>5.14</td>
<td>5.14</td>
<td>1</td>
<td>1.00</td>
<td>.33†</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82.48</td>
<td>5.15</td>
<td>16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**School District Math Criterion Reference Test Scores**

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>18.20 (2.10)</td>
</tr>
<tr>
<td>B</td>
<td>17.13 (2.47)</td>
</tr>
</tbody>
</table>

*Note. A = Students attending the Zoo-Based Experiential Academic High School Science Program; B = Students attending the School-Based Experiential Academic High School Science Program.  
*aSchool District Math Criterion Reference Test Scores between 1 and 10 were measured within the not proficient range and School District Math Criterion Reference Test Scores between 11 and 20 were measured within the proficient range.  
†ns.*
Table 19

*Analysis of Variance of Students (n = 10) Who Completed a Zoo-Based Academic High School Experiential Science Program Compared to Students (n = 8) Who Completed a School-Based Academic High School Experiential Science Program 11th-Grade Posttest School District Reading Criterion Reference Test Scores*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1.47</td>
<td>1.47</td>
<td>1</td>
<td>2.48</td>
<td>.13†</td>
</tr>
<tr>
<td>Within Groups</td>
<td>9.47</td>
<td>0.59</td>
<td>16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

School District Reading Criterion Reference Test Scoresa  Mean (SD)

- A  2.80 (0.79)
- B  3.38 (0.74)

*Note. A = Students attending the Zoo-Based Experiential Academic High School Science Program; B = Students attending the School-Based Experiential Academic High School Science Program.

aSchool District Reading Criterion Reference Test Scores 1 and 2 were measured within the not proficient range and School District Reading Criterion Reference Test Scores 3 and 4 were measured within the proficient range.

†ns.
Table 20

*Analysis of Variance of Students (n = 8) Who Completed a Zoo-Based Academic High School Experiential Science Program Compared to Students (n = 10) Who Completed a School-Based Academic High School Experiential Science Program 12th-Grade Posttest School District Math Criterion Reference Test Scores*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>0.07</td>
<td>0.07</td>
<td>1</td>
<td>0.01</td>
<td>.91*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>78.38</td>
<td>4.90</td>
<td>16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

School District Math Criterion Reference Test Scores\(^a\)  
\[\overline{A} = 18.38 (2.72)\]  
\[\overline{B} = 18.50 (1.71)\]

*Note. A = Students attending the Zoo-Based Experiential Academic High School Science Program; B = Students attending the School-Based Experiential Academic High School Science Program.  
\(^a\)School District Math Criterion Reference Test Scores between 1 and 10 were measured within the not proficient range and School District Math Criterion Reference Test Scores between 11 and 20 were measured within the proficient range.  
\(^*\)ns.*
Table 21

*Analysis of Variance of Students (n = 8) Who Completed a Zoo-Based Academic High School Experiential Science Program Compared to Students (n = 10) Who Completed a School-Based Academic High School Experiential Science Program 12th-Grade Posttest School District Reading Criterion Reference Test Scores*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>0.80</td>
<td>0.80</td>
<td>1</td>
<td>1.41</td>
<td>.25†</td>
</tr>
<tr>
<td>Within Groups</td>
<td>9.10</td>
<td>0.57</td>
<td>16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**School District Reading Criterion Reference Test Scores**

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.38 (0.74)</td>
</tr>
<tr>
<td>B</td>
<td>2.95 (0.76)</td>
</tr>
</tbody>
</table>

*Note.* A = Students attending the Zoo-Based Experiential Academic High School Science Program; B = Students attending the School-Based Experiential Academic High School Science Program.

*aSchool District Reading Criterion Reference Test Scores 1 and 2 were measured within the not proficient range and School District Reading Criterion Reference Test Scores 3 and 4 were measured within the proficient range.

*ns.*
Table 22

Students (n = 18) Who Completed a Zoo-Based Academic High School Experiential Science Program Beginning of the Year School Year Compared to Ending of the School Year Perception of Program Relevance

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>A</td>
<td>4.30 (0.54)</td>
<td>4.17 (0.35)</td>
</tr>
</tbody>
</table>

Note. A = Students in this analysis attended the Zoo-Based Experiential Academic High School Science Program for their Junior and Senior high school years.

a Likert Scale scores were 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.

†ns
Table 23

*Students (n = 18) Who Completed a Zoo-Based Academic High School Experiential Science Program Beginning of the Year School Year Compared to Ending of the School Year Perception of Program Rigor*

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest $M$</th>
<th>Pretest $SD$</th>
<th>Posttest $M$</th>
<th>Posttest $SD$</th>
<th>$d$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.02 (0.57)</td>
<td></td>
<td>4.26 (0.36)</td>
<td></td>
<td>0.371</td>
<td>1.58</td>
<td>.07</td>
</tr>
</tbody>
</table>

*Note.* A = Students in this analysis attended the Zoo-Based Experiential Academic High School Science Program for their Junior and Senior high school years.  

*a* Likert Scale scores were 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.  

*ns*
Table 24

*Students (n = 18) Who Completed a Zoo-Based Academic High School Experiential Science Program Beginning of the Year School Year Compared to Ending of the School Year Perception of Program Relationships*

| Perception of Program Relationships^a |
|-------------------------------|----------------|
|                               | Source       | Pretest | Posttest | d   | t    | p   |
|                               |              | M     | SD      | M   | SD   |     |
| A                             | 4.09 (0.49)  | 4.40  | 0.36    | 0.422 | 1.82 | .04* |

Note. A = Students in this analysis attended the Zoo-Based Experiential Academic High School Science Program for their Junior and Senior high school years. 
^a Likert Scale scores were 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree. 
*p < .05.
Table 25

Students (n = 18) Who Completed a School-Based Academic High School Experiential Science Program Beginning of the Year School Year Compared to Ending of the School Year Perception of Program Relevance

<table>
<thead>
<tr>
<th>Source</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>d</td>
</tr>
<tr>
<td>B</td>
<td>3.34 (0.48)</td>
<td>3.55 (0.53)</td>
<td>0.255</td>
<td>1.08</td>
<td>.15^</td>
</tr>
</tbody>
</table>

Note. B = Students in this analysis attended the School-Based Experiential Academic High School Science Program for their Junior and Senior high school years.

*a* Likert Scale scores were 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.
^*ns*
Table 26

Students (n = 18) Who Completed a School-Based Academic High School Experiential Science Program Beginning of the Year School Year Compared to Ending of the School Year Perception of Program Rigor

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
<th>d</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>3.75 (0.49)</td>
<td>3.73 (0.51)</td>
<td>-0.033</td>
<td>-0.19</td>
<td>.42†</td>
</tr>
</tbody>
</table>

Note. B = Students in this analysis attended the School-Based Experiential Academic High School Science Program for their Junior and Senior high school years.

a Likert Scale scores were 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.

†ns
Table 27

*Students (n = 18) Who Completed a School-Based Academic High School Experiential Science Program Beginning of the Year School Year Compared to Ending of the School Year Perception of Program Relationships*

<table>
<thead>
<tr>
<th>Perception of Program Relationships&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>B</td>
<td>3.60 (0.52)</td>
<td></td>
</tr>
</tbody>
</table>

<sup>Note</sup>. B = Students in this analysis attended the School-Based Experiential Academic High School Science Program for their Junior and Senior high school years.

<sup>a</sup> Likert Scale scores were 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.

<sup>*ns</sup>
Table 28

*Analysis of Variance of Students (n = 18) Who Completed a Zoo-Based Academic High School Experiential Science Program Compared to Students (n = 18) Who Completed a School-Based Academic High School Experiential Science Program Ending of the School Year Perceptions of Program Relevance*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>3.47</td>
<td>3.47</td>
<td>1</td>
<td>17.05</td>
<td>.0002***</td>
</tr>
<tr>
<td>Within Groups</td>
<td>6.91</td>
<td>0.20</td>
<td>34</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Perceptions of Program Relevance**

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.17 (0.35)</td>
</tr>
<tr>
<td>B</td>
<td>3.55 (0.53)</td>
</tr>
</tbody>
</table>

*Note. A = Students attending the Zoo-Based Experiential Academic High School Science Program; B = Students attending the School-Based Experiential Academic High School Science Program.

*a Likert Scale scores were 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.

***p < .001.*
Table 29

Analysis of Variance of Students (n = 18) Who Completed a Zoo-Based Academic High School Experiential Science Program Compared to Students (n = 18) Who Completed a School-Based Academic High School Experiential Science Program Ending of the School Year Perceptions of Program Rigor

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2.61</td>
<td>2.61</td>
<td>1</td>
<td>13.37</td>
<td>.001***</td>
</tr>
<tr>
<td>Within Groups</td>
<td>6.63</td>
<td>0.20</td>
<td>34</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Perceptions of Program Rigor\(^a\)  

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.26 (0.36)</td>
</tr>
<tr>
<td>B</td>
<td>3.73 (0.51)</td>
</tr>
</tbody>
</table>

Note. A = Students attending the Zoo-Based Experiential Academic High School Science Program; B = Students attending the School-Based Experiential Academic High School Science Program.  
\(^a\) Likert Scale scores were 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.  
***p = .001.
Table 30

*Analysis of Variance of Students (n = 18) Who Completed a Zoo-Based Academic High School Experiential Science Program Compared to Students (n = 18) Who Completed a School-Based Academic High School Experiential Science Program Ending of the School Year Perceptions of Program Relationships*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>5.56</td>
<td>5.56</td>
<td>1</td>
<td>24.84</td>
<td>.000***</td>
</tr>
<tr>
<td>Within Groups</td>
<td>7.61</td>
<td>0.22</td>
<td>34</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Perceptions of Program Relationships<sup>a</sup>

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.40 (0.36)</td>
</tr>
<tr>
<td>B</td>
<td>3.61 (0.56)</td>
</tr>
</tbody>
</table>

*Note. A = Students attending the Zoo-Based Experiential Academic High School Science Program; B = Students attending the School-Based Experiential Academic High School Science Program.

<sup>a</sup> Likert Scale scores were 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree.

***p < .001.
CHAPTER FIVE

Conclusions and Discussion

The following conclusions may be drawn from the study for each of the twenty research questions.

Research Question #1 Conclusion

Overall, pretest-posttest results indicated end of 11th-grade pretest PLAN normal curve equivalent test composite scores compared to ending 12th-grade posttest ACT normal curve equivalent test composite scores were in the direction of statistical improvement over time. Comparing students’ who completed the Zoo-Based Academic High School Experiential Science Program ending 12th-grade posttest ACT normal curve equivalent test composite scores with national percentile ranks based on ACT-tested high school graduates from 2009 to 2011 puts their performance in perspective. A posttest ACT normal curve equivalent test composite score of 20.83 converts to a Standard Score of 102, a Percentile Rank of 55, a Stanine Score of 5 (the middle stanine of the average range), and an achievement qualitative description of Average. Nationwide the average composite score for 2011 was 21.1. All scores are out of a possible 36. Finally, the statistically higher posttest ACT normal curve equivalent test composite score (+2.44) reflects the positive impact of student participation in the Zoo-Based Academic High School Experiential Science Program.

Research Question #2 Conclusion

Overall, pretest-posttest results indicated end of 11th-grade pretest PLAN normal curve equivalent test composite scores compared to ending 12th-grade posttest ACT normal curve equivalent test composite scores were in the direction of statistical
improvement over time. Comparing students’ who completed the School-Based Academic High School Experiential Science Program ending 12th-grade posttest ACT normal curve equivalent test composite scores with national percentile ranks based on ACT-tested high school graduates from 2009 to 2011 puts their performance in perspective. A posttest ACT normal curve equivalent test composite score of 20.72 converts to a Standard Score of 102, a Percentile Rank of 55, a Stanine Score of 5 (the middle stanine of the average range), and an achievement qualitative description of Average. Nationwide the average composite score for 2011 was 21.1. All scores are out of a possible 36. Finally, the statistically higher posttest ACT normal curve equivalent test composite score (+3.00) reflects positive impact of student participation in the School-Based Academic High School Experiential Science Program.

Research Question #3 Conclusion

Overall, results indicated that students’ who completed the Zoo-Based Academic High School Experiential Science Program compared to students’ who completed the School-Based Academic High School Experiential Science Program had statistically congruent ending of 12th-grade ACT normal curve equivalent test composite scores measuring within the average range and consistent with the nationwide average composite test score performance of college bound students. Based on measured ACT test performance results it may be asserted that both the zoo-based science program and the school-based science program equally prepared students for postsecondary success.

Research Question #4 Conclusion

Overall, pretest-posttest results indicated beginning 11th-grade overall grade point average compared to ending 11th-grade overall grade point average scores were in the
direction of non-statistical improvement over time. Comparing students’ who completed the Zoo-Based Academic High School Experiential Science Program ending 11th-grade overall grade point average scores with course grade nomenclature puts their performance in perspective. An ending 11th-grade overall grade point average mean score of 3.36 is equivalent to a letter grade of “B” and a qualitative description of Excellent. Finally, the non-statistical higher posttest overall grade point average mean score (+0.02) still reflects the positive impact of student participation in this academically oriented Zoo-Based Academic High School Experiential Science Program.

**Research Question #5 Conclusion**

Overall, pretest-posttest results indicated beginning 11th-grade overall grade point average compared to ending 11th-grade overall grade point average scores were in the direction of non-statistical lower scores over time. Comparing students’ who completed the School-Based Academic High School Experiential Science Program ending 11th-grade overall grade point average scores with course grade nomenclature puts their performance in perspective. An ending 11th-grade overall grade point average mean score of 3.33 is equivalent to a letter grade of “B” and a qualitative description of Excellent. Finally, the lower posttest overall grade point average mean score (-0.01) still reflects the positive impact of participation in this academically oriented School-Based Academic High School Experiential Science Program.

**Research Question #6 Conclusion**

Overall, results indicated that students’ who completed the Zoo-Based Academic High School Experiential Science Program compared to students’ who completed the School-Based Academic High School Experiential Science Program had statistically
congruent ending of 11th-grade overall grade point average scores measured within the “B” range with a qualitative description of Excellent, consistent with overall grade point average score performance of college bound students. Based on measured overall grade point average score performance results it may be asserted that both the zoo-based science program and the school-based science program equally prepared students for postsecondary success.

**Research Question #7 Conclusion**

Overall, pretest-posttest results indicated beginning 12th-grade overall grade point average compared to ending 12th-grade overall grade point average scores were in the direction of non-statistical improvement over time. Comparing students’ who completed the Zoo-Based Academic High School Experiential Science Program ending 12th-grade overall grade point average scores with course grade nomenclature puts their performance in perspective. An ending 12th-grade overall grade point average mean score of 3.11 is equivalent to a letter grade of “B” and a qualitative description of Excellent. Finally, the non-statistical higher posttest overall grade point average mean score (+0.02) still reflects the positive impact of student participation in this academically oriented Zoo-Based Academic High School Experiential Science Program.

**Research Question #8 Conclusion**

Overall, pretest-posttest results indicated beginning 12th-grade overall grade point average compared to ending 12th-grade overall grade point average scores were in the direction of statistically lower scores over time. Comparing students’ who completed the School-Based Academic High School Experiential Science Program ending 12th-grade overall grade point average scores with course grade nomenclature puts their
performance in perspective. An ending 12th-grade overall grade point average mean score of 3.23 is equivalent to a letter grade of “B” and a qualitative description of Excellent. Finally, the lower posttest overall grade point average mean score (-0.06) still reflects the positive impact of student participation in this academically oriented School-Based Academic High School Experiential Science Program.

**Research Question #9 Conclusion**

Overall, results indicated that students’ who completed the Zoo-Based Academic High School Experiential Science Program compared to students’ who completed the School-Based Academic High School Experiential Science Program had statistically congruent ending of 12th-grade overall grade point average scores measured within the “B” range with a qualitative description of Excellent, consistent with overall grade point average score performance of college bound students. Based on measured overall grade point average score performance results it may be asserted that both the zoo-based science program and the school-based science program equally prepared students for postsecondary success.

**Research Question #10 Conclusion**

Overall, pretest-posttest results indicated beginning 11th-grade science grade point average compared to ending 11th-grade science grade point average scores were in the direction of statistically lower scores over time. Comparing students’ who completed the Zoo-Based Academic High School Experiential Science Program ending 11th-grade science grade point average scores with course grade nomenclature puts their performance in perspective. An ending 11th-grade science grade point average mean score of 3.43 is equivalent to a letter grade of “B” and a qualitative description of
Excellent. Finally, the statistically lower posttest science grade point average mean score (-0.32) still reflects the positive impact of student participation in this academically oriented Zoo-Based Academic High School Experiential Science Program.

Research Question #11 Conclusion

Overall, pretest-posttest results indicated beginning 11th-grade science grade point average compared to ending 11th-grade science grade point average scores were in the direction of non-statistical improvement over time. Comparing students’ who completed the School-Based Academic High School Experiential Science Program ending 11th-grade science grade point average scores with course grade nomenclature puts their performance in perspective. An ending 11th-grade science grade point average mean score of 3.48 is equivalent to a letter grade of “B” and a qualitative description of Excellent. Finally, the statistically improved posttest science grade point average mean score (+0.01) still reflects the positive impact of student participation in this academically oriented School-Based Academic High School Experiential Science Program.

Research Question #12 Conclusion

Overall, results indicated that students’ who completed the Zoo-Based Academic High School Experiential Science Program compared to students’ who completed the School-Based Academic High School Experiential Science Program had statistically congruent ending of 11th-grade science grade point average scores measured within the “B” range with a qualitative description of Excellent, consistent with science grade point average score performance of college bound students. Based on measured science grade point average score performance results it may be asserted that both the zoo-based
science program and the school-based science program equally prepared students for postsecondary success.

Research Question #13 Conclusion

Overall, pretest-posttest results indicated beginning 12th-grade science grade point average compared to ending 12th-grade science grade point average scores were in the direction of statistically improved scores over time. Comparing students’ who completed the Zoo-Based Academic High School Experiential Science Program ending 12th-grade science grade point average scores with course grade nomenclature puts their performance in perspective. An ending 12th-grade science grade point average mean score of 3.18 is equivalent to a letter grade of “B” and a qualitative description of Excellent. Finally, the statistically improved posttest science grade point average mean score (+0.27) still reflects the positive impact of student participation in this academically oriented Zoo-Based Academic High School Experiential Science Program.

Research Question #14 Conclusion

Overall, pretest-posttest results indicated beginning 12th-grade science grade point average compared to ending 12th-grade science grade point average scores were in the direction of non-statistically lower scores over time. Comparing students’ who completed the School-Based Academic High School Experiential Science Program ending 12th-grade science grade point average scores with course grade nomenclature puts their performance in perspective. An ending 12th-grade science grade point average mean score of 3.39 is equivalent to a letter grade of “B” and a qualitative description of Excellent. Finally, the non-statistically lower posttest science grade point average mean
score (-0.22) still reflects the positive impact of student participation in this academically oriented School-Based Academic High School Experiential Science Program.

**Research Question #15 Conclusion**

Overall, results indicated that students’ who completed the Zoo-Based Academic High School Experiential Science Program compared to students’ who completed the School-Based Academic High School Experiential Science Program had statistically congruent ending of 12th-grade science grade point average scores measured within the “B” range with a qualitative description of Excellent, consistent with science grade point average score performance of college bound students. Based on measured science grade point average score performance results it may be asserted that both the zoo-based science program and the school-based science program equally prepared students for postsecondary success.

**Research Question #16a Conclusion**

Overall, results indicated that students’ who completed the Zoo-Based Academic High School Experiential Science Program compared to students’ who completed the School-Based Academic High School Experiential Science Program had statistically congruent ending of 11th-grade school district math criterion test scores measured numerically between 11 and 20 for both groups with a qualitative description of Proficient, consistent with math score performance of college bound students. Based on measured school district math criterion test score performance results it may be asserted that both the zoo-based science program and the school-based science program equally prepared students for postsecondary success.
Research Question #16b Conclusion

Overall, results indicated that students’ who completed the Zoo-Based Academic High School Experiential Science Program compared to students’ who completed the School-Based Academic High School Experiential Science Program had statistically congruent ending of 11th-grade school district reading criterion test scores measured numerically between 3 and 4 for both groups with a qualitative description of Proficient, consistent with reading score performance of college bound students. Based on measured school district reading criterion test score performance results it may be asserted that both the zoo-based science program and the school-based science programs equally prepared students for postsecondary success.

Research Question #17a Conclusion

Overall, results indicated that students’ who completed the Zoo-Based Academic High School Experiential Science Program compared to students’ who completed the School-Based Academic High School Experiential Science Program had statistically congruent ending of 12th-grade school district math criterion test scores measured numerically between 11 and 20 for both groups with a qualitative description of Proficient, consistent with math score performance of college bound students. Based on measured school district math criterion test score performance results it may be asserted that both the zoo-based science program and the school-based science program equally prepared students for postsecondary success.

Research Question #17b Conclusion

Overall, results indicated that students’ who completed the Zoo-Based Academic High School Experiential Science Program compared to students’ who completed the
School-Based Academic High School Experiential Science Program had statistically congruent ending of 12th-grade school district reading criterion test scores measured numerically between 3 and 4 for both groups with a qualitative description of Proficient, consistent with reading score performance of college bound students. Based on measured school district reading criterion test score performance results it may be asserted that both the zoo-based science program and the school-based science program equally prepared students for postsecondary success.

**Research Question #18a Conclusion**

Overall, pretest-posttest results indicated ending school year overall perceptions of program relevance were in the direction of non-statistically lower perception scores over time. Comparing students’ who completed the Zoo-Based Academic High School Experiential Science Program ending school year overall perceptions of program relevance scores on a Likert Scale (1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree) and scoring nomenclature puts their performance in perspective. An ending school year overall perception of program relevance score of 4.17 indicates that these students believed that their Zoo-Based Academic High School Experiential Science Program had, for them, Agreed program relevance. Finally, the non-statistically lower posttest overall perception of program relevance score (-0.13) still reflects the impact this program had on students’ Agreed perceptions of program relevance.

**Research Question #18b Conclusion**

Overall, pretest-posttest results indicated ending school year overall perceptions of program rigor were in the direction of non-statistically improved perception scores
over time. Comparing students’ who completed the Zoo-Based Academic High School Experiential Science Program ending school year overall perceptions of program rigor scores on a Likert Scale (1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree) and scoring nomenclature puts their performance in perspective. An ending school year overall perception of program rigor score of 4.26 indicates that these students believed that their Zoo-Based Academic High School Experiential Science Program had, for them, Agreed program rigor. Finally, the non-statistically improved posttest overall perception of program rigor score (+0.24) still reflects the impact this program had on students’ Agreed perceptions of program rigor.

**Research Question #18c Conclusion**

Overall, pretest-posttest results indicated ending school year overall perceptions of program relationships were in the direction of statistically improved perception scores over time. Comparing students’ who completed the Zoo-Based Academic High School Experiential Science Program ending school year overall perceptions of program relationships scores on a Likert Scale (1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree) and scoring nomenclature puts their performance in perspective. An ending school year overall perception of program relationships score of 4.40 indicates that these students believed that their Zoo-Based Academic High School Experiential Science Program had, for them, Agreed program relationships. Finally, the statistically improved posttest overall perception of program relationship score (+0.31) reflects the impact this program had on students’ Agreed perceptions of program relationships.
Research Question #19a Conclusion

Overall, pretest-posttest results indicated ending school year overall perceptions of program relevance were in the direction of non-statistically improved perception scores over time. Comparing students’ who completed the School-Based Academic High School Experiential Science Program ending school year overall perceptions of program relevance scores on a Likert Scale (1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree) and scoring nomenclature puts their performance in perspective. An ending school year overall perception of program relevance score of 3.55 indicates that these students believed that their School-Based Academic High School Experiential Science Program had, for them, Neutral program relevance. Finally, the non-statistically improved posttest overall perception of program relevance score (+0.21) still reflects the impact this program had on students’ Neutral perceptions of program relevance.

Research Question #19b Conclusion

Overall, pretest-posttest results indicated ending school year overall perceptions of program rigor were in the direction of non-statistically lower perception scores over time. Comparing students’ who completed the School-Based Academic High School Experiential Science Program ending school year overall perceptions of program rigor scores on a Likert Scale (1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree) and scoring nomenclature puts their performance in perspective. An ending school year overall perception of program rigor score of 3.73 indicates that these students believed that their School-Based Academic High School Experiential Science Program had, for them, Neutral program rigor. Finally, the non-statistically lower
posttest overall perception of program rigor score (+0.02) still reflects the impact this program had on students’ Neutral perceptions of program rigor.

**Research Question #19c Conclusion**

Overall, pretest-posttest results indicated ending school year overall perceptions of program relationships were in the direction of non-statistically improved perception scores over time. Comparing students’ who completed the School-Based Academic High School Experiential Science Program ending school year overall perceptions of program relationships scores on a Likert Scale (1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree) and scoring nomenclature puts their performance in perspective. An ending school year overall perception of program relationships score of 3.61 indicates that these students believed that their School-Based Academic High School Experiential Science Program had, for them, Neutral program relationships. Finally, the non-statistically improved posttest overall perception of program relationship score (+0.01) reflects the impact this program had on students’ Neutral perceptions of program relationships.

**Research Question #20a Conclusion**

Overall, results indicated that students’ who completed the Zoo-Based Academic High School Experiential Science Program compared to students’ who completed the School-Based Academic High School Experiential Science Program had statistically greater ending of school year Likert scale perceptions (1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree) of program relevance measured within the Agreed range where students in the School-Based Academic High School Experiential Science Program had overall program relevance perceptions
measured within the Neutral range. Based on this finding it may be asserted that students completing the Zoo-Based Academic High School Experiential Science Program believed that overall program relevance in their school setting was more apparent to them than to their peers who completed the School-Based Academic High School Experiential Science Program.

**Research Question #20b Conclusion**

Overall, results indicated that students’ who completed the Zoo-Based Academic High School Experiential Science Program compared to students’ who completed the School-Based Academic High School Experiential Science Program had statistically greater ending of school year Likert scale perceptions (1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree) of program rigor measured within the Agreed range where students in the School-Based Academic High School Experiential Science Program had overall program rigor perceptions measured within the Neutral range. Based on this finding it may be asserted that students completing the Zoo-Based Academic High School Experiential Science Program believed that overall program rigor in their school setting was more apparent to them than to their peers who completed the School-Based Academic High School Experiential Science Program.

**Research Question #20c Conclusion**

Overall, results indicated that students’ who completed the Zoo-Based Academic High School Experiential Science Program compared to students’ who completed the School-Based Academic High School Experiential Science Program had statistically greater ending of school year Likert scale perceptions (1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree) of program relationships
measured within the Agreed range where students in the School-Based Academic High School Experiential Science Program had overall program relationships perceptions measured within the Neutral range. Based on this finding it may be asserted that students completing the Zoo-Based Academic High School Experiential Science Program believed that overall program relationships in their school setting was more apparent to them than to their peers who completed the School-Based Academic High School Experiential Science Program.

Discussion

The Zoo-Based Academic High School Experiential Science Program and the School-Based Academic High School Experiential Science Program have shown a positive impact on student academic achievement and have proven to equally prepare students for post secondary success. Both groups of students, those who completed the zoo-based science program and those who completed the school-based science program have improved average achievement scores on the ACT normal curve equivalent test composite scores, overall grade point average scores, science grade point average scores, math district criterion reference test scores, and reading district criterion reference test scores. As a result, the zoo-based science program and the school-based science program have effectively established high academic standards and are equally preparing students to be competitive in today’s global work force.

The students’ overall perception of relevance, rigor and relationships in their school setting was more apparent to the students who completed the Zoo-Based Academic High School Experiential Science Program than their peers who completed the School-Based Academic High School Experiential Science Program. The students’ overall perception of relevance, rigor, and relationships in both learning environments sets these two academically equivalent programs
apart giving the research school district more options to successfully prepare students to be competitive in today’s global workforce.

**Implications for practice.** The average ranking of students in the United States on international math and science exams suggest that our students, while receiving a breadth of content knowledge, may not be receiving the depth of knowledge they need to be competitive in math and science careers (Bybee, 2010; Grigg et al., 2006; Mourshed et al., 2010; Sawchuk, 2010). Creating educational environments that have a balanced, rigorous curriculum, experiential learning in real-world science and math environments, while providing a sense of belonging is better preparing students to be competitive in today’s global work force (Achieve, Inc., 2009; Kemple, 2004; Kemple & Willner, 2008; Pittman, 2005). In order to establish positive learning environments and create a culture of learning; a school district must develop new content knowledge and skills, establish small learning communities, and have access to new resources (Dryer, 1996; Fullan, 2006; Manning & Saddlemire, 1996; Sergiovanni, 1994). Effective science and math learning environments where teachers can freely guide students through experiential curriculum, supported by access to professional resources, and the establishment of alternative learning environments, in the business community, allows for students to explore careers and make a connection to their lives outside of school.

**Implications for policy.** Educators, community partners, and business leaders know we need to address the issue of better preparing our students for success, whether it be preparing them to be globally competitive on science and math examinations, successful in the classroom, or become competitive for careers of today (Achieve, Inc., 2009). The educational system must address the instructional needs of students while preparing them for work experiences of the future. Changes in both the classroom and
the workplace are necessary in order to penetrate the barriers between classroom community of practice and the workplace community of practice (Hugh et al., 2006). To better prepare our students for success in the global economy innovative high school programs must be established to increase the number of students who graduate and successfully transition into postsecondary education or the global work force (Achieve, Inc., 2005; Kemple, 2004; Kemple & Willner, 2008; Quint, 2006).

Educators and community partners, like local cultural centers, must establish non-traditional educational settings at their organizations to accomplish the common goal of preparing our students for success in the future. Educators have seen the impact of innovative high school programs, similar to Omaha’s Henry Doorly Zoo’s Zoo Academy, across the country decrease the number of students dropping out, improving school climate, strengthening curriculum and instruction, decreasing the achievement gap between majority and minority students, and preparing students for transition to postsecondary programs or employment after graduation (Kemple, 2004; Kemple & Willner, 2008; Quint, 2006).

Innovative traditional and non-traditional high school programs must be established to allow for students to complete their core curricular courses during their freshman and sophomore years and opening up science and math electives and unique non-traditional education opportunities for students to explore a variety of career pathways during their junior and senior years (Achieve, Inc., 2005).

**Implications for further research.** The Zoo-Based Academic High School Experiential Science Program and the School-Based Academic High School Experiential Science Program were found to be equally successful academic programs, giving the research school district
multiple options to prepare students for transition to postsecondary programs or employment after graduation. Research must be conducted to determine the impact the zoo-based program has on student postsecondary success and student success in science and math careers. The differences in school learning environments did not impact the academic success of the students in the zoo-based science program or the school-based science program, but did show a difference in how students’ perceived relevance, rigor, and relationships in the two programs. Therefore, additional research must be conducted on how to identify students who thrive in traditional and non-traditional learning environments. Developing a tool to identify the different instructional needs of students who are successful in traditional and non-traditional school settings will open more options for the research school district to utilize in their preparation of a scientifically-literate citizenry.
References


