IMPACT OF JIGSAW ON THE ACHIEVEMENT AND ATTITUDES OF SAUDI ARABIAN MALE HIGH SCHOOL SCIENCE STUDENTS

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IMPACT OF JIGSAW ON THE ACHIEVEMENT AND ATTITUDES OF SAUDI ARABIAN MALE HIGH SCHOOL SCIENCE STUDENTS

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Dissertation

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ABSTRACT

The aim of the study is to investigate the impact of cooperative learning instruction, specifically by using the Jigsaw instructional strategy on science achievement and attitudes towards science among 11th grade students. Based upon previous research literature, it was hypothesized that significant differences existed on gains between general science achievement of experimental group and control group. The quasi-experimental design was chosen for this study. The study sample consisted of 50 students of 11th grade class who were equally distributed among experimental group and control group, matched on the basis of their annual examination at general science scores. The students’ achievement was measured through the implementation of 30-item achievement test used as a pre-test, as well as a post-test and deferred (follow-up) test. The experiment group was taught through cooperative learning while control group was taught through the instructions of “traditional teaching”. The material was used such as lesson plans, worksheets and quizzes, designed to implement Jigsaw as a cooperative learning methodology. For the attitude scale towards science, a published 30-item Likert scale called Test of Science Related Attitudes (TOSRA) has been translated to Arabic in order to determine the students' attitudes ranging between strongly agree to strongly disagree. The data were analyzed through repeated measure analysis and multivariate analysis of variance with a .05 selected level of significance. The results of this study showed that using Jigsaw as a cooperative learning strategy has improved the students' achievement.
for the benefit of the experimental group. However, there was no significant change on the students' attitudes towards science for both groups, where the scores of all the attitude subscales were at or near the neutral level.
DEDICATION

I would like to dedicate this work to…

my parents, wife, and children;

Al Baha University;

King Abdullah who is still in our hearts;

all educators who seeks knowledge; and

all science teachers.
ACKNOWLEDGEMENTS

In the Name of Allah, the Merciful, the Compassionate

First and foremost, I am grateful to Allah who has given me the ability to complete this study.

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CHAPTER I
INTRODUCTION

One of the many challenges in teaching is how to capture students’ attention during the instruction process. Researchers have been looking for the best ways to encourage student participation and to keep students on track and engaged. Since the 20th century, the findings of research studies have helped teachers discover the most efficient teaching methods (Vail, 2010). Teaching science effectively so students can requires the selection of teaching methods aimed at students’ learning senses. One of the best teaching methods for science is cooperative learning where small teams at different levels use a variety of activities to improve their understanding of the subject matter (Zemelman & Daniels, 2012). Cooperative learning posits the importance of cooperation among the group members (rather than merely working together) in order to acquire the intended outcome. Cooperative learning is an arrangement in which students with a variety of ability levels and awarded on the basis of the success of the group (Woolfolk, 2004) and is unlike traditional small-group work.

Many of the studies investigating the effects of cooperative learning as stated by Kose (2010) indicate that students who work together in small groups learn better, retain more information, and build better relationships with individual classmates and members of the group (Kose, 2010). In Egypt, for example, Salem (1998) found that cooperative learning positively influences the achievement and attitudes of students toward science.
and that the cooperative-learning strategy known as Jigsaw has led to better student success. Moreover, Hasanin (2000) found that Jigsaw was a more effective teaching method than the individual-learning strategy not only in terms of student achievement but also in terms of the students’ attitudes toward science. Alghamdi and Gillies (2013) showed that there are statistically significant differences between the mean scores of students who were taught English in a Jigsaw cooperative-learning environment in Saudi Arabia compared with those who were taught English using the traditional small-group method.

Slavin’s (1995) review of 70 studies that used cooperative learning as a teaching method for more than four weeks in secondary and elementary schools found that 61% of the studies showed that students obtained better results when they learned cooperatively than did their control-group peers. In addition, Slavin (1995) reviewed an additional 99 such studies. He found that 5% of the studies extensively supported control-group gains, while 63% of the studies appreciably supported gains when cooperative-learning strategies were used.

On the same level of importance, the attitudes of students toward science are essential in the education process. Multiple definitions can be found to define the term attitudes. Martin (1984) defined attitudes as the mental predisposition toward people, objects, subjects, and events, to name a few. According to Martin (1984), attitudes toward science specifically are important for three reasons. First, a child’s attitude carries a mental state of readiness. In other words, with a positive attitude, a child will perceive science objects, topics, activities, and people positively. Second, attitudes are not innate. Contemporary psychologists maintain that attitudes are learned and are organized through
experiences as children develop (Halloran, 1970; Oskamp, 1977). A child’s attitude can be changed through experience. Teachers and parents have the greatest influence on science attitudes (George and Kaplan, 1998). Finally, attitudes are the dynamic results of a child’s experiences. As a result, attitudes are both emotional and intellectual and influence the decisions and evaluations a child uses to set priorities and preferences (Martin, 1984). Based on the information presented above and because of the importance of studying the attitudes Saudi Arabian students toward science, this research project examines the impact of Jigsaw on the achievement and attitudes of Saudi Arabian male high school science students.

Problem Statement

The science achievement of Saudi Arabian students is critical. The 2015 TIMSS (Trends in International Mathematics and Science Study) report found that of the countries studied, Saudi Arabia at the bottom for student achievement in science and mathematics (TIMSS, 2015). The science achievement score decreased from 429 in 2011 to 390 in 2015 in Grade 4. In the same way, the science achievement score decreased from 436 in 2011 to 396 in 2015 in Grade 8. This drop reflects a major problem in Saudi Arabian education at a time when increases educational achievement would be expected based on the huge budget dedicated to education. In this regard, Wiseman and Al-bakr (2012) cited many factors that need to be considered:

Many characteristics play vital roles in student achievement at the classroom level. Some of these characteristics are related to students’ socio-economic status, while others are related to teachers’ ability to teach, interact with, and motivate students. The challenge for policymakers and educators, in the Gulf countries and elsewhere, is to design teacher certification processes that effectively chase the most elusive of goals: teacher quality. (p. 307)
Despite of the shortage of studies addressing the Saudi Arabian attitudes toward science, students in Saudi Arabia generally have negative attitudes toward science (Al-Shargi, 1988; Alharbi, 2012; Alhammad, 2015). The main reasons for the negative attitudes toward science can be found in the literature. Teacher preparation, improper school buildings, and the absence of a social culture relevant to science are the main reasons. Also at play is the gap between what students learn at school and what they experience outside of school in Saudi Arabia.

In Saudi Arabia, a few studies have measured the impact of cooperative learning on students’ achievement and attitudes toward science in high school (Alharbi, 2008); however, the incorrect application of the cooperative-learning methods in many schools must be considered. In Saudi Arabian schools, teachers often put students in groups without facilitating research-based cooperative-learning instructional methods (Alghamdi & Gillies, 2013). This misconception about how to use cooperative learning properly and the shortage of studies in the field prompted the current examination of the impact of using Jigsaw as a cooperative learning strategy impact students’ attitudes toward science.

Schools in Saudi Arabia are incompatible with the social pattern of Saudi Arabian people. Saudi Arabian society is quite socially active outside of school, making that lifestyle incompatible with school practices where the focus is on the individual efforts of students to perform well. In an effort to make schools more culturally relevant, this study created a school with a communal ethos rather than one focused on the individual student. Students participating in the study would be instructed to work cooperatively to achieve common goals exactly as they do in life outside of school in Saudi Arabia. Jigsaw was chosen as the cooperative-learning strategy because it emphasizes
interactions among groups of students and is culturally relevant. The study then investigated the impact of Jigsaw as a cooperative-learning instructional strategy in terms of the achievement and attitudes of Saudi Arabian male high school science students.

Purpose Statement

The purpose of this study was to investigate the impact of cooperative-learning instruction when Jigsaw is used to gauge student achievement in and attitudes toward science (Aronson, 1978). The study measure the change in science achievement and attitudes toward science of male Saudi Arabian high school students through engagement with content about biodiversity and conservation in the environmental sciences and by using Jigsaw as a cooperative-learning instructional method. The study also sought to improve the practice of Saudi Arabian teachers and incorporate pedagogy relevant to Saudi Arabian culture into high school science classrooms.

Research Questions

This study was guided by the following research questions:

1. What is the impact of Jigsaw on the achievement of Saudi Arabian male high school science students?

2. What is the impact of Jigsaw on the attitudes of Saudi Arabian male high school science students, specifically their attitude toward scientific inquiry, adoption of scientific attitudes, and enjoyment of science lessons (Alharbi, 2012)?

Research Hypotheses

This study proposed the following hypotheses:

1. There is no significant growth in science achievement at the three test points (pre-test, post-test, and follow-up test) between the experimental group using Jigsaw and the control group for the study.
2. There is no significant growth in attitude scores at the three test points (pre-test, post-test, and follow-up test) between the experimental group using Jigsaw and the control group for the study.

Significance of the Study

The study is significant because it represents a culturally relevant learning style that is compatible with Saudi Arabians’ daily public life. Saudi Arabians have been known as a socially active society where the tribe plays an important role in social life. A Saudi Arabian tribe consists of numerous families, which themselves contain a large number of members; however, family members envision kinship in the tribe as most important. Interaction between family members and tribe members is critical. In this regard, Litvin (as cited in Mansour & Al-Shamrani, 2015) wrote:

In the Arab Gulf countries, students form groups or pairs with friends based on family or tribe. Students would not work in groups or pairs with some of the other students who did not belong to their family or tribe, but would help friends and share answers for doing homework. (p. 122)

The social norms in Saudi Arabia emphasize the importance of cooperation in most activities; however, the teaching and learning practices at Saudi Arabian schools emphasize individual learning and progress more so than group work. Given this discrepancy between in school and out of school, it is important for high school students to be exposed to teaching methods that are more culturally relevant. That objective can be achieved through the implementation of strategies and teaching methods such as communal-based cooperative learning that make teaching practices compatible with Saudi Arabian social norms. Culturally relevant teaching essentially means that teachers create a bridge between students’ home and school lives and uses the backgrounds,
knowledge, and experiences of the students to inform the teacher’s lessons and teaching methods (Howard, 2003, p. 196).

According to the Saudi Ministry of Education (2005), one of the fundamental goals of education in Saudi Arabia is to strengthen the students’ background about the culture and social problems of their society and to prepare students to use effective problem-solving skills. Strategies to tackle social problems should be implemented in the classroom setting. The use of cooperative learning in this study was intended to enrich the students’ ability to be part of the solution by communicating with others and sharing ideas and thoughts about environmental issues. Ladson-Billings (1995) discussed the integration of education with culture. To make that integration happen, education must be compatible with the structure and ethos of the community in order to be accepted.

This study therefore used environmental issues such as biodiversity and conservation integrate education with culture. Students were directed to work cooperatively to investigate, question, and solve problems related to the environment. Al Ghanem (2009) reported that the Saudi Arabian science curriculum has not been changed and does not take social values into account. Al Ghanem also stressed that although social values should be reinforced and preserved, social ills must be identified, examined, and solved.

The community where this study took place (Al Baha, Saudi Arabia) is a closed community. The traditions and the voice of the tribe are still strong, unlike in other cities in Saudi Arabia. Many factors, such as its geographical location, have isolated Al Baha. Based on its geographical location and its lack of economic value to the country, the
government has neglected Al Baha. This neglect and the absence of the services keep this city rural and leads to practices based on the old traditions.

A few studies exist that indicate the significance of using cooperative learning for raising student achievement and affecting attitudes at the elementary and middle school levels in Saudi Arabia (Alharbi, 2008; Alghamdi & Gillies, 2013), but none of the studies were conducted examined the effect of using Jigsaw as a cooperative-learning strategy in a high school setting. The current study therefore uses Jigsaw to assess its effect on academic achievement and attitudes toward science among high school students. Based on the data collected from observations in Saudi high schools and from information obtained from interviews of teachers, a clear understanding of cooperative learning does not exist. A review of the literature uncovered little information about studies that examined cooperative-learning strategies at the high school level.

In addition, based on the recommendations in some of the studies that have been conducted in elementary and middle schools that such studies should be done at the secondary level (Alharbi, 2012), this study was an effort to add something new to the secondary school literature. Moreover, this study will help teachers learn about the attitudes of secondary students toward science. This study will be a guide for teachers and researchers interested in the impact of Jigsaw on science achievement and attitudes toward science among Saudi Arabian male high school science students.

Definition of Terms

This study determined the impact of using Jigsaw as a cooperative-learning instructional strategy in terms of achievement and attitude among Saudi Arabian male high school science students. The following terms are used throughout this study.
Attitudes

The definition of *attitudes* varies among researchers, with some saying that the term refers to the beliefs, others saying it refers to values, and still others saying it refers to opinions. All of these terms are cross-disciplinary and are connected to social behavior in many fields, such as education. According to Gagne and Briggs (1974), attitude is an internal state that affects an individual’s choice of action toward an object, person, or event. Eagly and Chaiken (1993) define *attitude* as a tendency to evaluate an entity with some degree of favor or disfavor, ordinarily expressed in cognitive, affective, and behavioral responses. Some researchers note the complex nature of attitudes. According to Germann (1988), attitude is a complex cognitive process that reflects values or feelings toward learning a subject, including science.

For this study, *attitude* is defined as the response of a person toward something through acceptance or denial and which can be inferred from the person’s reactions or a rating on an attitudes scale.

Cooperative Learning

Cooperative learning is one of several active-learning styles. The sense of interacting with others, working together, sharing tasks, and encouraging one another becomes an additional educational strategy that teachers seek to facilitate in school classrooms. According to Gillies (2007), cooperative learning involves students working together in small groups to accomplish shared goals. Johnson, Johnson, and Toylor (1993) defined *cooperative learning* as “the instructional use of small groups so that students work together to maximize their own and each other’s learning” (p. 9). According to Jacobs, Power, and Inn (2002), cooperative learning refers to the “principles and techniques for helping students work together more effectively” (p. ix).
For this study, cooperative learning is defined as a teaching technique where students in small groups interact with each other to acquire the proposed goals. It is more than just putting students into groups and giving them structured activities; rather, cooperative learning also involves creating a learning environment that includes specific elements and instructions intended to increase the potential for rich and deep learning by the participants.

Jigsaw

Jigsaw is a specific cooperative-learning technique. Jigsaw enhances positive student interdependence, leading to the feeling among group members that what helps one member benefits all of the members and that what hurts one member hurts all of the members (Jacobs and Power and Inn, 2002). According to Mengduo and Xiaoling (2010):

Each group member in the original Jigsaw strategy was assigned a different part of material. Then all the students from different groups who had the same learning material gathered together and formed an “expert group” to discuss and communicate with each other until they all mastered the material. Later, the students returned back to their home group to teach the material to other members of their group. (p. 114)

For this study, Jigsaw is an active cooperative-learning strategy where the teacher arranges students in groups of a certain number of students. Each group member is assigned a different piece of information that needs to be researched. Next, group members assigned the same piece of information gather to research the topic and share ideas about the information gathered. Eventually, students return to their original groups to put all the pieces together to see the topic as a whole and to teach one another. Teachers may use additional techniques to enhance students learning such as graphic organizers and other worksheets that facilitate the acquisition of scientific information.
Secondary School in Saudi Arabia

According to UNESCO (2011), secondary education is the final stage of general education in Saudi Arabia and lasts three years—from Grades 10 through 12. All students in secondary school study a general curriculum during the first year and can choose for the remaining two years one of the following tracks: administration and social science; natural science; or sharia and Arabic studies. At the end of secondary education, successful students receive a secondary school certificate. According to Hakeem (2012), “secondary school is the transition stage that transfers students from the basic level of education to the beginning of the professional and specialist education” (p. 82).

For this study, secondary school is the highest level of basic general education in Saudi Arabia. It is where students receive instruction in a variety of subject and can choose from different tracks based on the student’s academic ability. Secondary education last three years, and students are 16 through 18 years of age. This age range is a time when students need special care and attention as they are nearing adulthood. Students in secondary school need different kinds of teaching methods that can help prepare them to engage in social life and function in the job market after graduation.

Chapter Summary

In Saudi Arabia, demand is increasing for a renewed focus on student-centered teaching methods to improve the students’ skills, including the ability to work cooperatively in groups rather than just individually in the classroom. Therefore, Chapter 1 introduced the study and presented the problem statement, the purpose statement, the research questions, the research hypotheses, the significance of the study, and the definition of terms.
Chapter 2 presents the relevant research and theoretical foundation of cooperative learning and its effects on the academic achievement and attitudes of students. Chapter 2 also describes the study methodology.
CHAPTER II
LITERATURE REVIEW

Introduction

This chapter describes the theoretical framework for using Jigsaw as a cooperative-learning instructional strategy to impact achievement and attitudes of Saudi Arabian male high school science students. Moreover, because cooperative learning is one of the teaching methods used to achieve better results in science field, this chapter describes the relevant literature for each construct of the study. The chapter includes general background about cooperative learning, structuring cooperative group work, aspects that make cooperative learning vital, and outcomes of cooperative-learning research.

This chapter also addresses attitudes in general, attitudes toward science in particular, research background about attitudes, why people have attitudes, attitudes toward science in general, attitudes toward science in Saudi Arabia. The last section of the chapter addresses the general background of education in Saudi Arabia, the historical background of Saudi Arabian education, Saudi Arabian education policy and philosophy, and secondary education and science education in Saudi Arabia. The chapter addresses these concepts in detail to support the base of research.
Theoretical Framework

While many theories in education may inform the current study, it was essential to select two theories that would ground the research. Selected were the social constructivism theory developed by Vygotsky (1978) and motivation theory, which developed through the collaboration of many educators in the early 1990s.

**Motivation theory.** Motivation theory derives from the works of Atkinson, 1964; Deutsch, 1962; Lewin, 1947; and Skinner, 1968. The theory has been widely accepted for decades as a means of understanding the impact of motivation in learners in diverse K-12 environments. Slavin (1983) reflected on Lewin’s work, which the latter referred to as “group dynamics.” Lewin (1947) described group dynamics as the way that groups and individuals act and react to changing circumstances. Motivation theory emerged as a concept dedicated to the advancement of knowledge regarding (a) the nature of groups, (b) the groups’ laws, (c) the establishment and development of and interactions with other groups, and (d) individuals and institutions. Slavin (1983) indicated that in a cooperative goal structure, the group members’ attainment of individual goals is dependent on the cooperation and motivation of the entire group. Therefore, group members learn to help their group members and do whatever helps the group to succeed.

From the motivational perspective, according to Slavin (1987), cooperative learning improves achievement scores because the cooperative reward structure creates peer norms and sanctions that support individual efforts. Slavin’s claim was based on the study of cooperative learning and the cooperative school (1987). Slavin’s study showed that people working together toward a common goal could accomplish more than people working as individuals. This kind of group motivation to achieve goals has been
developed in association with cooperative learning strategies and found to be instructionally effective in secondary school (Slavin, 1987, p. 7). Furthermore, to support Slavin's notion about the common goal and group work, Ahuja (1994) stated, “motivational perspectives concentrate more on the reward or goal structures under which a group operates” (p. 9).

Motivation is one of the most significant determinants of students’ success or failure in the classroom (Hidi and Harackiewicz, 2000; Reeve, 1996; Ryan and Connell, 1989). Studies have shown that active involvement in learning activities is more motivating than passive involvement. One example is Zahorik’s study (1996) as cited by Welch, Gradin, and Sandell (2002). In addition, student control and responsibility also are associated with increased motivation, which translates into increased learning and retention of information (Eggen & Kauchak, 2001).

Applications of motivation theory in K-12 education have continued for years, yielding several promising results among learners. According to Nichols and Miller (1994), some educators consider motivation an essential part of learning. This belief may be based on earlier works by Slavin (1984), who argued that the key factor inspiring the success of cooperative-learning group environments is the positive motivational influence of the group mates to support learning. Slavin’s (1984) Team-Assisted Individualization Program (TAI) began as an attempt to improve individualized instruction. TAI provides small groups of four or five students the opportunity to work jointly and cooperatively to accomplish learning objectives. When peers who work together recognize that their rewards are dependent on the success of their teammates, they may provide emotional
and tutorial support for learning. Such support for learning is not typical in traditional classrooms.

Slavin’s model of cooperative learning has been applied to research studies that connected the benefits of cooperative learning and motivation to education as shown in many studies. Based on the positive results of such research, a similar model of cooperative learning was used for the current study. Although some studies have explored student’s achievements and attitudes toward science at the high school level in Saudi Arabia, no study has explored achievement and attitudes using the framework of cooperative learning. Taking insights from Slavin’s framework and its application in research, the current study used the Jigsaw strategy as a motivator for Saudi Arabian students’ learning.

Social constructivism theory. A second theory that helped to strengthen the rationale for the current study is social constructivism, which was developed by Vygotsky (1978). Social constructivism theory has been widely applied in the field of educational research. Vygotsky’s theories stress the fundamental role of social interaction in the development of cognitive purposes. Vygotsky strongly believed that community plays a focal role in the process of “making meaning” (Wertsch, 1985). According to Kim (2001), “social constructivism emphasizes the importance of culture and context in understanding what occurs in society and constructing knowledge based on this understanding” (p. 2).

The current study’s examination of attitudes toward science can be connected to student behavior with the social constructivism theory. According to Alrehaily (2011), “outcomes of behaviors can be predicted and evaluated not only through the person’s
expression but also through effective interactions with peers and community. A person’s behavior and performance are influenced by internal and external factors” (p. 7). Al Rehaily added that the internal factors might include confidence, for example, while the external factors might be culture, ethnic background, parents, peers, teachers, and access to environmental resources. All of the factors work to support or to discourage a student’s status in learning. These factors can be used to build the social participation of students in the learning process.

A review of the related science-education research showed that Western countries have using the constructivist approach for a long time. The constructivist approach in general and social constructivist theory in particular give students an excellent opportunity to use previous knowledge and experience along with peer cooperation to understand scientific concepts. In Saudi Arabia, traditional teaching is still used. Educational leaders and stakeholders in Saudi Arabia have not taken students’ participation and views into account. It is worth noting that in Saudi Arabia, the teacher and the textbook are the main sources of learning (Alhammad, 2015).

In this regard, Hourani (2011) found in his empirical study of science education in the Arab Gulf that schools do not apply the constructivist approach because classrooms are not equipped for cooperative learning. Schools in the Arab Gulf also suffer from a lack of computers in the classrooms, as is the case in Saudi Arabia. According to Mansour and Al-Shamrani (2015), the lack of consideration of the sociocultural contexts hinders the development of education in general and science education in particular in Gulf countries.
The literature showed that the first educational policy in Saudi Arabia was issued in 1969. According to Al Ghanem (2009), educational policy was considered to be the foundation for the education system in the Saudi Arabia. Since then, no papers have reported or mentioned the necessary use of the social constructivist approach in schools. In this regard, Al Ghanem noted that the educational policies and plans in Saudi Arabia did not inspire the imagination of science curriculum designers to consider what must be done and how it is to be done.

Social constructivism is considered appropriate as a theoretical foundation for the current study because the theory is both coherent and fairly well substantiated by previous research. Slavin (2003) reported that Piaget and Vygotsky assured the social nature of learning. Vygotsky and Piaget suggested the use of mixed-ability learning groups to boost conceptual change. Learning, as suggested by Vygotsky (1978), is a social activity. With the current emphasis on social constructivism, the cooperative-learning approach has allowed educators to structure a more student-centered environment by allowing students to learn through interacting with their peers and teacher to achieve their learning goals (McWhaw, Schnackenberg, Sclater, & Abrami, 2003).

Hausfather, (1996) stated that Vygotsky’s work viewed education as central to cognitive development and an essential sociocultural activity. Vygotsky deemed the social organization of instruction “an essential part of schools’ acculturation of the child into the practices of the society experiences” (Moll, 1990). Furthermore, Vygotsky links sociohistorical psychology with a theory of schooling. Vygotsky also has noted that child development is a very complex process between the child and the social environment. To
understand the relationship, one can notice how the social environment supports the child’s development. Therefore, what a child can do cooperatively with others now, he or she will be able to do independently later in the social life (Hausfather, 1996, p. 5).

In general, social constructivists view learning as a social process. According to Kim (2001), MacMahon (1997) stated, “learning does not take place only within an individual, nor is it a passive development of behaviors that are shaped by external forces. Meaningful learning occurs when individuals are engaged in social activities” (p. 3). These social activities include planning together, making a strategy to search, conducting discussions, and drawing conclusions. The importance of social constructivism as a theory of learning is that it can provide the framework needed to help science teachers move from a transmission model to more of an active-learner model. An active learner works with the teacher to construct knowledge by solving problems, engaging in inquiry, and participating actively in the learning process as in cooperative learning.

As a perspective of the current study, Slavin’s statement about the implications of the social constructivism theory is pertinent. According to Slavin (2003):

Most of the modern constructivist thought draws most heavily on Vygotsky’s theories, which have been used to support classroom instructional methods that emphasize cooperative learning, project-based learning, and discovery. One of the key principles derived from Vygotsky’s ideas is his emphasis on the social nature of learning (Hickey, 1997; O’Connor, 1998; Salomon and Perkins, 1998). Vygotsky proposed that children learn through joint interactions with adults and more capable peers. (p. 258)

To clarify this thought, Slavin (2003) stated that “on cooperative projects children are exposed to their peers’ thinking processes; this method not only makes the learning outcome available to all students, but also makes other students’ thinking processes
available to all” (p. 258). Slavin (2003) added, “Vygotsky noted that successful problem solvers talk themselves through difficult problems. In cooperative groups, children can hear this inner speech out loud and can learn how successful problem solvers are thinking through their approaches” (p. 258).

Vygotsky, as cited by Slavin (2003), used the term zone of proximal development “to describe the place where a child’s spontaneous concepts meet the ‘systematicity and logic of adult reasoning.’” Slavin continued, saying, “In the zone of proximal development children are working within their zone of proximal development when they are engaged in tasks that they could not do alone but can do with the assistance of peers or adults” (p. 358). This zone differs from child to child and reflects the learner’s ability to understand the logic of scientific concepts. For this reason, Vygotsky viewed tests and school tasks that exclusively looked at the child’s individual problem-solving ability as inadequate. Vygotsky argued that the progress in concept formation achieved by the child in cooperation with adults was a much more viable way to look at the learner’s capabilities (Slavin, 2003).

Vygotsky is a firm believer that social interaction and cultural influences have a huge effect on a student and how learning occurs; therefore, Vygotsky used scaffolding in his theory, leading to the understanding that children learn more effectively when they have others to support them. Vygotsky also used scaffolding as an assisted-learning process that supports the zone of proximal development—or getting to the next level of understanding—of each student with the assistance of teachers, peers, or other adults (Powell & Kalina, 2009).
Because the current study would include exploring similar constructs such as attitudes and behavior of high school students, the study used Jigsaw as a cooperative-learning strategy to stimulate the ability of students to do better in science and a social constructivism framework to compare any changes in students’ achievements and attitudes toward science after such exposure.

Cooperative Learning

General Background

In the last decades, there was a huge interest in cooperative learning as one of the most important teaching methods all over the world. Educators consider cooperative learning as an active instruction that leads to a positive learning experience. Cooperative learning is a student-focused teaching strategy in which small groups of students are responsible not just for their learning, but the learning of all other group members. In this strategy, students interact with each other in the same group to acquire and practice the information and tasks of a subject matter to solve a problem, gain new information, complete a task or achieve a goal.

According to Slavin (2011), learning environments for the 21st century must be ones in which students are actively engaged in learning tasks and with each other. It is a fact that today teachers are in competition with many other information sources such as television, computer games, and all sorts of engaging computer-related technology. In addition, the expectation that children may learn passively is becoming increasingly unbelievable. Cooperative Learning offers a practical way of creating exciting social and engaging classroom environments. The purpose of such an environment is to help students master all the traditional skills and knowledge as well as develop creative and
interactive skills. Students need the traditional skills in today’s economy and the modern lifestyle in the current society. Therefore, Slavin (2011) stated, “we can say that cooperative learning itself is being reshaped for the 21st century, particularly in partnership with developments in technology” (p. 3).

In science education, it is obvious that small-group discussion work has become increasingly important as a new trend in the teaching method (Oliveira and Sadler, 2008). According to Wolfensberger and Canella (2015):

Several factors many of them related to the emergence of the concept of scientific literacy have contributed to the growing interest in this approach. One of the most significant of these factors is the spread of constructivist views of learning. Another is the goal of preparing young people to participate as citizens in political decision-making on scientific matters, and yet another is the focus on the role of argument in understanding science. (p. 865)

Cooperative learning, in general, is suitable for all students’ levels. According to Slavin (1995) “Cooperative learning methods generally work equally well for all types of students. However occasional studies find particular advantages for high or low achievers in either boys or girls the great majority of them find equal benefits for all types of students” (p. 8). Moreover, Slavin added the assumption that parents and teachers sometimes worry that cooperative learning would hold back the high-achievers. In fact, research provides no support for the following claim: the high achievers gain from cooperative learning as much as do minimal and average achievers as the same as high achievers in traditional classes (Slavin, 1995).

To acquire true cooperative learning, we should understand the mechanism of putting students in groups and how to make those groups functional such as in Jigsaw strategy. Cooperative learning is not merely putting students in a group to do things. There are big differences between simply putting students together in groups to learn and
structuring groups of students to work cooperatively and interact together in real cooperative learning style. If we have a group of students sitting at the same table doing their work, but those students are free to talk and do whatever they want, it is not structured to be a cooperative group (Johnson and Johnson, 1994; Slavin, 1995). In cooperative learning, a group must have both a positive interdependence and a sense of individual accountability. Moreover, the teacher should observe and give feedback to each group on how well they are managing the group tasks. Also, the teacher should structure procedures for groups to effectively “process” what they are working on such as in Jigsaw, where each student has a different role in the learning process (Johnson et al., 1991).

According to Slavin (1995) “the positive effects of cooperative learning have been reported across a broad spectrum of researches that included: academic achievement, intergroup relations, acceptance of mainstreamed academically handicapped students, self-esteem, self-confidence, attitudes, control, time on task and classroom behavior, liking classmates, cooperation, altruism, and the ability to take another’s perspective” (p. 49). Johnson and Johnson (1992) pointed out that the “interpersonal exchange within cooperative learning groups, and especially the intellectual challenge resulting from conflict among ideas and conclusions (i.e. controversy), promotes critical thinking, higher level reasoning, and metacognitive thought” (p. 121).

To show the positive effects of cooperative learning Slavin (1995) stated that:

A review of 99 studies of cooperative learning of durations of at least four weeks in elementary and secondary schools compared the achievement gains of the cooperative approaches with control group learning. Of sixty-four studies of cooperative learning methods that provided group rewards based on the sum of
members’ individual learning (categorized here as Structured Team Learning Methods), fifty (78%) found significantly positive effects on achievement, and none found negative effects. (p. 76)

Structuring Cooperative Group Work

There is a vast array of different forms of cooperative learning, but all of them share the main concept of having students work in small groups to help each other learn the academic tasks. According to Slavin (2011), in cooperative learning there are two main categories. First, what we called "Structured Team Learning" involves rewards to teams based on the learning progress of their members, and is characterized by individual accountability, which means that team success depends on individual learning, not the whole group product. The second category is: "Informal Group Learning Methods" which covers methods more focused on social projects, dynamics, and discussions than on mastery of well-specified content to teach. As an effort to clarify those categories, the researcher will add some explanations about each category as mentioned below.

First: Structured team-learning methods. In this section, the researcher will present the main kinds of structured team learning methods as below:

Student Team Learning (STL). This kind of cooperative learning technique is known as (STL). According to Slavin (2011), STL emphasizes the use of team goals and collective definitions of success. STL can only be achieved when all members of the team learn the objectives being taught. In Student Team Learning, the most important thing is not to do something together, but to learn something as a part of the team. In classes using STL, there are three main concepts: (1) Team rewards, (2) Individual accountability, (3) Equal opportunities for all students to succeed.
The role of the team rewards is to enhance basic skill achievement. According to Slavin (1995) “it is not enough simply to tell students to work together. They must have a reason to take one another’s achievement seriously. Further, if students are rewarded for doing better than they have in the past, they will be more motivated to achieve than if they are rewarded based on their performance in comparison to others—rewards for improvement make success neither too difficult nor too easy for students to achieve” (p. 4).

Individual accountability refers to the ability to associate positively with other members to share team progress. According to Slavin (1995), "individual accountability focuses team activity on explaining concepts to one another and making sure that everyone on the team is ready for a quiz or other assessment that they will be taking without teammate help" (p. 3). The purpose of cooperative learning groups is to create academically strong students and to accomplish that students must contribute and share interest because the team's success depends on the individual learning of all team members.

The aim of equal opportunities is to create a classroom environment where all students can thrive together. Also, this concept helps students understand that individual characteristics make people unique and not ‘different’ in a negative way. According to Slavin (1995) “with equal opportunities for success, students contribute to their teams by improving over their past performances, so that high, average, and low achievers are equally challenged to do their best and the contributions of all team members are valued" (p. 3).
**Student Teams-Achievement Divisions (STAD).** To define this technique, Slavin (1994) stated that:

In STAD students are assigned to four-member learning teams, which are mixed in performance level, sex and ethnicity. The teacher presents a lesson, and the students work within their teams to make sure that all team members have understood the lesson. Finally, all students take individual quizzes on the material, and they are not allowed to help each other. Students’ quiz scores are compared to their own past averages, and points are awarded based on the degree to which students can meet or exceed their own earlier performances. These points are then summed to form team scores, and teams that meet certain criteria earn certificates or other rewards. (p. 53)

In this regard, Jacobs, Power, and Inn (2002) declared that once the teacher calculates the number of points individual students have earned for their team, these points are averaged to determine if the team will receive recognition or not. The recognition takes the form of certificates, bulletin board notices, or the chance to do a team's handshake or silent cheer.

**Teams-Games-Tournament (TGT).** This kind of technique uses the same teamwork and teacher presentations as in STAD, but the only difference is replacing the quizzes with weekly tournaments for more competition. According to Slavin (2011), students compete with members from other teams to collect points for their team. For example, students compete at three-person “tournament tables” against others with a similar record in a subject. A procedure changing table assignments is recommended to keep the competition “fair.” According to Slavin (1995) “the winner student at each tournament table brings the same amount of points to his or her team, regardless of which table it is; this means that low achievers (competing with other low achievers) and high achievers (competing with other high achievers) have equal opportunity for success. This technique involving rewards as in STAD, where high performing teams can earn certificates or other forms of team rewards” (p. 4).
Team Assisted Individualization (TAI). This technique shares with STAD and TGT the use of the four-member mixed-ability learning teams and certificates for high-performing teams. But while STAD and TGT use a single pace of instruction for the class, TAI combines cooperative learning with individualized instruction (Slavin et al. 1986). To address this technique Slavin (2011) stated that:

In TAI, students enter an individualized sequence according to a placement test and then proceed at their own rates. In general, team member’s work on different units. Teammates check each other’s work against answer sheets and help one another with any problems. Final unit tests are taken without teammate help and are scored by student monitors. Each week, teachers total the number of units completed by all team members and give certificates or other team rewards to teams that exceed a criterion score based on the number of final tests passed, with extra points for perfect papers and completed homework. (p. 68)

Second: Informal group learning methods. In the following section, the researcher will present the main kinds of informal group learning methods as below:

**Jigsaw.** The Jigsaw method is a widely used cooperative learning method, which was first proposed by Elliot Aronson in 1978. According to Aronson (1978), "the Jigsaw technique is an alternative to conventional classroom teaching methods. Rather than grouping a whole class around a teacher, the students are taught to work in smaller interdependent groups; each child is given a part of a topic to be studied, and when finished, the students fit their pieces of the subject area together to form a complete "Jigsaw" picture" (p. 9). According to Berger and Hanze (2015), This kind of group work involves students switching the roles between different groups and acting as both expert teachers and novice students. In the first stage, students should form ‘expert groups’ that are assigned to be experts in a specific subtopic. Together, students within an expert group research and discuss the subtopic, and address questions and problems. Later in Jigsaw cooperative learning strategy, students in the expert groups break up and
recombine with ‘experts’ in other subtopics (from different expert groups) to form teaching groups. Each student in the expert's group will teach the rest of the group (novice students) his or her expert subtopic.

In this way, students will study the whole topic because the only way for students to learn the others' materials is to listen carefully to their teammates. The team members are motivated to support and show respect and interest in one another’s work (Slavin, 2011). Rather than teachers providing the materials for Jigsaw, expert teams can begin with topics and research them on their own before reporting to their home teams (Jacobs et al., 2002). Altun (2015) has defined Jigsaw technique by stating that:

In Jigsaw technique students are divided into groups of 5-6 members in this technique. Each member works on his subject and students from different groups working on the same subject gather and create expert groups. The subject is discussed in depth in the expert groups. Students learn the subject completely in the expert groups and teach their subject to other students when they return to their original groups. Even if the students are graded individually, students need others for a good mark and therefore this technique requires cooperative working. (p. 453)

**Learning Together.** This technique was first developed by Johnson and Johnson (1999). The name of the learning together strategy was derived from the focus on the appropriate and integrated use of cooperative, competitive, and individualistic learning. According to Johnson and Johnson (1999), "students are more productive when they work together cooperatively, the faculty and staff are more productive when they work in cooperative teams. Teachers should work in teaching teams, a school-base decision making procedure involving task forces and ad-hoc decision groups should be utilized, and faculty meetings should be models of effective cooperative efforts to promote beneficial learning together" (p. 23).
According to Slavin (2011), “this model involves students working on assignment sheets in four- or five-member heterogeneous groups. Each group hand in a single sheet and receive praise and rewards based on the group product. Learning together strategy emphasizes team-building activities before students begin working together and also how can they conduct regular discussions within groups about how well they are collaborating” (p. 7).

Group Investigation. Group investigation was developed by Shlomo Sharan and Yael Sharan (1992). According to Slavin (2011):

Students in the group investigation work cooperatively in small groups with what we call inquiry, group discussion, and shared planning and project realization. In this method, students form their own groups to include between 2- 6 member groups. After that, students will choose the sub-topics from a unit being studied by the entire class, the groups further break down their sub-topics into individual tasks and design the activities that are necessary to prepare group reports. Then each group should make a presentation to communicate its findings to the entire class. (p. 7)

Aspects that Make Cooperative Learning Vital

There is a vast array of important components that work together to develop good cooperative learning. In this regard, Jones and Jones (2008) reported that:

Johnson, Johnson, and Smith (1991) define cooperative learning as “the instructional use of small groups so that students work together to maximize their own and each other's learning.” Based on their research, they have proposed five essential elements that are necessary to construct effective cooperative learning experiences: positive interdependence, promotive face-to-face interaction, individual accountability, social skills, and group processing. (p. 62)

In addition to promoting social skills, Williams (2007) added that cooperative learning is also “enhancing the personal competencies of self-reflection and accurate self-assessment. When students are working closely with others students in the same team or with other teams, learners can evaluate their own strengths and weaknesses by comparing themselves with others, utilizing the diversity of the group ability to accomplish their
mutual goal. It is obvious that cooperative learning encourages students to become reflective practitioners and strive for continuous improvement through the group members' participation in solving problems or finishing tasks” (p. 5).

Orprayoon (2014) cited that “cooperative learning enhances children’s ability to construct knowledge as they engage in discovering new ideas with each other. In addition, it enhances students’ self-esteem and helps teachers with classroom management…” (p. 81). Moreover, cooperative learning makes students experience more positive relationships with other members in different groups and between students and the teacher. It also promotes more positive self-esteem and attitudes towards the subject area (Slavin, 1995).

Motivation is one of the most important aspects that develop a good cooperative learning. In this regard, Slavin (2011) stated “the motivationalist perspective assumes that the motivation has the greatest impact on the learning process. Furthermore, the motivationalist scholars focus especially on the reward or goal structure under which students operate” (p. 8). On the other hand, the social cohesion perspective suggests that the effects of cooperative learning are dependent on the cohesiveness of the group and how they maintain close relationships to drive their ability to work together towards achieving better performance (Slavin, 2011). In the social cohesion perspective, Johnson and Johnson (1999) stated, “Students help each other to learn because they care about the group and its members and come to derive the benefits of self-identity from group membership” (p.27).
Outcomes of Cooperative Learning Research

There have been a variety of outcomes that researchers got from their investigations about cooperative learning. In teaching by using cooperative learning, the study of Berger and Hanze (2015) assessed the impact of expert students' instructional quality on the academic performance of novice students in 12th-grade physics classes organized in an expert model of cooperative learning “Jigsaw Classroom.” In this study, the instructional quality of 129 expert students was measured by a newly developed system. This study revealed that academic performance of novice students increases with the quality of expert students’ instruction. Moreover, they infer that cooperative learning may be more successful for less challenging topics. The reason is that if the tasks are too difficult, the cooperative learning method may not foster feelings of competence.

The study of Phillips (2010) took place in a suburban high school of 822 students. The student body consisted of 46% female students and 54% male students. The school population was predominantly white (99%). The school district was composed of middle-class to upper-class professional families. This study was built based on a case study that showed observational evidence about the patterns and experiences of student interaction in discussions within cooperative learning groups in several high school geometry classes. Results were derived from data collected in observations, audiotapes, and student journals/notebooks. The researcher had used a multiple-case study to examine the discussions of two groups of students in cooperative learning groups. Each one of these groups participated in three different activities: Placemat, to build team friendship; Numbered Heads, to strengthen positive interconnection; and STAD, to ensure individual accountability. The study of Phillips (2010) pointed out that “students showed a more
positive feeling towards cooperative learning, stated an increased appreciation for cooperative learning, developed trust in their group members, and were able to analyze what they were doing well and what areas needed work” (p. 116).

Ahuja (1994) studied the effects of cooperative learning instructional strategy on the academic achievement and attitudes towards science of middle school students. The population was seventh-grade science students. The sample consisted of five seventh grade classes in Columbus. The students were ranged from a lower to a middle level socio-economic status. Students in the study were approximately 50% African American and 50% Caucasian students. The study lasted for seven weeks. Quasi-experimental control group design was used in this study. Students were taught by using Jigsaw cooperative learning strategy. The use of cooperative learning according to Ahuja (1994) has shown a significant improvement of the students' achievement in science and also has improved the students' attitudes towards science as compared to traditionally taught students.

The study of Demirici (2010) investigated how a cooperative learning approach affected 7th-grade primary school students’ achievements and attitudes. The aim of the study was to discover whether there is a significant difference between the means of achievement and attitude scores under a cooperative learning approach and a conventional learning approach. An experimental method was used in the study. The “pre-test post-test design with control group” method was employed. The achievement test for this study was prepared with at 38 test items, with every item having four options. Attitude scale for the science lesson was used as both pre- and post-attitude. The researcher had developed an attitude scale including 32 items. The attitude scale was
given to both the experimental and the control group before and after the experimental teaching unit. Jigsaw was used as a cooperative learning strategy in this study.

In teaching science by using cooperative learning, the study of Demirci (2010) has revealed that “there is a significant difference in the mean value of the difference between pre-test and post-test grades for a science lesson taught under a cooperative learning approach when compared to the same lesson taught using a conventional learning approach. The cooperative learning approach is more efficient than the conventional approach. The pupils taught in their science class using a conventional learning approach developed a positive attitude about the science lesson” (p. 46).

The study of Altun (2015) about the effect of cooperative learning on students’ achievement and views on the science and technology course consisted of 13 boys and 7 girls, with a total of 20 students studying at a private middle school in Istanbul. Jigsaw and Team Game Tournament (TGT) techniques were used in this study. Mixed method design was used in this study as the research design. The findings of this study indicated, “Cooperative learning method has a favorable effect on learning. Which means that the cooperation based learning-teaching environment provided cooperation, supported permanent learning, and provided opportunities to be successful, contributed to the development of social and personal skills” (p. 463).

Batool and Parveen (2012) studied the effects of cooperative learning on the achievement of students in general science at secondary level. The study sample composed of 36 students of a 9th-grade class. Students were distributed equally among experimental group and control group. The distribution was based on the basic of their annual examination at general science scores. The research design of the study was pre-
test post-test control group design. The findings of this study reported that “cooperative learning method is superior to traditional method in general science achievement of 9th-grade students in Pakistan” (p. 154).

Hong (2010) studied the effects of a collaborative science intervention on high-achieving students’ learning anxiety and attitudes towards science. Thirty-seven high achieving students in eighth-grade (16 boys and 21 girls) were selected as an experimental group for this study. Participants joined a 20-week collaborative science intervention. The collaborative science intervention integrated and utilized an innovative teaching strategy. Mixed method quantitative and qualitative research design was used. The findings revealed that experimental group students experienced significant impact as seen through increased attitudes and decreased anxiety of learning science. Hong (2010) stated, “The experimental group students gained a significant amount of curiosity and interest in learning science. The students' engagement in cooperative learning helped them to foster positive attitudes to strengthen their cooperation with team members” (p. 85).

In contrast to the studies that support the positive effects of cooperative learning is the study of Chiu (2002) about the effects of cooperative teamwork on secondary science in Taiwan. The participants in this study were ninety-four 10th-grade students ages 16 and 17. All the students were girls divided into two Earth Science classes. The groups were cooperative team groups and individual groups. The findings of this study found that “both groups showed significant improvements in skills and attitudes. However, the students in the team situation did not demonstrate significantly better skills or attitudes than the students in the individual situation” (p. 262).
By having different learning styles, the study of Colak (2015) was designed to determine the effectiveness of cooperative learning activities in ensuring deep learning according to students’ learning styles. The researcher used single-group pre-test post-test design. The sample of this study composed of 39 students attending the course as a part of a pedagogical certification program at a state university in Turkey. This study included many instructions and activities such as (cooperative learning, multiple intelligences, drama, six hats, examples, discussions, role playing, problem-based teaching, the 5E teaching method and project-based teaching methods). All these instructions were implemented during the 6-week study period. The researcher also used different cooperative learning techniques such as (team game tournament, student teams achievement divisions, Jigsaw, and group investigation). The findings of this study showed that “students with cooperative and competitive learning styles succeeded better with the deep learning approach than students with avoidant, dependent, and participative learning styles. On the other hand, the students’ post-test scores for surface learning showed no significant differences regarding learning styles” (p. 17).

The good effects of cooperative learning are not merely limited to the academic gains. The techniques of small groups allow students to interact with their peers and also enhance their social skills. To prove that, Drakeford (2012) conducted his study with a multiple baseline design across two subjects to determine the effectiveness of cooperative learning techniques on increasing student participation. The study was implemented on two male secondary students attending the bound pre-college program. In the study procedures, each student has to work in small groups with specific roles. Two observers were documenting the amount of time each student participated during the cooperative
learning activities. As an effort to measure the effectiveness of the treatment, a multiple baseline across subjects was used in this study. The results' of this study showed that “cooperative learning techniques increased student’s participation in specific roles to encourage individual members and taking notes, providing feedback to the smaller group, or speaking to the larger group” (p. 139).

In Kenya, the study of Keraro, Wachanga, and Orora, (2007) investigated the effects of using the cooperative concept mapping teaching approach on secondary school students’ motivation in biology. The research design of this study was a non-equivalent control group design. This design is one of the quasi-experimental research designs. A random sampling of four co-educational secondary schools was used. The four schools were further randomly assigned to four groups. The study sample consisted of 156 students in the secondary school in Gucha District, Kenya. The results of this study showed that “the students who were exposed to the cooperative learning approach have significantly higher motivation than those taught through regular methods. Furthermore, the results also indicate that there is no statistically significant gender difference in motivation towards the learning of biology among secondary school students exposed to cooperative learning strategy” (p. 111).

For more evidence of the positive effects of cooperative learning strategy on secondary school students’ achievement, the study of Ajaja (2010) studied the effects of cooperative learning strategy on junior secondary school students’ achievement in integrated science. The design of the study was a 2x2x2 factorial, pre-test, post-test control group design. The research design included two instructional groups, (cooperative learning groups and traditional classroom groups). The other factor was sex (male and
female). The third factor was the ability (high and low), and finally, the repeated testing (pre-test and post-test). The population of this study was composed of 205 junior students from where a sample of 120 students was randomly selected. The results of this study showed that “there are a significant higher achievement test scores of students in cooperative learning group than those in traditional classroom. Also, there are significant higher attitude scores of students in cooperative learning group than those in traditional classroom. In addition to a significant higher achievement test score of all students of varying abilities in cooperative learning group than those in traditional classroom” (p. 1).

In a study of experiences and reflections of students about teaching Atomic Structure in a Jigsaw classroom in lower secondary school chemistry lessons, Eliks (2005) stated that about 40% to more than 60% made positive statements concerning cooperative learning (on average in all groups 48%). Their answers mainly mentioned that they liked working in small groups, or they felt that there was an improvement in the atmosphere in the classroom, or they liked working together with all of the students or with some students with whom they previously had not had much contact. Moreover, some students mentioned how it was very important for them to be responsible for other classmates and that all of the students were included in the process. They also mentioned how these factors made the lesson more attractive for them.

In Egypt, the study of Salem (1998) about the effectiveness of using cooperative learning in the teaching of environmental science on the students' achievement and their attitudes has shown important results such as that the usage of the cooperative learning strategy has increased the students' achievement. Also, the usage of cooperative learning has improved their attitudes towards the environment. The study of Hasanin (2002)
showed that the usage of cooperative learning in teaching science has increased the students' achievement and improved their learning skills such as critical thinking, creative thinking, communication, and cooperation. However, the results revealed that there were no differences in the students’ attitudes between the control group who used the individual strategy of learning and the experimental group who used the cooperative learning strategy.

Attitudes

General Background

The term ‘attitudes” has been considered a central concept of social psychology. We can find this term in western literature as early as the 18th century as stated by Aiken (2002) to refer to an internal state of preparation for action. In the 18th century, many educators were fascinated by this concept. Thomas and Znaniecki (1918) mentioned: "This concept (attitude) is probably the most distinctive and indispensable concept in contemporary American social psychology" (p. 43).

Schwarz and Bohner (2001) stated that the attitude concept has received a lot of attention and has changed many times over the years. The old definitions were too broad and encompassed cognitive, affective, motivational, and behavioral components. For example, Allport (1935) defined an attitude as "a mental and neural state of readiness, organized through experience, exerting a directive and dynamic influence upon the individual's response to all objects and situations with which it is related" (p. 810). Then after a decade, Krech and Crutchfield (1948) wrote, "An attitude can be defined as an enduring organization of motivational, emotional, perceptual, and cognitive processes with respect to some aspect of the individual's world" (p. 152). The previous definitions
were emphasizing the sustained nature of attitudes and their close relationship to the individuals' behavior. Various sociologists and psychologists were defining attitudes simply in terms of the probability that a person will show specified behaviors in specified situations (Wood, 2000, p. 540).

Over time, the changes in the definitions made the concept lose a lot of its concentration on like or dislike as mentioned in Eagly and Chaiken (1993) when they defined attitudes as "tendencies to evaluate an entity with some degree of favor or disfavor, ordinarily expressed in cognitive, affective, and behavioral responses" (p. 155). Nowadays, many educators have combined elements from several definitions to produce a new definition such as what Aiken (2002) stated; “attitudes may be viewed as learned cognitive, affective, and behavioral predispositions to respond positively or negatively to certain objects, situations, institutions, concepts, or persons. Attitudes may be quite individual and thereby reflective of and related to personality characteristics such as a need for closure” (p. 3). The need for closure was defined as a desire to complete a task, such as finding an answer to a question or a solution to a problem.

The Purpose of Attitudes

As mentioned in the previous definitions' presentations, attitudes are a hypothetical construct, invented by researchers to account for a body of phenomena or situations. Attitudes are not observable directly, but we can infer them from individuals' self-reports and behavior towards things. Accordingly, the processes underlying self-reports of attitudes are central in our inferences about the nature of attitudes (Schwarz and Bohner, 2001).
Moreover, the simple indications of attitudes were referred to as the like or dislike of things. In other words, attitudes were defined as judging things or situations. Therefore, attitudes can help us define how we see situations, as well as define how we behave towards the situation or object. In this regards Pickens, (2005) stated that:

Attitudes might simply be an enduring evaluation of a person or object (e.g., “I like John best of my coworkers”), or other emotional reactions to objects and to people (e.g., “I dislike bossy people” or “Jane makes me angry”). Attitudes also provide us with internal cognitions or beliefs and thoughts about people and objects (e.g., “Jane should work harder” or “Sam does not like working in this department”). Attitudes cause us to behave in a particular way towards an object or person (e.g., “I write clearly in patients’ charts because it upsets me when I can’t read someone else’s handwriting”). Although the feeling and belief components of attitudes are internal to a person, we can view a person’s attitude from his or her resulting behavior. (p. 48)

In his explanations of attitudes Aiken (2002) reported, “Both motivation and cognitive functions could be served by attitudes. Depending on their intensity, it has been proven that attitudes can shorten response time to attitude-relevant stimuli, contribute to the efficient organization of one's perceptions and thoughts about different aspects of the world, and facilitate planning and decision-making in many aspects” (p. 3).

Attitudes Towards Science

A review of the literature revealed that for the past 50 years, many studies have focused on attitudes towards science, both as a concept tied to scientific literacy and as a distinct construct among the many constructs used to measure students' attitudes. According to Lakshmi (2004), “developing positive attitudes towards science has been an exposed goal of most of curriculum development efforts since the late 1950s. It was hoped that increasing interest in science would result in increased science enrolment, which in turn would yield a larger science work force pool and a science literate public” (p. 53).
There are essential differences between two kinds of attitudes that are related to science. Lado (2011) cited that Gardner (1975) “drew a clear distinction between “attitude towards science” and “scientific attitudes,” indicating that “scientific attitudes” referred to perspectives on science in society while “attitudes towards science” referred to perspectives on school science” (p. 44).

Lado (2011) explained the distinctions between scientific attitudes and attitudes toward science. In this regard he stated:

In addition to the important distinctions made between “scientific attitudes” and “attitudes towards science,” researchers such as Osborne and associates (2003) and Simon (2000) claimed that the construct “attitude towards science” is complex—not just a unitary mental attribute, but rather a multi-dimensional attribute comprised of several sub-constructs. According to these authors, the sub-constructs comprising “attitude towards science” include perceptions about science teachers, anxiety about science, enjoyment of science, beliefs about the value of science, self-esteem with regard to one’s performance as a student of science, views of one’s achievement in science, and fear of failure in science courses. (p. 44)

According to Akcay, Yager, Iskaner, and Turgut (2010) “attitudes towards science and scientists influence views of science, future career awareness, and classroom participation. Students who have positive attitudes show increased attention to classroom instruction and participate more in science activities” (p. 2). In terms of pointing out some factors that may affect the attitudes towards science such as gender and ethnicity, Akcay et al., (2010) stated that:

Many research studies indicate the main factors influencing attitudes towards science. Probably gender is the most significant variable related student attitudes towards science as stated by (Gardner, 1975; Schibeci, 1984; Weinburgh, 1995). This factor works through many signs that make children receive messages about gender and ethnic stereotypes everyday from television programs and commercials, books, and the adults around them. They also see pictures of scientists most of whom are all men, are all white, and have strange/weird behaviors. The strong correlation between attitude towards science and achievement indicate little difference between girls and boys. Moreover, more
positive attitudes are necessary for girls to enable them to achieve high scores (Weingburgh, 1995; Jarvis and Pell, 2005). (p. 3)

Studying typical school science sometimes leads to negative attitudes towards studying science. In this regard, Yager (1996) declared, “It is important to develop student positive attitude towards science. When they have positive attitudes, the learning of scientific information and science process skills are enhanced” (p. 34). Furthermore, Ackay (2010) cited that Penick and Yager (1982) mentioned, “After fourth grade, student attitude towards science starts to decline through junior and high school. Assessment of student attitudes towards science have been conducted and reported. Student responses indicate that student interest in science decreases the longer the students study science” (p. 3).

Attitudes Towards Science in Saudi Arabia

In general, it seems like there are huge demands for more improvements in the Saudi science-teaching field. There have been too many reports about flaws in the current Saudi Arabian science curriculum and content (Al-hurr and Ar-rumi 2002; Radwan, 1991). Al-hurr and Ar-rumi (2002) indicated that there is evidence of defeatism and instability in education in many of the Gulf Countries such as Saudi Arabia, Qatar, Oman, Bahrain, and United Arab Emirates. Radwan (1991) indicated that the lack of effectiveness, specifically in Saudi Arabian science instruction, is of concern to authorities. Unfortunately, Saudi Arabia is still suffering from the same problem now. This lack of efficacy in Saudi Arabian science instruction has a direct negative notable impact on the students’ understanding and attitudes towards science-related subjects (Alharbi, 2012).
Al Hokail, (2011) mentioned many reasons for the negative attitudes towards many subjects in Saudi education including science. One of the essential reasons is the weakness of teachers’ preparation in colleges and universities, which has a huge impact on the students who want to study science. Although, the Ministry of Education has done some improvements in that regard such as closing the old teachers' institutions and engaging the colleges of teachers under the universities, the changing of the students' general attitudes about some subjects such as science still exist.

The other reason for the negative attitudes towards many subjects in Saudi education including science is the division of the secondary school into four main groups of specialty. According to Alghamdi and Abduljawad (2015), there is no balance in the students’ number when dividing them to the four groups of specialty. The MOE indicated that (23.6%) of students are studying in religious studies and Arabic language, and (42.8%) of students are studying in social and management studies. Also (31.6%) are studying in the scientific studies, while just (0.2%) of students are studying the practical studies which we need most to fulfill the societal needs for them.

In addition to what has been presented above, Alghamdi and Abduljawad (2015) added the final reason of the negative attitudes towards many subjects in Saudi education including science, which is the problem of improper school buildings. In Saudi Arabia, we call them the rented buildings or the rented schools. Sometimes, the Ministry of Education resorts to renting a normal residential house and turning it into a school. Renting houses to be schools should be a temporary solution, but in many cases, this temporary solution lasts forever. These buildings lack laboratories, workshop places, and
many other components that are necessary for any other school nationwide in Saudi Arabia.

Outcomes of Attitudes Towards Science

There have been many outcomes that researchers have reported from investigating attitudes towards science in different aspects. Most of the attitudes towards science change positively after using different teaching methods or a new kind of instruction in teaching science. A review of the literature reveals that after using (science- technology-society) (STS) approach, Akcay et al., (2010) found that students in classes taught with an STS approach develop more positive attitudes towards science when compared to students in classes taught with a textbook-oriented approach. In an association of student science achievement and attitudes about science with student-reported frequency of teacher lecture demonstrations and student-centered learning, Odom and Bell (2015) found that student-centered learning was positively associated with the attitude towards science. In the same way, Maxfield (2011) reported that the two-problem based learning’ groups used Jigsaw in his study had developed a significantly more positive attitude towards science than the other groups that used traditional small groups.

In the study that addresses the impact of participating in an after-school robotics competition on high school students’ attitudes towards science, Welch and Huffman (2011) found that students who participated in a robotic competition had a more positive attitude towards science and science-related areas in the Test of Science-Related Attitude scale. In the study of longitudinal impact of an inquiry-based science program on students’ attitudes towards science, Gibson and Chase (2002) found that the interviews and surveys about summer science exploration program suggested that students had a
more positive attitude towards science and a higher interest in science careers than students who registered in the program, but were not selected.

In their efforts to find out the impact of problem-based learning on student attitudes towards science, problem-solving skills and their perceptions of the learning environment, Ferreira and Trudle (2012) found a significant increase in student attitudes towards science, problem-solving skills, and positive views about the learning environment. Another study made by Gautreau and Binns (2012) showed that student attitudes towards science and content achievements were examined in three secondary biology classrooms using an environmentally place-based curriculum as well as a traditional curriculum. The results of this study showed some attitude measures are correlated with ability-group tracking. The little change in science attitudes noticed occurred during the study for all three groups.

If we were to be specific about cooperative learning and its influence on the students’ attitudes towards science, the study of Ajaja and Ejovwoke (2010) showed a significantly higher achievement in test scores of students in the cooperative learning group than others in the traditional classroom. The students' higher achievement leads to significantly higher attitude scores of students in the cooperative learning group than others in the traditional classroom. In the same way, the results of Kose (2010) which is about the effects of cooperative learning on eighth-grade students' achievement and attitude towards science, showed that the students in the experimental group had better performance on the post-science achievement scale and post-attitude scale towards science. To determine if there are effects of cooperative learning instructional strategy on the academic achievement and attitudes towards science, Ahuja (1994) found that even
though there was a general dislike for science, the students felt that if they were allowed to work in groups in science classes and given the opportunity to do more activities in science classes their attitudes towards science could change. Ahuja indicated that the use of cooperative learning had improved the attitudes towards science class as compared to traditionally taught students. The students with negative attitudes towards science started to view science in a less negative manner.

Moreover, Demirci (2010) found that the students taught in their science class using a cooperative learning approach developed a positive attitude about the science lesson. As a result, the applications of cooperative learning affected both achievement and attitude. In the same way, Hong (2010) revealed that research findings showed that students in the experimental group experienced significant impact as seen through increased attitudes and decreased anxiety in learning science. Furthermore, in the experiences and reflections about teaching atomic structure in a Jigsaw classroom in lower secondary school chemistry lessons, Eliks (2005) showed that the students' integration of the Jigsaw into science lessons was positive and students liked science lessons more when such methods as Jigsaw were applied. In addition, Hasanin (2002) and Salem (1998) found that the usage of Jigsaw as a cooperative learning strategy has increased both the achievement and the attitudes of students towards science.

Sometimes, there are other factors that seem not to have a large effect on attitudes, but in reality they are affecting the whole process. In a study conducted by Faris (2009) to investigate the impact of homogeneous versus heterogeneous collaborative learning grouping in multicultural classes on the students’ achievements and attitudes towards learning science, Faris (2009) concluded that:
The main effects of group structure on the students’ attitudes towards learning science were demonstrated in the heterogeneous group. It affected all the attitude components except the “working with students from different cultural backgrounds” dimension, where nearly all group types had the same effect. However, this positive attitude was enhanced when the effect of mixed ability classes was combined with the effect of multiculturalism. Having foreign students or students from different cultures in a mixed ability class, yielded the best-desired results. (p. 2)

Gender, Ethnicity, and Grade Level could play a role in students' attitudes towards science. Weinburgh (2000) found out in her study that female students have more positive attitudes towards the teacher, value to society, and are less anxious. On the other hand, males have more positive attitudes towards self-concept in science, enjoyment of science, and motivation in science. The study of Abayomi (2015) supported the previous result and revealed that there was a significant difference observed in the attitude of male and female students where boys had more positive attitudes toward science and greater levels of participation in scientific extra-curricular activities. A positive relationship was observed in the attitude and performance of students in science.

Moreover, Weinburgh (2000) found that white students had more positive attitudes than the students of African-American ethnicity on the teacher, value, self-concept, and enjoyment scales. Also, they were less anxious about science. She also added that:

There is not a lot of research on student attitudes as influenced by ethnicity. However, ethnic differences in science course selection are pronounced African American students are as likely as white students to take biology in high school but much less likely to take chemistry or physics. In addition, differences in achievement by ethnicity are more pronounced than differences by gender. Scores for whites are substantially higher than those for African Americans (NSF, 1996). (p.4).
For the grade level, students showed less positive attitudes as they continued in school. The 6th grade students showed more positive attitudes than the 7th grade; and the 7th grade showed more positive than the 8th grade. Weinberg (2000) stated that:

Kahle and Lakes (1983) suggest that the lack of positive attitudes towards science by females begins in the elementary grades. However, in a study of 1,200 students enrolled in grades four through six, Pogge (1986) found that students have a positive attitude towards science. The Sadkers (1986) report that gender differences are more pronounced in middle school, while Weinburgh (1994) reports that they continue into high school and that grade level is a significant predictor of student attitudes towards science. (p. 4).

### Education in Saudi Arabia

**General Background**

Saudi Arabia is a Middle Eastern country located in southwestern Asia. It occupies more than 80 percent of the Arabian Peninsula between the Red Sea in the west and the Arabian Gulf in the east. The land area of Saudi Arabia is approximately 2,240,000 square km and is bordered to the north by Kuwait, Iraq, and Jordan, to the east by Qatar, Bahrain, the United Arab Emirates and Oman, and to the south by Yemen. According to Alharbi (2012), Saudi Arabia's terrain is mostly desert, with limited sources of groundwater. According to the 2015 census, the population of Saudi Arabia was estimated to be about 31,540,000 million, including about 7.5 million resident foreigners. Until the late 1960s, most of the population was nomadic Bedouin or semi-nomadic; due to rapid economic and urban growth, more than 98 percent of the population currently is settled and live in modern cities (Alharbi, 2012).

The Arabic language is the official language in Saudi Arabia, and usually, people speak more than 20 different accents based on the region in which they live. The cultural
attitude in Saudi Arabia is highly conservative, and the country adheres to a strict interpretation of Islamic religious law. People in Saudi Arabia are conservative due to many factors. The most important factor is the instructions of the Islamic religion. Islam has many rules for followers to protect them socially, economically, globally, etc. People from other cultures and religions see Saudis in a mysterious way.

For example, when a woman refuses to shake hands with men, that is because there are religious rules which prevent that to happen, but some people are more lenient than others. Moreover, when women cover their heads, that is because of the religious rules, but when you see women in Saudi Arabia cover all their bodies, that is just one of the traditions of the Saudi women. Another factor is that Saudi people live in a tribal society, where those tribes have many norms and traditions controlling all life aspects. What people from outside of Saudi Arabia get confused about is that they do not know the differences between tribal norms and traditions and rules of Islam.

Ghamdi (1982) stated that cultural presentations must conform to narrowly defined standards of ethics. In Saudi Arabia there is segregation between men and women. They are not permitted to attend public events together or work in some careers together, such as education. Most Saudis are ethnically Arab, but some are of mixed ethnic origin and are descended from Indians, Turks, Indonesians, and Africans; most of them immigrated as pilgrims to Makkah and stayed in the Western region (Hijaz). There are also significant numbers of expatriate workers from North America, South Asia, Europe, and East Asia.

According to Alharbi (2012), the modern political state of Saudi Arabia was declared as a sovereign state in September 23, 1932. At the time of unification, Saudi
Arabia was one of the poorest, most desolate nations on earth (Griffin, 1989). The struggle to enter the modern century began when Saudi Arabia came into contact with the rest of the world in 1933, which marked its discovery of oil in the Eastern Province of the Kingdom (Ghamdi, 1982). After the discovery of oil, Saudi Arabia finally gained financial solvency. Oil concessions were granted, and money began to trickle in, but to the Saudi government, it was like a flood of money. The price of the oil was twenty-five cents for each barrel of oil. Four American oil companies, known collectively as ARAMCO (Arab-American Oil Company), owned the Saudi’s oil (Griffin, 1989). However, that situation changed after World War II, when the Saudi government arranged to take over fifty percent of the operations (Ghamdi, 1982).

Today ARAMCO is completely Saudi-owned, and annual oil revenues run into billions of dollars. With the influx of money from oil, the beginning of modernization and transformation started to shape a new nation with rooted principles that derived from Islamic rules and regulations. The exposure of the Saudi people to western cultures has made huge effects on the people's daily life. The interaction of the Saudis with other nationalities has developed different ways of trading language, business, and lifestyle (Alosaimi, 2013).

The Saudi economy is now firmly integrated with that of the West. According to Alharbi (2012), this factor forced the country to undergo tremendous social, economic, cultural and educational changes. Oil production brought wealth to the country, and the government launched ambitious plans for development in many aspects. Cities increased in demographics. The establishment and growth of a formal educational system
accompanied the new developments, and emphasis was placed on providing improved schooling to all urban and rural areas.

The fruit of the new life emerged when the country found that western technology brought in by oil interests, made all aspects of change unavoidable. David Long (1976) remarks about this conflict: “In Saudi Arabia, a traditional conservative Islamic society has suddenly been confronted with the full force of twentieth century western technology and thoughts” (p. 12). According to Al-Ghanem (1999) “for the Saudi government, the question was not how to resist change, even though there were some Saudis who advocated such an approach, but rather, where to start working and how to identify the appropriate mechanisms to meet the challenge of changing thoughts” (p. 39).

Historical Background of the Saudi Educational System

Education in Saudi Arabia has traveled through many stages since the seventh century. At that time there was no Saudi Arabia as it is now, it was called the Arab Peninsula. According to Al Mazro (1997), the education began with the teaching of Islam and the Holy Quran, and that was taking place in small rooms that were attached to the mosques and called "Kuttabs." According to Otibi (1993), Imams taught the lessons and the program of study was dominated by the Islamic tradition of religious and classical learning. Learning was based on the recitation of the Quran and the prophet's tradition; reading and writing received secondary emphasis. Additionally, students studied religion, Arabic language literature, and basic arithmetic (Otibi, 1993, p. 13). However, “Kuttabs were the only type of education that existed in the Arabian Peninsula except for the western part of it, which was under the rule of the Turks who introduced centralized governmental education” (Almazro, 1997, p. 11).
King Abdul-Aziz established the Directorate of Education (DOE) in 1924, and that was to create a formal education system to meet the educational needs of Saudi people at that time. According to Hasan (1979), “the DOE was to manage the school system in the western region of the country and to carry out the expansion of public education to the rest of the country. The first formal educational program was introduced in Makkah in the year 1926. In 1947, the number of schools in the country reached 65 with 10,000 male students enrolled in these schools” (p.53). Al Saloom (1988) mentioned that by the mid-1950s, the number of schools increased to 326 elementary schools, 75 secondary schools, one vocational school, eight institutes for preparing teachers, and six schools for teaching English.

According to the Ministry of Education (MOE) (1990), there was a major shift in the Saudi educational system in 1953 when the Kingdom replaced the DOE with the Ministry of Education (MOE), which became fully responsible for the education of male students. The aim of MOE was to implement the most modern and contemporary educational thought, by updating education and linking it with the social, economic, and scientific process in society. After that in 1965, another major shift in the Saudi educational system was made according to Otibi (1993), with the establishment of the Higher Committee for Educational Policy. The Committee’s main objectives were to state general goals and develop principles for the Saudi educational system. Specifically, it focused on curriculum development, teacher training programs, educational administration and so on.
Policy and Philosophy of Education in Saudi Arabia

The educational system in Saudi Arabia as stated by Al-Ghanem (1999) was established to support the applications of the Islamic philosophy on which the country was originally founded. The aim of the Saudi educational philosophy is to create a faithful generation, which will be able to preserve Islamic thoughts and culture. Also, prepare the new generation at the same time to be able to provide technical, and educational expertise to the nation. According to Al Osaimi (2013), The MOE issued a policy document in 1970, which is still applied currently, stating that education must teach students about God and Islam at all stages of education and in all fields. Therefore, it can be seen that the Saudi educational policy has Islam as its basis, as Islamic principles inform every aspect of life in Saudi Arabia. As an effort to explain the philosophy of Saudi education, Otibi (1993) stated that the Ministry of Education has derived from this policy some basic principles, which can be considered as a framework by which educational philosophy can be defined. The implication of these principles formulated as follows:

1. Foster a holistic Islamic concept of the universe, mankind, and life.
2. Emphasize that life on earth is a stage of work and production during which the individual invests his/her capacities with a full understanding of and faith in the eternal life in the other world.
3. Engender faith in human dignity as decreed by the Holy Quran, and cooperate with other nations to attain justice, peace, and humanitarian progress.
4. Emphasize the importance of the scientific knowledge as an avenue for building a new society, create different kinds of thinking among youngsters and encourage them to explore knowledge domains.
5. Use an Islamic orientation to judge theories and applications of science and knowledge in all their forms, items, curricula, and instruction.
6. Make profit from all kinds of useful human knowledge and experiences.
7. Promote the harmonious coordination between science and technology since they are the most important means of cultural, social, economic and physical development.
8. Fit education in all its stages into the state’s general development plans.
9. Promote prudent interaction with other cultures.
10. Provide opportunities for development for the individuals to participate effectively in the growth of the community in which he/she lives.
11. Emphasize the determination of the female’s right to obtain equal educational opportunities.
12. Use Arabic as the language of education in all its forms and stages unless need dictates otherwise. (Otibi, 1993, p. 32)

According to the previous principles, the Ministry of Education stated general goals for the education system. As stated by Alosaimi (2013), the implication of these goals can be outlined as below:

1. The student must be provided with the necessary information and skills to become a worthwhile member of society.
2. Enhance the students’ feelings about society’s problems (e.g. social, economic and cultural) and to assist in resolving them.
3. Individuals’ dignity must be reinforced and he/she must be given equal opportunities to develop his/her skills to participate in the development of the country.
4. To encourage the ethos of scientific thinking and research, reinforcing observation and to inform the student about God’s miracles and wisdom to orient social life in the right direction.
5. To teach students about great achievements in literature, science, and other fields, showing that scientific progress results from the efforts of all mankind.
6. Mathematical thinking, arithmetical skills, reading skill and reading habits should all be developed, and the student should be trained in the use of the language of figures and its uses in the scientific field.
7. To teach students to express themselves correctly in speech and writing.
8. To teach students at least one foreign language so they can benefit from it.
9. To view each student as an individual and to be able to direct them and help them to grow in a way best suited to their abilities.
10. To allow students to have the opportunity to do manual work and gain experience in laboratories, building and agricultural work.
11. To study the scientific principles of various activities to encourage progress and innovation in mechanical production. (Alosaimi, 2013, p. 16)

Secondary Education in Saudi Arabia

Secondary education is the last three years of the general education in Saudi Arabia. Al- Abdulkareem (2004) has stated that before 1937, there was no secondary-level education in Saudi Arabia. The Saudi Institution was the first high school opened in
1926, but most of the Saudi education scholars assert that the real beginning of secondary education started with the development of the Foreign Mission preparatory school in 1937. According to Al Sunbul (1998) the initial purpose of this school was to prepare Saudi students for higher education in Egyptian universities. Consequently, the course study was similar to the Egyptian course study and most of the teachers were from Egypt. The Foreign Mission school program began as a three-year commitment; but in 1944 educational planners changed it, as a consequence of integrating the intermediate and secondary school system to a five-year program. In 1958, secondary education resumed being a three-year program (Al Sunbul, 1998, p. 62).

Accordingly, there are now three types of secondary education available in Saudi Arabia: (1) Quranic school, (2) general (academic) school, and (3) vocational (professional) school. Although all educational levels in Saudi concentrate on teaching Islamic principles, Quranic School offers specific concentration on Islamic studies to prepare students for a specialty in Islamic law (Al Sunbul, 1998, p. 32). According to Al-Abdulkareem (2004) students in general high school follow a general course study in the first year. Then, each student specializes in either liberal arts or science for the next two years. According to Luqman (1983), "the vocational schools in the Kingdom of Saudi Arabia are mainly designed to produce skilled workers, as reflected in the heavy emphasis on practical work programs. The curricula and syllabi especially in the vocational schools, thus give very little attention to related subjects and aim rather to teach and train students in some trades in relatively short period of time" (p. 7).

The general high school course study has been changed many times over the years, as educational policy makers and course study planners have determined that the
course program did not meet individual and national needs. Saudi educational policy makers developed a new high school plan in 1993 because of the negative social consequences for both students and the society (Al Zaid, 1990). According to Roy (1992) "Although government data show high entrance rates at all levels of education, withdraw from school was high, where people find jobs with convenient salaries. This case is seeming contradictions primarily due to a low rate of retention for which remedy is sought through lowering the performance standards to allow students to get through the system. The Saudi government must develop a sounder policy concerning the quality of education at the elementary and secondary levels" (p. 477).

In this regard, Al Saloom (1988) believes that this kind of school will meet the students' needs by giving them the opportunity to choose the courses that reconcile to their interests, as well as developing a high school structure which allows students to experience different activities. Since that reform happened, the educators have been criticizing general secondary education. They feel that the educational course program, especially at the general high school level, is not well defined. Their main concern is that the high schools do not adequately prepare students for either college or the labor market.

Science Education

The science education has been found in Saudi Arabia since the establishment of the General Directorate of Education in 1926. Many developments have been made in science education since then, which were corresponding to the Saudi government's educational development plans. In fact, it was not until 1937 that science education entered the secondary education curriculum (Al-Hussaini, 1983). Physics, chemistry, and biology were included in this course study, and these were joined by geology in 1962.
As previously mentioned about the science course program that was taken from the Egyptian educational system until the mid-1960s, Alosaimi (2013) states:

It was mainly Egyptian educators working for the Ministry of Education who prepared the science textbooks for all levels of general education. Around 1975, the Educational Center for Science and Mathematics at the American University of Beirut developed science textbooks for all levels of general education. Then in 1984, the National Committee for Science Education (NCSE) was instituted by the regulation of Ministerial Decision No. 1095/17. This Committee continues to act in an advisory capacity to the Educational Development Organization of the Ministry of Education. (p. 18)

As a result of the huge demands to reform the science content, leaders of the ministry of education in Saudi Arabia sought to get help from other countries. According to David (1993), the main change in science education in Saudi Arabia took place when the experts at the American University in Beirut developed the science course study. Although there was a large criticism of that kind of course program, eventually that criticism settled down.

Currently, the Ministry of Education has the full responsibility for preparing and developing the national science education course study and textbooks for all levels and for both male and female students. According to Alosaimi (2013) “This department has specialists, which their main task is to review and update the textbooks. They take feedback from a few schools where the textbooks are piloted. The textbooks are then modified according to the feedback and tested again in a slightly larger number of schools. If any more modifications are required, these are carried out and the textbook is then distributed throughout the whole country free with no charge, where the education is free in Saudi Arabia” (p.19).

In his study, Al Abdulkareem (2004) stated that the educational reform in science education in Saudi Arabia must jointly and severally address all the components of an
educational system and the concept of systemic reform. There was a need for a standards-based learning system and establishing benchmarks for science in Saudi education. He added that the curriculum reform project needs to set benchmarks for the science curriculum in Saudi, and the structure of the reform should apply to a network base instead of to the hierarchy system. In addition, he reported some suggestions such as school-based ongoing professional development for teachers, and reshaping students and teachers’ evaluation procedures.

Nowadays, science in Saudi secondary schools is divided into chemistry, physics, biology, geology and environmental science, each of which has a different textbook. The science education is deep and strong. The textbooks are clear and of a high standard in every aspect. The science information is specific and linked to global science education especially with the last reform of science curriculums (Alharbi, 2012).

Chapter Summary

This literature review began with an illustration of the theoretical framework of this study. Then, the researcher moved to an explanation of cooperative learning, cooperative learning methods, and outcomes of cooperative learning. Next, the researcher expressed the attitudes, attitudes towards science, and outcomes of attitudes towards science. Finally, the researcher finished the literature review with the explanation of education in Saudi Arabia by giving the general background, policy and philosophy of education in Saudi Arabia, secondary education, and science education in Saudi Arabia.
CHAPTER III
METHODOLOGY

Introduction

This study investigated the impact of Jigsaw as a cooperative learning strategy in terms of high school students’ achievement and attitudes toward science in Saudi Arabia. A quasi-experimental design was applied with two groups of student participants: an experimental group and a control group. Students studied biodiversity and conservation for four weeks. An achievement test and an attitude assessment were administered to determine how much the students learned and whether their attitudes toward science had changed.

This chapter explains the study settings, the research sample, the research design, the instructional approaches, the instructional materials, the data collection and the analysis in detail. The following research question guided the study: What is the impact of using Jigsaw as a cooperative learning instructional strategy in Saudi high school science classroom on male students’ achievement and attitude towards science?

Research Setting

The setting for this study was two environmental science classes in one of the public schools in Al Baha, Saudi Arabia. The school was similar to most schools in Saudi Arabia with classrooms, a technology center, laboratories, and a library. The school had six 10th-grade classes, six 11th-grade classes, and six 12th-grade classes with
approximately 25 students in each class. The total number of students was 450. The students participating in research study were in the eleventh grade. The researcher had not met the students before the study started. All students in the study were boys because of the separation between boys and girls in Saudi Arabian schools. The accessible sample was 50 Muslim boys in the eleventh grade. All of the students spoke Arabic and studied in a public school. The students’ average age was 17 years.

Sample

To determine the sample size and the statistical power for a research study, Cohen (1992) has stated that statistical power analysis exploits the relationships among the four variables involved in statistical inference: sample size, significance criterion, population effect size, and statistical power. However, statistical power analysis is most useful for determining the $N$ value needed for a specified power and a given significance criterion and effect size. According to Gall and Borg (2007), the term statistical power refers to the probability that a particular test of statistical significance will lead to rejection of a false null hypothesis.

To determine the $N$ value, Cohen (1992) used a table that shows the $N$ value for a small, medium, and large effect size at a power of 0.80 when the significance value is .05. To detect large differences between two independent sample means at significance of .05, each group needed an $N$ value of 26. Because the study was conducted under fixed conditions, it was not possible to change the number of students in each classroom to have the same number of students as Cohen stipulated. In this study, 25 students were in each classroom.
Research Design

The study applied a quasi-experimental design to answer the research questions:

1. What is the impact of Jigsaw on the achievement of Saudi Arabian male high school science students?
2. What is the impact of Jigsaw on the attitudes of Saudi Arabian male high school science students, specifically their attitude toward scientific inquiry, adoption of scientific attitudes, and enjoyment of science lessons?

According to Gall and Borg (2007), a quasi-experimental design is often used in educational research when random assignment is not possible or practical, such as in this study. The class structure and the students existed before the study began, making the random selection of individual students for the experimental group and the control group impossible. Therefore, a nonequivalent control group pre-test – post-test design was used as shown below:

Group 1: \( O_1 \ast O_2 \ O_3 \)
Group 2: \( O_1 \ O_2 \ O_3 \)

Where \( O_1 \) is the pre-test, \( O_2 \) is the post-test, \( O_3 \) is the follow-up test, and \( \ast \) is the treatment. In this study, 25 students were in each of two similar classrooms: one for the experimental group and one for the control group. On the first day of the study, the students in each classroom were numbered randomly and divided into two groups. Each randomly assigned group had 25 students. Students remained in their assigned group for the duration of the experiment, including three assessment points.

Two pre-tests were administered: one to measure achievement and one to gauge students’ attitudes toward science. Next, two different teaching methods were
implemented. Jigsaw was used with the experimental group, while traditional instructional strategies were used with the control group. After both groups received instruction in the subject matter, a post-test to measure students’ achievement and a post-test to gauge students’ attitudes toward science were administered. Three weeks after the last day of instruction, a follow-up test (i.e. a deferred test) was administered to determine whether the students’ achievement and attitudes toward science had changed or remained the same. Finally, the variables listed in the data analysis section of this chapter were compared.

Research Design Plan

![Research Design Plan](image)

*Figure 3.1. Research design plan for experimental group and control group from start of study to comparison of results.*
Instructional Approaches

The science classes were designed to provide the students with opportunities to read and research information about biodiversity and conservation. Students in both groups studied a chapter on biodiversity and conservation, with one group using Jigsaw and the other group using a traditional learning method. The students attended four 50-minute periods each week.

Students in both groups studied the biodiversity and conservation chapter either by traditional learning method or Jigsaw as a cooperative learning strategy, which would be associated with some extended activities. During the study time, students spent time each day silently reading the material the researcher had provided. The students worked as the researcher gave instruction. In addition, several short quizzes were given to assess what the students had learned.

After the fourth week of teaching, the students’ achievement in the subject matter and their attitudes toward science were assessed. Afterward, the researcher guided the students through the course material, activities, quizzes, and side discussions and administered a final exam. Students also had been encouraged to search for and read online resources and to visit the school library to find relevant materials and additional resources to enhance their independent learning. In the classroom, the students used the same information in group activities and worked cooperatively in workshops.

Jigsaw. Students in the experimental group used the cooperative learning method known as Jigsaw. Aronson, Blaney, Stephan, Sikes, and Snapp (1978) are proponents of Jigsaw. Each student was assigned to a five- or six-member group and given a section of academic material that the whole group would be studying. The students studied their
assigned sections to become experts in the specific content area. Each group included one expert for each section of the material. The experts later returned to their original groups and taught the information to the other team members.

Finally, all group members were quizzed on the entire subject. The quiz score contributed to individual grades and to group scores. With Jigsaw, each individual’s performance contributes directly to the performance of the other group members; however, because each member’s positive behavior contributes to the rewards of the other group members, Jigsaw constitutes cooperative learning. In this study, the Jigsaw groups were rewarded based on their performance because it was seen as a way to enhance the students’ motivation.

According to Lin (2006), Jigsaw works well in a biology class when the teacher’s objective is for students to understand the relationships between factors that can affect the body or the environment. All of the students read their assigned topic and met with other students assigned the same topic to discuss, clarify, and summarize the main ideas in writing. Textbooks and other reference materials were provided to each group. The teacher circulated among the groups to facilitate student comprehension of more difficult concepts. After becoming experts about their topic, students returned to their home groups. Each member explained the main ideas that they had learned in their expert groups. Either individual quizzes or group quizzes were given after the information had been shared in the home groups.

Roles in Jigsaw cooperative learning. Students in Jigsaw groups are assigned to at least one role. The assignment of specific roles and responsibilities is one of the most important steps in the cooperative-learning process (Aronson, 1978). Giving students
different roles and responsibilities and the circulation of those roles enables students to sharpen their skills in a variety of areas. In this study, each group consisted of five students. Each student had a specific role from the list of roles described below:

1. Leader: This person’s task was to manage the group and ensure that the members fulfilled their roles in a timely manner.
2. Recorder: This person’s task was to record the group’s answers, discussions, and outcomes. The notes were compiled as plain text or in the form of graphics such as word webs or mind maps.
3. Reader and Observer: This person’s tasks were to read the instructions or other information orally to the group in addition to observing and noting the group dynamics for better group functioning in the future.
4. Reporter (or Spokesperson): This person’s task was to report the group’s conclusions to the group and to the entire class.
5. Checker: This person’s task was to ensure that each member understood the content and could explain explicitly how the conclusions or solutions were derived.

Formation of Jigsaw groups. In this study, students were divided into five five-member groups. As shown in Figure 3.2, Jigsaw involves three phases. In Phase 1, all of the students meet in their assigned home group and give their group a name. Next, each student chooses a role in the home group and recognizes the other group members. In Phase 2, the students move to the expert groups to study a specific theme or content and choose a role to play in their expert group. In Phase 3, the students return to their home groups to teach one another what they have learned in the expert groups and distribute all
written information collected. For ease in distinguishing the home group in Phase 1 from
the home group in Phase 3, it is convenient to refer to home group in Phase 1 as “home
group 1” and the home group in Phase 3 “home group 2.” The roles of students in home
group 1 and home group 2 are the same.

Figure 3.2. The Jigsaw instructional process. The process involves three phases: home
groups, expert groups, and return to home groups.

Experience with cooperative learning. The researcher worked as a lecturer in the
Department of Curriculum and Instruction at Al Baha University in Saudi Arabia and
taught new teachers how to teach science and supervised teacher candidates in schools.
The researcher has taken many workshops on how to teach cooperative learning and how
to use other instructional methods. The researcher’s lectures typically involved multiple
instructional methods because the approach was deemed to be the most appropriate way
to teach students at the college level. Jigsaw was used as a cooperative-learning strategy because it was doable, efficient, and easy for students to apply to their future job.

Instructional Materials

The instructional materials for this study included a textbook, worksheets, and weekly quizzes. The textbook used was *Environmental Science* (Obekan, 2013). It is the standardized book for all Saudi Arabian students and was developed by a group of specialists in the Ministry of Education. Some parts of this book are Arabic translations from *Biology*, a McGraw-Hill publication (Biggs et al., 2009). The *Environmental Science* textbook has five chapters and includes pictures, graphs, and activities. For this study, Chapter 4 was used.

In addition to *Environmental Science*, the Ministry of Education has distributed another book called *Directory of Scientific Experiments* (Obekan, 2013). All of the activities and worksheets used to teach Chapter 4 were from *Directory of Scientific Experiments*. The experiments in Obekan (2013) are projects for multiple class periods. The experiments therefore were broken into smaller parts to fit the study’s 50-minute class period. Students in both the experimental group and the control groups were able to conduct the experiments associated with Chapter 4.

The weekly quizzes also were taken from *Environmental Science* (Obekan, 2013). At the end of each chapter, several assessment questions are given for each topic in the chapter. Questions selected from those provided in the textbook were used for the overall assessments later and to quiz students weekly to measure comprehension and understanding. The questions were of four types: multiple choice, short answer, open-
ended, and critical thinking. The same questions were used for both the experimental group and the control group.

Data Collection

This section discusses the data collected to answer the research questions. The data for this study were collected from two instruments: an achievement test and a scale of attitudes toward science. Both instruments included a pre-test, a post-test, and a follow-up (deferred) test.

*Achievement test.* A pre-test, a post-test, and follow-up test were administered to measure the students’ comprehension. The pre-test occurred before instruction and the post-test after instruction. The follow-up test administered three weeks after the last day of instruction. The results of the three tests were considered to be measures of the students’ knowledge about biodiversity and conservation at the time the tests were administered. The pre-test results supported the intention of using Jigsaw meet students’ needs, while the post-test indicated the students’ progress or struggles. The results of follow-up test indicated how much information students had retained since the instruction ended.

To measure the students’ achievement before and after instruction, an achievement test of biodiversity and conservation designed by Al Waily (2014) was used for this study. The achievement test consisted of 30 items. Test items included true-or-false and multiple-choice questions. The highest possible total score was 30. The test was timed, and students had 35 minutes to complete it. The test was designed to measure three Bloom’s taxonomy levels of objectives: knowledge, comprehension, and analysis. Thirty percent of the questions (9 questions) measured knowledge, 47% of the questions
(14 questions) measured comprehension, and 23% of the questions (7 questions) measured analytical ability.

According to Al Waily (2014), the achievement test has a high degree of reliability. Al Waily used Cronbach’s alpha to measure the reliability of each of the three Bloom’s taxonomy levels of objectives (i.e., knowledge, comprehension, and analysis) that were used in the current study as stated below in Table 3.1.

<table>
<thead>
<tr>
<th>Bloom’s Taxonomy Objective</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>0.94</td>
</tr>
<tr>
<td>Comprehension</td>
<td>0.93</td>
</tr>
<tr>
<td>Analysis</td>
<td>0.91</td>
</tr>
<tr>
<td>Total of all levels</td>
<td>0.93</td>
</tr>
</tbody>
</table>

Also in his efforts to ensure a high level of reliability, Al Waily (2014) calculated a split-half correlation coefficient (i.e., the coefficient of internal consistency) and then measured the correlation between the two halves of the test by using Spearman’s correlation. The total value of Spearman’s correlation was 0.86 for all three levels of objectives, which indicates a high level of reliability. To validate the results, Waily presented the test to several specialists in the subject matter and asked them to give their opinions about the clarity of the questions, the appropriateness of the questions to the objectives to be measured, the extent to which the questions covered the three Bloom’s taxonomy objectives, and whether any changes or additions were needed. The biodiversity and conservation test was deemed reliable and valid; therefore, the test was used to measure the students’ achievement at three assessment points.

*Attitudes towards science scale.* To determine the study participants’ attitudes toward science, a published scale was used. One of the best attitude scales is the Test of

According to Fraser (1981), TOSRA is designed to measure secondary school students’ attitudes toward science. The theoretical basis for TOSRA came from the categories that Klopfer (1971) developed for the attitudinal domain in the field of science education. According to Fraser (1978), “Initially, there were five subscales of first developed TOSRA. Then, two new subscales i.e. Normality of Scientists and Career Interest in Science were added” (p. 1). The seven subscales of TOSRA are Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science (Fraser, 1981, p. 1).

According to Fraser (1981), TOSRA uses a 5-point Likert response scale (i.e., 1 = strongly agree, 2 = agree, 3 = uncertain, 4 = disagree, 5 = strongly disagree) with which most respondents are familiar. One of the issues that researchers should consider when deciding whether to use TOSRA or not, is its length. According to Fraser (1978):

Using 70 items of TOSRA in full may be too excessive for informal science evaluations. However, TOSRA also has been subdivided into subscales. Each one measures a different aspect of science attitudes and interests and can be used alone. Each one of these subscales have [sic] ten items, which may be much more suitable for a brief evaluation. (p. 2)

These subscales include Social Implications of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science.

Fraser (1981) added:

Because the subscales have been separately validated, researchers may use all TOSRA components or some of them as needed. One or more of these separate
subscales may be useful for evaluators as they may relate more closely to a particular informal science project as my intention in this study. (p. 3).

Also according to Fraser (1981):

The final form of TOSRA was obtained after refining preliminary versions in two successive stages. The first stage involved modifying a pool of items in the light of reactions solicited from a group of science teachers and experts in educational measurement. The second stage involved the field-testing of a version of TOSRA containing 14 items per scale and the subsequent use of the item analysis techniques described in Fraser (1977) to reduce the length of each scale to 10 items. (p. 3)

Fraser (1981) continued:

The internal consistency reliability (the extent to which items in a given scale measure the same attitude) was estimated for TOSRA scales using the Cronbach’s coefficient. Reliability coefficient ranged from 0.66 to 0.93 with a mean of 0.82 for the Year 7 sample, from 0.64 to 0.93 with a mean of 0.80 for the Year 8 sample, from 0.69 to 0.92 with a mean of 0.81 for the Year 9 sample, and from 0.67 to 0.93 with a mean of 0.84 for the Year 10 sample. These values for the reliability coefficient are generally high for scales whose length is only 10 items, and all values are large enough to indicate that each TOSRA scale had quite good internal consistency reliability at each level. (p. 4)

In addition to internal consistency reliability coefficients, Fraser estimated the test-retest reliability of the TOSRA scale. According to Fraser (1981):

The calculations were based on data from a sub-sample of 238 students comprising the Year 8 and Year 9 classes in four of the schools (two coeducational government high schools, one independent Catholic girls school and one independent non-Catholic boys school) in the original sample. These students responded to TOSRA a second time approximately two weeks after the first administration. (p. 4)

Fraser further noted that the test-retest coefficients ranged from 0.69 to 0.84 with a mean of 0.78, thus indicating that all TOSRA scales displayed quite good test-retest reliability.
Table 3.2 *Internal Consistency and Test-Retest Reliability for Overall Scale*

<table>
<thead>
<tr>
<th>Reliability Approach Reported in the Instrument</th>
<th>Value of Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal consistency (Cronbach’s alpha)</td>
<td>0.82</td>
</tr>
<tr>
<td>Test-retest</td>
<td>0.78</td>
</tr>
</tbody>
</table>

Using TOSRA in Current Study

To collect quantitative data that reflected the students’ attitudes toward science in the current study, TOSRA was modified to include only three of the instrument’s seven subscales were used: Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, and Enjoyment of Science Lessons. These subscales were selected because they contained items that most directly addressed the need to identify the attitudes that students in the experimental group had developed after being taught with the Jigsaw cooperative-learning method. Alharbi (2012) used these same subscales to measure Saudi Arabian students’ attitudes toward science.

According to Alharbi (2012), his study focused on the results from the three most reliable TOSRA subscales: Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, and Enjoyment of Science Lessons. The subscales were not only to understand which factors shape students’ attitudes toward science, but also to highlight the causes of students’ negative attitudes toward science. Such subscales were also implemented in this study to measure the attitudes of the students towards science.

The internal consistency and test-retest reliability values for the three subscales that Alharbi (2012) used in his research are shown in Table 3.3. The acceptable consistency of reliability values ranged from 0.70 to 0.92. Alharbi (2012) stated that according to Mcmillan and Schumacher (1993), the acceptable range for most
instruments used in exploratory research is 0.70 to 0.90. The test-retest reliability ranged from 0.75 to 0.79.

Table 3.3 *Internal Consistency and Test-Retest Reliability for Three TOSRA Subscales*

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Internal Consistency (Alpha coefficient)</th>
<th>Test-Retest Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude to scientific inquiry</td>
<td>0.82</td>
<td>0.79</td>
</tr>
<tr>
<td>Adoption of scientific attitude</td>
<td>0.70</td>
<td>0.75</td>
</tr>
<tr>
<td>Enjoyment of science lessons</td>
<td>0.92</td>
<td>0.78</td>
</tr>
</tbody>
</table>

*Note: TOSRA = Test of Science Related Attitudes.*

Alharbi (2012) translated TOSRA into Arabic to make it easier for respondents to understand, though the content remained the same. In his efforts to validate TOSRA in the Arabic language version, Alharbi administered the scale to 20 participants. The Cronbach’s alpha coefficient was used to assess the internal consistency reliability of the scales and to obtain evidence that could be used to support the validity of the instrument. The internal consistency was determined on the 30 items in TOSRA representing students’ attitudes toward science and was found to be 0.67. This value aligned with the values of the internal consistency reliability for TOSRA that has been reported by Fraser (1977), when the range was between 0.69 and 0.84.

Data Analysis

The quantitative method of research was used to present the results of current study. The quantitative data were analyzed statistically with the aid of the Statistical Packages for Social Science (SPSS) software. The data were studied individually and as a group.

Repeated measure analysis and multivariate analysis based on the sphericity assumption were used for this study. According to Krueger and Tian (2004), the repeated measures ANOVA is used to compare group means on a dependent variable across
repeated measurements of time. Time often is referred to as the within-subjects factor, whereas a fixed, or non-changing, variable (e.g., gender) is referred to as the between-subjects factor (Huck, 1974). Repeated measure analysis helps researchers to measure the same subject over time or under different conditions. Moreover, repeated measure designs allow researchers to monitor how participants change over time in both long-term and short-term situations. The current study used Cronbach’s alpha (to gauge internal consistency), split-half methodology (to gauge reliability), and a test of normality (to test whether the underlying distribution is normal) to analyze the collected data. Other tools used to analyze the data are discussed in Chapter IV.

Table 3.4 *Structure of Data Analysis for Hypotheses 1 and 2*

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Assessment</th>
<th>Group</th>
<th>Analysis Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis 1: Achievement test</td>
<td>Pre-test, post-test, and follow-up test</td>
<td>Experimental and control</td>
<td>Multivariate</td>
</tr>
<tr>
<td>Hypothesis 2: Attitude toward science (overall)</td>
<td>Pre-test, post-test, and follow-up test</td>
<td>Experimental and control</td>
<td>Repeated measure</td>
</tr>
<tr>
<td>Hypothesis 2a: Attitude to scientific inquiry</td>
<td>Pre-test, post-test, and follow-up test</td>
<td>Experimental and control</td>
<td>Multivariate</td>
</tr>
<tr>
<td>Hypothesis 2b: Adoption of scientific attitude</td>
<td>Pre-test, post-test, and follow-up test</td>
<td>Experimental and control</td>
<td>Repeated measure</td>
</tr>
<tr>
<td>Hypothesis 2c: Enjoyment of science lessons</td>
<td>Pre-test, post-test, and follow-up test</td>
<td>Experimental and control</td>
<td>Multivariate</td>
</tr>
</tbody>
</table>

Internal and External Validity

Validity describes the degree to which a research study measures what it intends to measure. In experimental research, there are two types of validity: internal and
external. Internal validity refers to the validity of the measurement and the test itself, while external validity refers to the ability to generalize the findings to the target population. According to Gall and Borg (2007), internal validity is the extent to which variables other than the treatment variable provides reasonable explanations of the experimental results; external validity is the extent to which the experimental findings can be generalized to other cases. Both types of validity are important when analyzing the appropriateness, meaningfulness, and usefulness of a research study; however, a variety of factors can affect both types of validity. Some of these factors are discussed below as they pertain to the current study.

Internal validity. Concerns arose about internal validity as it relates to the implementation of the study. According to Gall and Borg (2007), many “threats” can affect internal validity, including history, testing, and experiment implementation.

History. This threat arose because other events occurred during the month that students received their classroom instruction. For example, the timeline of the study meant that the classroom instruction lasted for only one month in one of the two participating schools. This factor, however, is a minor issue given the short duration of the study.

Testing. This threat arose because the pre-test allowed the students to see the test questions that also would be used for the post-test at the end of the instruction period. After three more weeks, the follow-up test with the same questions was administered. Because the questions were the same on all of the tests, improvement in the students’ test scores could be the result of the students’ growing familiarity with the test questions, starting with the pre-test. The issue, however, was unavoidable, and the month spent
studying biodiversity and conservation materials likely minimized the effect of pre-testing.

*Experiment implementation.* According to Gall and Borg (2007):

Despite a good research design, the implementation of the experiment can affect the scores on the dependent variable in a way that does not reflect the treatment. This may cause a change in the scores on the dependent variable for either the treatment group or the control group. (p. 175).

In the current study, the researcher led the teaching process for both groups, thereby minimizing the effects of the experiment-implementation threat.

*External validity.* A number of threats also can affect external validity, including population validity and ecological validity (Gall and Borg, 2007).

*Population validity.* Population validity describes the extent to which a researcher can generalize the experimental group to the larger population. In general, the more representative the experimental group, the more confidence one can have in generalizing the sample to the population. In the current study, the researcher had a specific and experimentally accessible population. Moreover, the sample was intentional. The population-validity threat, therefore, was an external threat to the study.

*Ecological validity.* The ecological-validity threat is comprised of two effects: the Hawthorne effect and the experimenter effect. The Hawthorne effect arose in the current study when the students became aware of their participation in the study, when they became aware of the hypothesis, and when they received special attention that improved their performance. For example, the experimental group received special attention because the Jigsaw cooperative-learning instructional strategy was used rather than the traditional instructional method used with the control group. The second ecological-validity threat, experimenter effect, occurs when the treatment becomes effective or
ineffective because of the particular experimenter or the particular person who administers the treatment. The experimenter effect arose in the current study because the researcher led the instruction for both the experimental group and the control group.

Research Plan

Activities for the experimental group and the control group during each week of the study are summarized in Table 3.5.

Table 3.5 Research Plan Activities for Experimental Group and Control Group, by Week and Subject-Matter Topic

<table>
<thead>
<tr>
<th>Week</th>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The researcher meets with students in the experimental group and explains the project goals and the type of instruction to be use. The researcher administers the achievement pre-test followed by the scale of attitudes toward science. Students participate in an ice-breaker and other activities, followed by assignment to Jigsaw cooperative-learning groups. The researcher gives an example of cooperative learning, and students complete graphic organizers pertaining to the cooperative-learning example. Students present the final results of the example lesson.</td>
<td>The researcher meets with students in the control group and explains the project goals and the type of instruction to be use. The researcher administers the achievement pre-test followed by the scale of attitudes toward science. Students participate in an ice-breaker and other activities. The researcher introduces the topic: biodiversity and conservation. The researcher continues to discuss biodiversity and conservation. Students are assigned worksheets to complete.</td>
</tr>
<tr>
<td>2</td>
<td>The researcher tells students that the title of topic 1 is introduction to biodiversity and conservation, The researcher refreshes the students’ knowledge about the subject. The researcher covers the following subtopics: communities and genetic diversity, the importance of biodiversity, and the direct and indirect economic value of biodiversity. Students answer questions 6 and 7 from the assigned textbook as a</td>
<td>The researcher reviews the lecture from last week, checks the students’ completed worksheets. The researcher continues to lecture about the importance of biodiversity and begins talking about the direct and indirect economic value of biodiversity. Students answer questions 6 and 7 from the assigned textbook as a</td>
</tr>
</tbody>
</table>
indirect economic value of biodiversity.

Students work in home groups using graphic organizers.

Students move to the experts groups, with the researcher working with each group.

Students return to their home groups to teach one another.

Students summarize the information and present their findings to the whole class.

The researcher assesses the students’ knowledge on the topic studied.

The researcher tells students that the title of topic 2 is threats to biodiversity.

The researcher covers the following subtopics: extinction rates and factors that threaten biodiversity (pollution, overexploitation, habitat loss, fragmentation of habitat, introduced species)

Students work in home groups using graphic organizers.

Students move to the experts groups, with the researcher working with each group.

Students return to their home groups to teach one another.

Students summarize the information and present their findings to the whole class.

The researcher assesses the students’ knowledge on the topic studied.

The researcher tells students that the title of topic 3 is conserving biodiversity.

The researcher reviews vocabulary words with the students.

The researcher begins lecturing
The researcher tells students that the subtopics are natural resources (renewable resources, nonrenewable resources, and sustainability), protecting biodiversity (protecting areas inside Saudi Arabia, international protected areas, biodiversity hot spots, and corridors between habitat fragments), and restoring ecosystems (bioremediation and biological augmentation).

Students move to the experts groups, with the researcher working with each group.

Students return to their home groups to teach one another.

Students summarize the information and present their findings to the whole class.

The researcher reviews all of the information covered in weeks 1 through 4.

The researcher assesses the students’ knowledge on the topic studied in week 4.

The researcher rewards the best-performing groups and those who scored highest on the quizzes over the four weeks.

<table>
<thead>
<tr>
<th></th>
<th>The researcher administers the achievement post-test and the scale of attitudes toward science on the first day of the week.</th>
<th>The researcher administers the achievement post-test and the scale of attitudes toward science on the first day of the week.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>No meeting</td>
<td>No meeting</td>
</tr>
<tr>
<td>7</td>
<td>The researcher administers the achievement follow-up test and the scale of attitudes toward science on the last day of the week.</td>
<td>The researcher administers the achievement follow-up test and the scale of attitudes toward science on the last day of the week.</td>
</tr>
</tbody>
</table>
Study Planning

Preparation

The researcher prepared the materials needed for implementing the study, including a letter from the College of Education at Al Baha University to the school district participating in the study and a letter from the school district to the school where the study will take place. The two letters are the only legal documents that a researcher needs to have to conduct studies in Saudi Arabia. In Saudi Arabia, approval from a human-subjects committee and parent consent forms are not required. After the school district reviewed all of the study materials, the researcher received the permission to conduct the study.

Implementation

Implementation of the study at Al Sarwat high school began on July 11, 2016. On the first day of the study, the researcher gathered all the students from two 11th-grade science classrooms to randomly assign students to either the experimental group or the control group.

After the groups were determined, the researcher started planning the schedule for each group. The schedule included an opening lecture about the project, forming the experimental group’s Jigsaw cooperative-learning groups, conducting an ice-break activity, discussing an example of Jigsaw as a cooperative-learning strategy, and administering the achievement pre-test, post-test, and follow-up test. The researcher made the schedule based on four 50-minute periods a week from Monday through Thursday.
Classroom Schedules and Activities

To more easily discuss the classroom schedules and activities for both the experimental group and the control group, a naming convention was devised in which numbers are used to indicate weeks, and letters are used to indicate days. For example, the first day of the first week would be written as W1 (a). The study was conducted over seven weeks (W1 to W7), and each week had four days (a, b, c, and d). In addition, the following terms are used: *home group 1 (HG1)* refers to the original group at the beginning of the process, *experts group* refers to the break-out research groups, and *home group 2 (HG2)* refers to the group to which students return after completing work in the experts groups.

*Experimental-group general instructions.* The researcher started with the experimental group in W1 (a) by introducing himself to the students and talking about the importance of conducting such studies to improve the field of education in Saudi Arabia. The researcher then explained the role of students in the experimental group and how they will study the topic of biodiversity and conservation in Chapter 4 of the assigned textbook. Next, the researcher administered the achievement pre-test and the scale of attitudes toward science.

In W1 (b), the researcher explained the materials associated with the study and then had the students participate in an ice-breaking activity. Next, the researcher had the students engage in activities that would lead to the assignment of students to cooperative-learning groups and enable the researcher to learn about the students’ abilities and personalities.
In W1 (c), the researcher explained and gave an example of Jigsaw as a cooperative-learning strategy. During the class period, the students worked individually in their groups for about 10 minutes, writing on a provided worksheet what they know about the topic and what they want to know about the topic. Next, the researcher provided the students with worksheets for experts-groups work. The students worked together for 20 minutes to determine how to answer the questions on the worksheets and select the main ideas of the content for each topic presented. Each group member was provided with color-coded folder to organize daily notes, cooperation guides, and other information gathered during the cooperative-learning class.

After about 30 minutes, the students had completed the study materials and were ready to return to their home groups (HG2) to teach the other students what they have learned. Students spent the remaining 15 minutes of class teaching each other about what they had learned in their experts groups and completing the group worksheets to be discussed the next day. In W1 (d), the students met in their home groups, where each student was assigned a specific and unique role. The following roles were distributed among the five students in each group:

- Leader: This person’s task was to manage the group and ensure that the members fulfilled their roles in a timely manner.

- Recorder: This person’s task was to record the group’s answers, discussions, and outcomes. The notes were to be compiled as plain text or in the form of graphics such as word webs or mind maps.

- Reader and Observer: This person’s tasks were to read the instructions or other information orally to the group in addition to observing and noting the group
dynamics for better group functioning in the future.

- Reporter (or Spokesperson): This person’s task was to report the group’s conclusions to the group and to the entire class.
- Checker: This person’s task was to ensure that each member understood the content and could explain explicitly how the conclusions or solutions were derived.

The students talked about their roles and then spent 10 minutes making sure that everyone fully understood the information about the topic studied. Combined with the 15 minutes of discussion on day (e), the students spent a total of 25 minutes discussing the topic. Next, the groups shared and discussed the information with the researcher. Each group presented the members’ work to the whole class. During the last 10 minutes of class, the researcher tested the students’ knowledge about the topic studied. This process was repeated for each topic on biodiversity and conservation included in Chapter 4 of the assigned textbook.

*Experimental-group rewards system.* The rewards system for this study was based on the work of the whole group rather than on any one person’s work. Rewards were presented at the end of W4 rather than after the completion of each topic; however, students made nominations individually each week for the best group presentation. Students wrote their choice on a small sheet of paper and gave the ballots to the researcher. The researcher calculated the votes and presented the results each week.

Another factor used in determining the group winner was each group’s total score on the weekly quizzes. Sometimes the winner of the group-presentation vote was not the same as the group that had the best score on the weekly quiz. Usually, the researcher
wrote the name of the each week’s winning group on the honor plate in the classroom to encourage all students to work harder so their group could be the winner at the end of the next topic. The researcher referred to the winning groups frequently to motivate all of the students. At the end of W4, the researcher gave all of the winning groups a list of rewards from which they could select what they wanted. The rewards were in three categories: personal prizes (e.g., pens, study materials), general prizes for the classroom needs (e.g., clock, bookshelf, first-aid kit), and donations to help students with disabilities. After the achievement post-test, the researcher honored all winning groups and gave them their rewards.

*Control-group general instructions.* The researcher started on W1 (a) with the control group the same way he did with the experimental group by introducing himself to the students and talking about the importance of conducting such studies to improve the field of education in Saudi Arabia. The researcher then explained the role of students in the control group and how they will study the topic of biodiversity and conservation in Chapter 4 of the assigned textbook. Next, the researcher administered the achievement pre-test and the scale of attitudes toward science.

In W1 (b), the researcher explained the materials associated with the study and then had the students participate in an ice-breaking activity. Next, the researcher had the students engage in activities that would enable the researcher to learn about the students’ abilities and personalities.

In W1 (c), students began studying the content in Chapter 4 of the assigned textbook. During class time, the students also worked individually for about 15 minutes to complete the study worksheets that were provided to them. The researcher usually
lectured for 20 minutes to 30 minutes and led class discussions about the content topic for the week. Students spent the remaining time either completing worksheets or taking a quiz on the instructional content for the day.

In W2, W3, and W4, the researcher continued to use the traditional lecture method of instruction. Students worked individually for most of the course time. Students worked in groups in some cases, such as when a textbook activity required a joint effort. Students were tested and graded in the regular manner without additional rewards. The researcher used the school’s educational resources room, library, and laboratory and field studies as needed. The researcher administered the achievement post-test and the scale of attitudes toward science after the final instructional period. Three weeks later, the researcher administered the achievement follow-up test and the scale of attitudes toward science.

Weekly Course Planning

Experimental Group

*Week 1.* The researcher started W1 (a) by introducing himself to the students and talking about the importance of conducting such studies to improve the field of education in Saudi Arabia. Next, the researcher reviewed the plan for implementing the study with the experimental group, including three achievement assessments (pre-test, post-test, and follow-up test) and three assessments of attitudes toward science. Then the researcher administered the achievement pre-test and the scale of attitudes toward science.

On W1 (b), the students participated in an ice-breaking activity to ensure their cooperation and interaction during the study. The researcher implemented an activity called Tall Tower Challenge, which focuses on the construction and structure of tall
buildings. For this activity, the students worked in groups of five randomly selected members per group. The random-selection process involved having the students count off from one to five, starting over on every sixth person until each student had the number one, two, three, four, or five. Like-numbered students formed each group. The group activity involved putting symmetrical numbers together in the same group to develop the tallest tower with limited materials to support the weight of a golf ball for two minutes or longer. Students had to develop a design, build the tower, test and present their work on the tower to their classmates. The students also were asked to compare the towers for what worked and what went wrong and to find ways they can use to strengthen their group’s tower. In general, the students were excited to participate in the activity. At the end of the class period, one group succeeded by building the tallest and strongest tower (51 cm) that could support the weight of a golf ball for two minutes.

On W1 (c), the researcher began by giving an example of cooperative learning and referring to the Jigsaw method for classroom instruction. Next, the first subject for study was selected. Afterward, the count-off method was used to randomly assign students to their home groups. Each group had five students, with each student serving in a different role: leader, recorder, reader and observer, reporter/spokesperson, and checker. The researcher spent about 10 minutes discussing the group-member roles.

Next, the researcher explained how to use a graphic organizer known as a K-W-L chart, which designed to assist students in the learning process (Ogle, 1986) and refers to what students know, what they want to know, and what they have learned. The researcher modified the chart so that all sections of the chart were on one sheet of paper, making it easier for students to carry and keep with them during the learning process. The purpose
of K section of the chart is intended to help students recall their knowledge and experiences related to a particular topic. The W section is designed to help students arrange what they want or need to know to complete a task or to solve a problem. The L section is designed to help students review their knowledge at the end of a learning session. Only one student, who came from a different city, had used a K-W-L chart before now.

The researcher then gave an example lesson of cooperative learning with themes such as ecosystem interactions and community interactions and topics such as competition, predation, symbiosis, mutualism, commensalism, and parasitism. On days (c) and (d) of W1, students continued to use the school’s resources to individually research their assigned topic. Students also worked in their experts groups to generate common understanding of the lesson’s themes. The researcher’s role in this process was to facilitate student learning by observing the students in their groups and ensuring that they interact with other members of the group and participate in the learning process. The researcher also spent time guiding the students through the cooperative-learning process and answering the students’ questions.

When the students returned to their home group 2, they discussed the themes that had been studied in the experts groups, and they demonstrated every concept to the whole group. The students presented their work by drawing pictures and illustrations in addition to completing a K-W-L chart. At the end of the lesson, the researcher asked students to cooperatively answer some questions to assess their understanding of the themes that has been studied. Overall, the students showed great enthusiasm about the cooperative-learning group work and were ready to start the research study.
Week 2. On W2 (a), the researcher started working with students on the first lesson of biodiversity and conservation chapter in the assigned textbook. The students remained in their W1 groups with the same cooperative-learning roles. The researcher kept the groups and roles the same so the students to continue to build relationships and trust among the members and work cooperatively on the new lesson. Also on day (a), the researcher gave each group color-coded folders to use for organizing their daily notes and activities.

The researcher led a class discussion about what does biodiversity and conservation mean, wrote the main objectives of the lesson on the chalkboard before discussing them, and defined some new vocabulary words. After that, the researcher asked the students to work go to their home group 1, work on the K-W-L chart for the lesson, divide the lesson topics among themselves, and go the appropriate experts group to study the assigned topic all within a well-designed time frame. The researcher observed and monitored the students’ work and negotiations about the themes that would be studied under the main topic. The students fully understood their roles and what the researcher was expecting from them in the home groups and in the experts groups.

The researcher ensured that all of the five groups would have an equal amount of class work and activities by splitting the topics equally among the groups. Students worked on the following themes in W2: biodiversity and communities, genetic diversity, species diversity, ecosystem diversity, importance of biodiversity, and direct and indirect economic value of biodiversity.

On W2 (d), the students presented their work during the first 40 minutes of the class. The last 10 minutes of class was spent taking a short quiz to measure the students’
understanding of the lesson material followed by student nominations for the best group presentation and announcement of the quiz scores. The winners would receive a reward at the end of the session on day (d).

**Week 3.** In W3, the researcher repeated the process used in W2 but with a new topic: threats to biodiversity. Students studied the following themes: extinction rates and factors that threaten biodiversity (pollution, overexploitation, habitat loss, fragmentation of habitat, and introduced species).

On W3 (a), the students started working on the extinction-rated theme in their home groups. They were directed to work first on their K-W-L chart and then move to the experts groups. Each experts group discussed the extinction rates during a different time period and for different species as shown in two tables and an appendix in the assigned textbook. On days (b) and (c), the students studied five factors that threaten biodiversity, with each experts group responsible for one of five factors. In the second half of day (c), the students returned to their home group where they taught one another what they had learned and completed their K-W-L chart. On day (d), the students worked on their presentations and later in the class period gave their presentations to the whole class. Next, the researcher assessed the students’ knowledge and progress by having them take a short quiz. Each student took the quiz individually. Again, the students made their nominations for best group presentation, and the winning quiz scores were announced. The winners would receive a reward at the end of the session on W4 (d).

**Week 4.** In W4, the researcher repeated the process used during W2 and W3 but with a new topic: conserving biodiversity. Students studied the following themes: natural resources (renewable resources, nonrenewable resources, and sustainability), protecting
biodiversity (protecting areas inside Saudi Arabia, international protected areas, biodiversity hot spots, and corridors between habitat fragments), and restoring ecosystems (bioremediation and biological augmentation).

The students were directed to work on the K-W-L chart in their home group and then move to the experts groups. The students later returned to their home groups to teach one another and discuss the information gathered by the experts groups. On day (b), the students returned again to their home group to teach one another and work on their K-W-L chart.

On day (c), the students began the final lesson: restoring ecosystems. Themes included bioremediation and biological augmentation. The students worked on the K-W-L chart in their home group and then moved to the experts groups to discuss the lesson’s themes. Later, they returned to their home group to teach one another and to complete their K-W-L chart. On day (d), the students worked on their presentations and later in the class period gave their presentations to the whole class. Next, the researcher assessed the students’ knowledge and progress by having them take a short quiz. Each student took the quiz individually. Again, the students made their nominations for best group presentation, and the winning quiz scores were announced. The winners would receive a reward at the end of the session on W4 (d). By the end of W4, the researcher had finished Chapter 4 and was ready to administer the achievement post-test and the scale of attitudes towards science for the last time.

Week 5. On day (a), August 8, 2016, the researcher administered the achievement post-test and the scale of attitudes toward science for the last time. The class did not meet on days (b) through (d).
Week 6. The class did not meet this week.

Week 7. The class did not meet on days (a) through (c). On day (d), the achievement follow-up test was administered along with the follow-up scale of attitudes toward science.

General Notes About the Administration of the Study on the Experimental Group

Each Day

1. Students were working on KWL sheets in different stages and times in home group 1 and 2.

2. Students spend at least 10 minutes to read the instructions and fill out the K sheet and after the group discussion they fill out the W sheet in home group 1.

3. Students fill out the L sheet in the end of the class period in home group 2.

4. Students read about the new topics and collect information from books, internet if available, library and so on as they directed in the experts’ groups.

5. Students answer the questions and work on the activities that incorporated with each lesson in the students' book in experts’ groups and in home groups 2.

6. Students receive color coded files included all the instructions, activities, KWL sheets, and the presentation rubrics. Students return the files in the end of the class period.

7. Students discuss the information they gathered from experts' groups and decide what information should be presented in the end of the week in home groups 2.

8. Students in each home group were taking different roles weekly in each new lesson.

9. During the researcher teaching about biodiversity and conservation there was no specific time frame for the daily practices. The reason behind that was simple, the researcher found that teaching was dealing with humans who have different abilities, which required different time frames for each different task. Therefore, the researcher
was flexible in setting time for activities with no conflict of completing all the themes under the main topic.

Each Week
1. Students presenting their information in different ways by different methods such as posters, cards, PowerPoint, play. This is happening every week during day (d).
2. Assessing the students' presentations by using the cooperative learning project rubric every week on day (d).
3. Giving students short quiz to insure their understanding of the general objectives every week on day (d).
4. Nominating the best group presentation every week on day (d).
5. Conducting weekly meeting with the home groups' leaders to discuss how was everyone working and cooperating with the other members in each group and if there are any difficulties in managing the groups. This meeting usually happened during the class periods especially on days (b) and (c).

Control Group

Teacher’s role. With the traditional method of teaching, the teacher controls the learning environment, makes decisions about the content of the curriculum and specific outcomes, delivers lectures on the course content, and uses tests to assess what students have learned. The teacher is the reason that learning occurs (Barkley, 2010).

Week 1. The researcher started W1 (a) by introducing himself to the students and talking about the importance of conducting such studies to improve the field of education in Saudi Arabia. Next, the researcher reviewed the plan for implementing the study with the control group, including three achievement assessments (pre-test, post-test, and
follow-up test) and three assessments of attitudes toward science. Then the researcher administered the achievement pre-test and the scale of attitudes toward science.

In W1 (b), the students participated in an ice-breaking activity to ensure they could adapt to their role as a control group for the study. The researcher implemented an activity called Tall Tower Challenge, which focuses on the construction and structure of tall buildings. For this activity, the students worked in groups of five randomly selected members per group. The random-selection process involved having the students count off from one to five, starting over on every sixth person until each student had the number one, two, three, four, or five. Like-numbered students formed each group. The group activity involved putting symmetrical numbers together in the same group to develop the tallest tower with limited materials to support the weight of a golf ball for two minutes or longer. Students had to develop a design, build the tower, test and present their work on the tower to their classmates. The students also were asked to compare the towers for what worked and what went wrong and to find ways they can use to strengthen their group’s tower. In general, the students were excited to participate in the activity. At the end of the class period, one group succeeded by building the tallest and strongest tower (46 cm) that could support the weight of a golf ball for two minutes.

On days (c) and (d), the researcher introduced the chapter on biodiversity and conservation and lectured for approximately 30 minutes on the basics of biodiversity and conservation. A PowerPoint presentation accompanied the lecture. Afterward, the students individually read information related to the lesson for 20 minutes. On day (d), the students completed a worksheet related to the lesson topic and applicable vocabulary
Week 2. On day (a), the researcher reviewed the lecture from the previous week, led a discussion about the worksheet from last week the students had turned, and then returned the worksheets to the students. The researcher began a new lecture, this time about the importance of biodiversity. Themes included the direct and indirect economic value of biodiversity. Next, the students were given another worksheet to complete and, at the end of the lesson, were required to write a paper stating the main ideas about answering questions 6 and 7 from the assigned textbook. In W2 (d), the researcher quizzed the students for the first 10 minutes of class about the information covered in the first lesson and then moved on to the second lesson. The second lesson was about threats to biodiversity, such as extinction rates. The researcher lectured about two kinds of extinction and the main factors leading to extinction. Next, the researcher discussed with the students a related table from the assigned textbook.

Week 3. In W3 (a), the researcher continued lecturing about extinction. After concluding that topic, the researcher talked about other threats to biodiversity, including overexploitation, habitat loss, disruption of habitat, fragmentation of habitat, pollution, and introduced species. Students were given another worksheet. They were told to work on the worksheet during days (b) and (c) and then turn it in to the researcher, who would check their progress and discuss with them the information gained from the lecture. In W3 (d), the researcher quizzed the students for the first 10 minutes of class about the information presented so far. Next, the researcher worked with the students on an activity in the assigned textbook.
**Week 4.** On day (a), the students studied the last lesson of the Chapter 4. The researcher first introduced new vocabulary words and then gave a lecture on the different ways to conserve biodiversity. Next, the researcher showed the students a translated movie, “Here Comes the Sun,” that addressed themes such as renewable resources, nonrenewable resources, and sustainability. Afterward, the students discussed the main ideas pertaining to the conservation of biodiversity. On day (b), the students worked on another worksheet a while, and then the researcher lectured about international protected areas, biodiversity hot spots, and corridors between habitat fragments.

On W4 (c), the researcher checked the students’ worksheets from W4 (b) and then moved on to the last topic in the lesson: restoring ecosystems. This topic included themes such as bioremediation, biological augmentation, and legally protecting biodiversity. On W4 (d), the researcher reviewed all of the information presented during W4 before giving the students a short quiz to measure their understanding of the subject matter and to prepare them for the achievement post-test and the scale of attitudes toward science.

**Week 5.** On W5 (a), August 8, 2016, the researcher administered the achievement post-test and the scale of attitudes toward science for the last time. The class did not meet on days (b) through (d).

**Week 6.** The class did not meet this week.

**Week 7.** The class did not meet on days (a) through (c). On day (d), the achievement follow-up test was administered along with the follow-up scale of attitudes toward science.

It is worth noting that after the administration of the post-test, the experimental group stopped using Jigsaw and returned to the traditional instructional method used with
the control group. The researcher was not leading the class instruction during the three weeks after the administration of the post-test. Students in both the experimental group and the control group remained in the same groups until the administration of the follow-up test.

Chapter Summary

The current study was designed to investigate the impact of the Jigsaw cooperative-learning instructional strategy in terms of the achievement of high school science students and their attitudes toward science. The study measured the change in the achievement and attitudes toward science of male Saudi Arabian high school students taking an environmental science course. Jigsaw was used to teach lessons that focused on biodiversity and conservation. This chapter discussed the study settings, the research design, instructional approaches, data collection methods, and data analysis. This chapter also discussed internal and external validity, the research plan, and the procedures for implementing the study.
CHAPTER IV
ANALYSIS AND RESULTS

Introduction

This chapter presents the data analysis and the results of the research. This study intends to investigate the impact of using Jigsaw as a cooperative learning instructional strategy in a Saudi high school science classroom on male students’ achievement and attitude toward science. This study was guided by two main questions, which are:

1. What is the impact of using Jigsaw as a cooperative learning instructional strategy in a Saudi high school science classroom on male students' achievement?

2. What is the impact of using Jigsaw as a cooperative learning instructional strategy in a Saudi high school science classroom on male students' attitudes towards science, specifically their attitude to scientific inquiry, adoption of scientific attitudes, and enjoyment of science lessons?

Furthermore, this study also was guided by two research hypotheses, which are:

1. There is no significant difference in the growth of the three test points in the achievement test between the experimental group using the Jigsaw as a cooperative learning instructional strategy and the control group of the study.

2. There is no significant difference in the growth of the attitude score at the three test points between the experimental group using the Jigsaw as a cooperative learning instructional strategy and the control group of the study.
In this chapter, I am going to present the results of the achievement test and the results of the attitude toward science in three different assessment points—pre, post, and deferred (follow-up) tests. This chapter will also include tables and graphs to illustrate the results in an understandable way. Finally, a summary of the chapter will be presented at the end of this chapter.

Preliminary Analysis

Reliability Analysis. The term reliability in research refers to the consistency of a research study or measuring test. In this study, the researcher is assessing the study instruments reliability using Cronbach's alpha coefficients and the Split-half method.

- Cronbach's alpha is a measure used to assess the reliability, of a set of scale items or test items. In other words, the reliability of any given measurement refers to the extent to which it is a consistent measure of a concept. Cronbach's alpha is one way of measuring the strength of that consistency.

- The split-half method assesses the internal consistency of a test, such as psychometric tests and questionnaires. It measures the extent to which all parts of the test contribute equally to what is being measured.

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</tbody>
</table>
In Table (4.1), the researcher presented the values of the reliability of data collection tools for both published studies and the current study. The aim of presenting these values is to allow the reader to compare the reliability values, which were within the statistically acceptable values.

The Achievement Analysis and Results

The following analysis and results are set up to answer the first research question of this study that addresses students’ achievement in science as measured by Al Waily (2014). The first research question of this study is: What is the impact of Jigsaw as a cooperative learning instructional strategy in a Saudi high school science classroom on male students' science achievement? To answer this question, I tested the following hypothesis:

\( H_0: \) Means difference in students’ science achievement between students taught science using Jigsaw as a cooperative learning instructional strategy (experimental group) and students taught science using the traditional strategy (control group) does not significantly change over the three time points (pre-test, post-test and follow-up test) of measuring their science achievement.

The above hypothesis tests the effect of the interaction between the two teaching method strategies for science and the time factors on students’ science achievement with a 2 by 3 mixed MANOVA design. Mixed MANOVA designs combine between subjects’ factor(s) with within subject’s factor(s) to compare different treatment groups at different time points, different types of measures, or both at the same time. In this study, there is one between subjects’ factor, which constitutes the two groups of students: One group represents the students who taught science using Jigsaw as a cooperative learning
instructional strategy (called experimental group). The second group is the students who taught science using the traditional strategy (called control group). Students within each group are independent of each other as well as independent across the two groups.

This study also has one within subject’s factor, which is the time factor where each student’s science achievement was measured three times before (pre-test) teaching the students the science subject, after (post-test) teaching the students the science subject, and a final deferred (follow-up) measurement. Due to the fact that the three measurements (pre-test, post-test, and follow-up) were obtained from the same individual, these measurements are related to each other and need to be treated as a repeated measure to account for such relationship. The combination of the between subjects’ factor of the two groups (experimental versus control) with the within subject factor of three times measurement (pre-test, post-test and follow-up) creates a 2 by 3 mixed MANOVA design. Table (4.2) provides us with basic summary statistics of students’ science achievement scores for the two groups (experimental and control) for each of the three time points (pre-test, post-test and follow-up test).

Table 4.2 Summary Statistics of Students’ Science Achievement Scores for the Experimental and Control Groups Across Pre-Test, Post-Test and Follow-Up Test

<table>
<thead>
<tr>
<th></th>
<th>Statistic</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Follow-up Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Group</strong></td>
<td>Mean</td>
<td>5.52</td>
<td>26.84</td>
<td>16.36</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation</td>
<td>3.44</td>
<td>2.66</td>
<td>5.35</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td><strong>Experimental Group</strong></td>
<td>Mean</td>
<td>5.28</td>
<td>28.60</td>
<td>21.68</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation</td>
<td>3.52</td>
<td>1.83</td>
<td>4.54</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>
Checking the Assumptions for the Analysis

The validity of the result from multivariate analysis of variance (MANOVA) relies on validating three major assumptions. These assumptions are independent observations, normal distribution of the science achievement scores, and homogeneity of variance-covariance. The section below provides validation of each of these three assumptions.

Independent observations. The independent observations assumption was achieved by randomly selecting the participants of this study from the population of male high school students in Saudi Arabia. It implies that a particular student’s achievement score is unique to him. It represents a measure of that particular student’s science achievement that no other student’s achievement score in the study influenced or shared information with the particular student score. Severe violation of this assumption leads to biased results of the analysis. Students in this study were selected randomly, therefore, their scores on science achievements are assumed independent.

Normal distribution of the science achievement scores. Most of the parametric statistical analyses including MANOVA rely on the assumption that the populations from which the samples were selected are normally distributed. Yet most of the tests based on this assumption were found to be robust (less sensitive) to a small deviation from normality (Mertler & Vannatta, 2013). For this study, students’ science achievement scores from the three times of measurements (pre-test, post-test, and follow-up test) for the experimental and control groups are assumed to have a normal distribution in the populations. Indicators (numerical and graphical) help us assess the normality assumption of the dependent variable- students’ science achievement.
Two numerical indicators are the skew and kurtosis measures of the distribution. Absolute standardized values of the skew and kurtosis statistics that exceed the value ±3.29 suggest a violation of the normality assumption (Field, 2009). The skew and kurtosis standardized values are found by dividing each statistic by its standard error. Table (4.3) provides us with the measures of skew and kurtosis statistics with their standard errors for students’ science achievement scores within each of the experimental and control groups for the three time points (pre-test, post-test and follow-up test).

The largest absolute standardized value of the skew statistic is found for the experimental group at the post-test time where it is equal to \( \frac{-1.63}{4.6} = -3.54 \). This value is slightly greater than the thresh point of ±3.29 value for violating the normality. Similarly, the largest absolute standardized value of the kurtosis statistic is found for the experimental group at the post-test time where it is equal to \( \frac{2.62}{.90} = 2.91 \).

The above standardized value of kurtosis is smaller than the thresh point of ±3.29. Except for the post-test score for the experimental group, distributions of students’ achievement scores from all other groups can be considered as coming from populations with normal distributions, as none of these distributions have standardized measures of skew and kurtosis exceeding the ±3.29 value. It is expected the results of the analysis are to be robust to the small deviation of the achievement scores distribution from normality for the experimental group at the post-test time only. Further checks of the normality assumption are given below.
Table 4.3 *The Measures of Skew And Kurtosis for Students’ Science Achievement Scores Distribution*

<table>
<thead>
<tr>
<th></th>
<th>Statistic</th>
<th>Control</th>
<th>Std. Error</th>
<th>Experimental</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>Skew</td>
<td>.40</td>
<td>.98</td>
<td>.46</td>
<td>.46</td>
</tr>
<tr>
<td></td>
<td>Kurtosis</td>
<td>-.14</td>
<td>1.10</td>
<td>.90</td>
<td>.90</td>
</tr>
<tr>
<td>Post-test</td>
<td>Skew</td>
<td>-.49</td>
<td>-1.63</td>
<td>.46</td>
<td>.46</td>
</tr>
<tr>
<td></td>
<td>Kurtosis</td>
<td>-.83</td>
<td>2.62</td>
<td>.90</td>
<td>.90</td>
</tr>
<tr>
<td>Follow-up test</td>
<td>Skew</td>
<td>-.19</td>
<td>-.59</td>
<td>.46</td>
<td>.46</td>
</tr>
<tr>
<td></td>
<td>Kurtosis</td>
<td>-.91</td>
<td>-.20</td>
<td>.90</td>
<td>.90</td>
</tr>
</tbody>
</table>

Normal Q-Q plots presented in figures (4.1) through (4.3) provide another check of the normality assumption for students’ science achievement distribution at each of the three time points (pre-test, post-test and follow-up test) for the experimental and control groups.

*Figure 4.1. Normal Q-Q plots for students’ science achievement scores within each of the experimental and control groups at the Pre-test time point.*
Figure 4.2. Histograms and Normal Q-Q plots for students’ science achievement scores within each of the experimental and control groups at the Post-test time point.

Figure 4.3. Histograms and Normal Q-Q plots for students’ science achievement scores within each of the experimental and control groups at the follow-up test time point.

All Q-Q plots show that students’ science achievement scores closely line up with the 45-degree line except for the scores from the experimental group at the post-test time point figure (4.2). The plot shows lower achievement scores slightly depart from the line at its lower end indicating a negatively skewed distribution for this particular group only. Such deviation from normality should have insignificant impact on the results of the overall analysis.

Homogeneity of variance assumption. Generally, there are two approaches for testing the factor’s main effects and their interactions when using the mixed designs analysis. The first approach treats the three test time points as three different categories
(levels) of one within-subjects factor in a mixed repeated measures design. For this study, the mixed design combines the groups (experimental and control) as between-subjects factor with the time (pre, post, follow-up) as the within-subjects factor. This approach requires the validation of the sphericity assumption about students’ science achievement scores variance covariance matrix within the test time’s factor. This assumption often tends to be restrictive for its difficulty to validate. The sphericity assumption needs to be valid before interpreting the F-test results. Violating the sphericity assumption can lead to misinterpretation of the F-test values which can lead to wrong conclusions (Field, 2009). Nonetheless, tests in repeated measure approach tend to be more powerful than the tests in the multivariate analysis of the second approach.

*Multivariate Analysis of Variance Results.* The second approach, called the multivariate analysis of variance approach, involves treating the three test time measurements (pre-test, post-test and follow-up test) of students’ achievement as multiple outcomes (multiple dependent variables) in a multivariate analysis of variance. This approach tends to have a less restrictive assumption about the variance covariance matrix of students’ science achievement scores than the repeated measure approach with a reduced power for the tests. This approach is often used as an alternative to the repeated measures design approach when the assumption of sphericity of the repeated measures design is not valid.

The validity of the results using either the repeated measure approach or the multivariate analysis of variance approach relies on verifying the homogeneity of variance assumption for any of the two approaches. Testing the homogeneity of variance covariance assumption for the repeated measure approach involves testing the sphericity
assumption. Mauchly’s W test value = .73 of sphericity shows an approximate chi-square test value \[\chi^2(2) = 14.50, P = .00\] that is statistically significant, indicating that the sphericity assumption has not been met. One can safely proceed with the multivariate analysis of variance approach after checking its homogeneity of variance covariance assumption.

Test results of the homogeneity of variance-covariance matrix of students’ science achievement scores using Box’s M test of equality of variance-covariance matrices indicate that assumption is met, where Box’s M = 7.80 with F-test value \(F(6, 16693) = 1.21, p = .30\). Therefore, Wilks’ Lambda test is the appropriate test to use for the multivariate analysis of variance approach with valid homogeneity of variance-covariance matrix.

Multivariate Analysis of Variance Results

The F-test from the multivariate analysis of variance approach for testing the interaction between the tests times factor and groups factor, as shown in table (4.4), is statistically significant with F-test value \(F(2, 47) = 4.12, P = .022\) with partial \(\eta^2 = 0.15\). The effect size is 0.15 and observed power of the F-test equals to .70. It is worth noticing that the observed power of the F-test for the multivariate analysis of variance approach (0.70) is lower than the observed power for the F-test from the repeated measure design approach (0.83), yet both are high.

Table 4.4 *Multivariate Test of the Interaction Between the Time Points and Groups*

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>Sig.</th>
<th>Partial (\eta^2)</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tests</td>
<td>Wilks’ Lambda</td>
<td>.03</td>
<td>706.20</td>
<td>2.00</td>
<td>.00</td>
<td>.97</td>
<td>1.0</td>
</tr>
<tr>
<td>Tests * Groups</td>
<td>Wilks’ Lambda</td>
<td>.85</td>
<td>4.12</td>
<td>2.00</td>
<td>.02</td>
<td>.15</td>
<td>.70</td>
</tr>
</tbody>
</table>
The significance of the interaction between groups (experimental and control) and the three test times (pre-test, post-test, and follow-up test) indicates that the difference in students’ science achievement scores between the experimental and control group significantly depends on any particular time points that we are interested in. Figure (4.4) below clearly illustrates the significance differences in achievement scores between students in experimental and control groups, where these differences significantly change over the three test time points (pre-test, post-test, and deferred (follow-up) test). Students in the experimental group, on average, showed about the same achievement scores as the students in the control group before taking the science course. After taking the science course, students in the control group showed lower achievement scores than the experimental group at both times of the post-tests as well as the deferred test (follow-up) and more so at the deferred test.

By computing the effect size, the researcher found statistically significant differences in the post-test point for the benefit of the experimental group. The effect size was 0.78, which practically means that the experimental group was 28.23% higher than the control group. In the same way, by computing the effect size, the researcher found statistically significant differences in the follow-up point for the benefit of the experimental group. The effect size was 1.07, which practically means that the experimental group was 35.77% higher than the control group.
Students’ Science Achievement Trend Over Time

Due to the significant interaction between groups and test time factors, it is difficult to disentangle the effect of test time factors on students’ science achievement from the effect of group factor. It is difficult to study the change in science achievement over test times without examining that change separately for each of the two groups. To understand the trend in students’ science achievement for each group, polynomial contrasts test the significance of the linear and quadratic trends within each group. Table (4.5) presents the tests for these contrasts for both experimental and control groups. Table (4.5) and Figure (4.4) reveal that the experimental group shows significant change in their science achievement over the three test time points. Both the linear \[F(1, 24) = 189.41, P = .00, \text{Partial } \eta^2 = .89\] and the quadratic \[F(1, 24) = 605.23, P = .00, \text{Partial } \eta^2 = .96\] contrasts were highly statistically significant. These significant contrasts resulted from large effect
sizes (standardized differences in students’ achievement between the three test time points) for the linear contrast (.89) and the quadratic contrast (.95).

The linear contrast suggests that on average, there is an upward change (increase) in experimental group students’ achievement score from 5.28 at the pre-test to 21.68 at the follow-up test. When the trend in experimental group students’ achievement included the post-test estimated average of 28.60, the resulting quadratic contrast was also significant indicating that there is a sharp increase in students’ science achievement from 5.28 at the pre-test to 28.60 at the post-test and then a drop in students’ science achievement to 21.68 at the follow-up test. This quadratic concaved down fluctuation in students’ science achievement for the experimental group is highly significant with a large effect size of 0.96.

When examining the trend in students’ science achievement for the control group, the researcher can see a similar trend with different magnitudes at different test time points. The researcher found that both the linear [F(1, 24) = 51.79, P = .00, Partial $\eta^2=.68$] and the quadratic [ F(1, 24) = 431.54, P = .00, Partial $\eta^2=.95$] contrasts are statistically significant. Figure (4.4) shows that there is an upward trend in students’ achievement for the control group. Students’ achievement on average increased from 5.52 on the pre-test to 16.36 on the follow-up test. Further, we notice that while average students’ achievement scores for both the post-test and the follow-up test are higher than the pre-test average scores, the average score of 16.36 for the follow-up test is lower than 26.84 for the post-test average scores leading to a significant quadratic trend. That is, on average, students’ achievement for the control group increased from the pre-test to the
post-test and then dropped at the follow-up test. This fluctuation in control group
students’ achievement turned out to be statistically significant.

Table 4.5 *Polynomial Contrasts for Students’ Attitude Over Test Times*

<table>
<thead>
<tr>
<th>Group</th>
<th>Contrast</th>
<th>Df</th>
<th>F</th>
<th>Sig.</th>
<th>Partial $\eta^2$</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental</strong></td>
<td>Linear</td>
<td>1</td>
<td>189.41</td>
<td>.00</td>
<td>.89</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>1</td>
<td>605.23</td>
<td>.00</td>
<td>.96</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>Linear</td>
<td>1</td>
<td>51.79</td>
<td>.00</td>
<td>.68</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>1</td>
<td>431.54</td>
<td>.00</td>
<td>.95</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Error</strong></td>
<td>Linear</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Tests)</td>
<td>Quadratic</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Attitude Towards Science Scale Analysis

The following analyses are set up to answer the second research question of this
study that addresses students’ attitude toward science as measured by a modified Test of
Science-Related Attitude (TOSRA) instrument. A combined score from three TOSRA
subscales (attitude to scientific inquiry, adoption of scientific attitude and enjoyment of
science lessons) measures students’ total attitudes toward science. The second research
question of this study is: What is the impact of using Jigsaw as a cooperative learning
instructional strategy in a Saudi high school science classroom on male students' attitudes
towards science, specifically, their attitude to scientific inquiry, adoption of science, and
enjoyment of science lessons? Answering the above research question was accomplished
by testing the following hypothesis:

$H_0$: Means Difference in students’ attitude toward science between students taught
science using Jigsaw as a cooperative learning instructional strategy and students taught
science using the traditional strategy does not significantly change over the three test time
points (pre-test, post-test and follow-up test) of measuring their attitude.
The above hypothesis tests the effect of the interaction between the two teaching method strategies for science and the test time factors on students’ attitude with a 2 by 3 mixed MANOVA design. Similar to the design used for analyzing students’ achievement, Table (4.6) provides us with basic summary statistics of students’ attitude scores for the two groups (experimental and control) for each of the three test time points (pre-test, post-test and follow-up test).

Table 4.6 Summary Statistics for Students’ Attitudes Towards Science for the Experimental and Control Groups Across Three Test Time Points

<table>
<thead>
<tr>
<th>Experimental Vs. Control</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Follow-up test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>Mean</td>
<td>91.88</td>
<td>95.568</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation</td>
<td>34.94</td>
<td>30.68</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Experimental Group</td>
<td>Mean</td>
<td>93.92</td>
<td>93.12</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation</td>
<td>31.46</td>
<td>30.27</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

A note is in order here regarding the calculation of the attitude scores and their interpretation. Since there are a total of 30 items in the attitude scale with a range of 1 – 5 for the five options of Likert’s scale (SD, D, N, A, SA), the possible range of any student’s attitude score is from 30 to 150 based on the sum of the student’s score on each of the 30 items. Dividing the current score by 30 provides us with scores that range from 1- 5 that reflect the Likert’s scale categories. For example, dividing the means for the control group by 30 at each time point from table (4.6) above results in values 3.02, 3.19, and 3.16 respectively. These values indicate students’ responses on average hover around slightly higher than the neutral response on Likert’s scale with very small difference between the time points.
Similarly, dividing the means for the experimental group by 30 at each time point from table (4.6) results in the values 3.13, 3.10, and 3.16 respectively. These values indicate those students’ responses on average hover around slightly higher than the neutral response on Likert’s scale with very small difference between the time points when they are compared to the means for control group.

Checking the Assumptions for the Analysis

There are three major assumptions required to be valid for the tests to be unbiased and consistent. These are independent observations, normal distribution of the dependent variable, and the homogeneity of variance. The sections below provide validation of each of these three assumptions.

**Independent observations.** I have addressed this assumption earlier during the discussion for students’ science achievement. Similar conclusion will apply toward all other measurements of attitude subscale measurements including students’ overall attitude toward science.

**Normality assumption.** In this study, the researcher assumes normal distribution for the dependent variable of students’ attitude in the populations. Several indicators (numerical and graphical) help us verify the normality assumption of the dependent variable of students’ attitude within each group (experimental and control) as well as at each test time point (pre-test, post-test and follow-up test).

Two of the numerical indicators are the skew and kurtosis measures for the students’ attitude scores distribution. Absolute standardized values of the skew and kurtosis that exceed the value ±3.29 suggest a violation of the normality assumption (Field, 2009). The skew and kurtosis standardized values are found by dividing the
statistic for each of these two indicators by its standard error. Table (4.7) displays the statistics of skew and kurtosis with their standard errors for students’ attitude distribution within each of the experimental and control groups as well as within the three test time points (pre-test, post-test and follow-up test).

The largest absolute standardized value of the skew index is found for the experimental group at the post-test time where it is equal to $\frac{-28}{46} = -0.61$. Similarly, the largest absolute standardized value for the kurtosis index is found for the experimental group at the pre-test time where it is equal to $\frac{-92}{90} = -1.01$. These standardized values of skew and kurtosis are much smaller than the threshold point of ±3.29 to declare the distributions of students’ attitudes as being non-normal.

Table 4.7 Statistics for Skew and Kurtosis Indexes for Students’ Attitude Distribution

<table>
<thead>
<tr>
<th>Tests</th>
<th>Indexes</th>
<th>Statistic</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Experiment</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>Control</td>
</tr>
<tr>
<td>Pre-test</td>
<td>Skew</td>
<td>-0.11</td>
<td>-0.14</td>
</tr>
<tr>
<td></td>
<td>Kurtosis</td>
<td>-0.91</td>
<td>-0.92</td>
</tr>
<tr>
<td>Post-test</td>
<td>Skew</td>
<td>-0.27</td>
<td>-0.28</td>
</tr>
<tr>
<td></td>
<td>Kurtosis</td>
<td>-0.63</td>
<td>-0.64</td>
</tr>
<tr>
<td>Follow-up test</td>
<td>Skew</td>
<td>-0.11</td>
<td>-0.20</td>
</tr>
<tr>
<td></td>
<td>Kurtosis</td>
<td>-0.80</td>
<td>-0.78</td>
</tr>
</tbody>
</table>

Normal Q-Q plots presented in figures (4.5) through (4.7) provide similar validation of the normality assumption for students’ attitude distribution at each of the three test time points (pre-test, post-test and follow-up test) for the experimental and control groups.
Figure 4.5. Normal Q-Q plots for students’ attitude within each of the experimental and control groups at the pre-test time point.

Figure 4.6. Normal Q-Q plots for students’ attitude within each of the experimental and control groups at the post-test time point.

Figure 4.7. Normal Q-Q plots for students’ attitude within each of the experimental and control groups at the follow-up test time point.
The Homogeneity of variance assumption. This section has been discussed previously in the achievement test. Similar indications would be applied here in the attitude scale analysis. The validity of the results using either the repeated measure approach or the multivariate analysis of variance approach relies on verifying the homogeneity of variance assumption for any of the two approaches. Testing the homogeneity of variance covariance assumption for the repeated measure approach is achieved by testing the sphericity assumption. Mauchly’s W test value = .92 of sphericity shows an approximate chi-square test value [$\chi^2(2) = 3.93$, $P = .14$] that is statistically insignificant, indicating that the sphericity assumption has been met and one can safely proceed with the repeated measure analysis.

Repeated Measurement Analysis Results

The F-test from the repeated measure analysis for the interaction between the tests time factor and the group factor, as shown in Table (4.8), is statistically significant [$F(2, 96) = 6.85$, $P = .00$, partial $\eta^2 = .13$] at an alpha level of .05. The observed power of the F-test for the interaction effect is relatively high with a value of 0.91.

Table 4.8 Repeated Measures F-Test of the Interaction Between the Time Points and Groups

<table>
<thead>
<tr>
<th>Effect</th>
<th>df</th>
<th>$F$</th>
<th>Sig.</th>
<th>Partial $\eta^2$</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tests</td>
<td>2</td>
<td>5.37</td>
<td>.01</td>
<td>.10</td>
<td>.83</td>
</tr>
<tr>
<td>Tests* Group</td>
<td>2</td>
<td>6.85</td>
<td>.00</td>
<td>.13</td>
<td>.91</td>
</tr>
<tr>
<td>Error (Tests)</td>
<td>96</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The statistical significance of the interaction effect between groups and test times on students’ attitude indicates that the difference in students’ attitude scores between the experimental and control group depends on any particular test time point that we are interested in. A note is in order here regarding the practical significance of the overall change in students’ attitude for both groups as well as the individual groups. Table 4.8
shows that despite a statistically significant F-tests $[F(2,96) = 5.37, p = .01]$ for the test time points, we notice that there is a relatively small overall effect size of .10 ($\text{Partial } \eta^2 = .10$) for the test time points indicating that little change in students’ attitude has occurred overtime for both groups. For all practical purposes, this change in students’ attitude is negligible.

Similarly, when looking at change in students’ attitude within each group the F-test results $[F(2,96) = 6.85, p = .00]$ were statistically significant, yet with an overall small effect size of .13 ($\text{Partial } \eta^2 = .13$), it is an insignificant practical value. The bulk of this overall effect size stems from the difference in students’ attitude from the two groups at the post time test. To illustrate the researcher has calculated the specific effect size at post time for the difference in students’ attitude and found it to be noticeably small with the value of .06. This small effect size implies that only 2.39% of the control group showed a more positive attitude toward science than the experimental group. The specific small effect sizes imply that while there is a statistical deference in students’ attitude between the two groups, over time that difference in attitude is relatively small with no practical significant indication whether teaching science using Jigsaw as a cooperative learning method or the traditional teaching method.

Figure (4.8) below clearly illustrates the differences in students’ attitude scores between students in experimental and control groups, where these differences change over the three test time points. Students in the experimental group, on average, showed higher attitude scores than students in the control group before (pre-test) taking the science course.
After taking the science course (post-test), students in the control group showed higher attitude scores than the experimental group. Difference in attitude scores between the experimental and control groups became insignificant at the follow-up test measurement where the control group scored slightly higher than the experimental group.

**Figure 4.8.** Differences in students’ attitude between experimental and control groups across test time points.

**Students’ Total Attitude Trend Over Time**

Due to the significant interaction between groups and test time factors, it is difficult to disentangle the effect of test time factors on students’ attitude from the effect of group factor. That is, it is difficult to study the change in attitude over test times without examining that change separately for each of the two groups. To understand the trend in students’ attitude toward science for each group, a polynomial contrasts tests the significance of the linear and quadratic trends within each group.

Table (4.9) presents the tests for these contrasts for both experimental and control groups. Results from Table (4.9) and Figure (4.8) above show that experimental group
students show insignificant change in their attitude toward science over the three test time points. Both the linear \( F_{(1, 24)} = 1.18, P = .29, \text{Partial } \eta^2 = .05 \) and the quadratic \( F_{(1, 24)} = 2.33, P = .14, \text{Partial } \eta^2 = .09 \) contrasts were statistically insignificant. These insignificant contrasts resulted from a small effect size (standardized differences in students’ attitude between the three test time points) for the linear contrast (.05) and the quadratic contrasts (.09).

When examining the trend in students’ attitudes for the control group, however, the researcher found that both the linear \( F_{(1, 24)} = 9.25, P = .01, \text{Partial } \eta^2 = .28 \) and the quadratic \( F_{(1, 24)} = 10.74, P = .00, \text{Partial } \eta^2 = .31 \) contrasts are statistically significant. Figure (4.8) shows that there is an upward linear trend in students’ attitude for the control group. Students’ attitude on average increased from 91.88 on the pre-test to 95.56 on the post-test and to 94.88 on the follow-up test. Further, the researcher noticed that while average students’ attitude scores for both the post-test and the follow-up test are higher than the pre-test average scores, the average score for the follow-up test is lower than the post-test average scores leading to a significant quadratic trend. On average, students’ attitude in the control group increased from the pre-test to the post-test, and then dropped at the follow-up test. This fluctuation in control group students’ attitude turned out to be statistically significant.
Table 4.9 *Polynomial Contrasts for Students’ Attitude Over Test Times*

<table>
<thead>
<tr>
<th>Group</th>
<th>Contrast</th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
<th>Partial $\eta^2$</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>Linear</td>
<td>1</td>
<td>1.18</td>
<td>.29</td>
<td>.05</td>
<td>.18</td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>1</td>
<td>2.33</td>
<td>.14</td>
<td>.09</td>
<td>.31</td>
</tr>
<tr>
<td>Control</td>
<td>Linear</td>
<td>1</td>
<td>9.25</td>
<td>.01</td>
<td>.28</td>
<td>.83</td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>1</td>
<td>10.74</td>
<td>.00</td>
<td>.31</td>
<td>.88</td>
</tr>
<tr>
<td>Error (Tests)</td>
<td>Linear</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOSRA Subscales Analyses

The next three sections present the individual analysis and results for each of the three subscales of the TOSRA instrument. These analyses focus on the three subscales of students’ attitude to scientific inquiry, students’ adoption of scientific attitude and students’ enjoyment of science which make up students’ total attitude as measured by the TOSRA instrument toward science as taught when using Jigsaw as a cooperative learning instructional strategy.

Two important points were addressed in order to consider when interpreting the results of the analysis for each subscale. Unlike the scores from the combined total of students’ attitude, which are based on all 30 items of the TOSRS, the score for each of the subscales is based on ten items that make up the specific scale. The ten items were measured on Likert’s scale ranging from 1 to 5. Thus, each subscale’s possible score ranges in value between 10 and 50. The first point is that because of the smaller number of items (10 items) for each subscale, there is a likelihood of lower reliability scores for each subscale than the scores from the combined three subscales.

The second point is related to the calculation of a student’s score for each of the individual subscales and their interpretation. The possible range of any student’s attitude
subscale score is from 10 to 50 based on the sum of the student’s scores on each of the 10 items of the subscale. Dividing the current score by 10 provides us with a student’s score that ranges from 1- 5 as a reflection of Likert’s scale categories. Similar to the total attitude combined scores analysis, the two approaches of repeated measure and multivariate analysis are used to analyze the students’ attitude toward scientific inquiry subscale scores depending on whether the assumptions are met or not.

Students’ Attitudes Towards Scientific Inquiry Subscale Analysis

Addressing the subscale of students’ attitude toward scientific inquiry in the second research question presented earlier, the researcher restated the associated hypothesis to test and address the effect of interaction between groups (experimental and control) and test times (pre-test, post-test and follow-up test) on students’ attitude toward scientific inquiry subscale.

\( H_0: \) Means Difference in students’ attitude toward scientific inquiry scores between students taught science-using Jigsaw as a cooperative learning instructional strategy (experimental group) and students taught science using the traditional strategy (control group) does not significantly change over test times (pre, post and follow-up).

The above hypothesis tests the interaction effect between the two teaching method strategies for science and the test time factors on students’ attitude toward scientific inquiry with a similar 2 by 3 mixed analysis design used in analyzing students’ attitudes of the combined scales. Table (4.10) and table (4.11) provide a descriptive break down of count and percentage of students’ agreements and disagreements with each of the subscale items. The following table provides a list of all thirty items with their item number and its associated attitude subscale.
Table 4.10 *A List of All Thirty Items with Their Item Numbers and Their Associated Attitude Subscale*

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Item #</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inquiry</td>
<td>1</td>
<td>I would prefer to find out why something happens by doing an experiment than by being told</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Doing experiments is not as good as finding out information from teachers</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>I would prefer to do experiments to check that I get the same results</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>I would rather agree with other people than do an experiment to find out for myself</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>I would prefer to do my own experiments than to find out information from a teacher</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>I would rather find out about things by asking an expert than by doing an experiment</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>I would rather solve a problem by doing an experiment than being told the answer</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>It is better to ask the teacher the answer than to find it out by doing experiments</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>I would prefer to do an experiment on a topic than to read about it in science magazines</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>It is better to be told scientific facts than to find them out from experiments</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>I enjoy reading about things which disagree with my previous ideas</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>I dislike repeating experiments to check that I get the same results</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>I am curious about the world in which we live</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Finding out about new things is unimportant</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>I like to listen to people whose opinions are different from mine</td>
</tr>
<tr>
<td>Adoption</td>
<td>17</td>
<td>I find it boring to hear about new ideas</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>In science experiments, I like to use new methods which I have not used before</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>I am unwilling to change my ideas when evidence shows that the ideas are poor</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>In science experiments, I report unexpected results as well as expected ones</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>I dislike listening to other people's opinions</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>3</td>
<td>Science lessons are fun</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>I dislike science lessons</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>School should have more science lessons each week</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Science lessons bore me</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>Sciences is one of the most interesting school subjects</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>Science lessons are a waste of time</td>
</tr>
</tbody>
</table>

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Table 4.10 A List of All Thirty Items With Their Item Numbers and their Associated Attitude Subscale (Continued)

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre-test</th>
<th>Control Group</th>
<th>Follow-up</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>D N A</td>
<td>D N A</td>
<td>D N A</td>
<td>D N A</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The count table above shows that 46% of the experimental group students responded in agreement with all the items in the attitude subscale which is slightly higher than 42% for the students in the control group at pre-test time point. This small difference of (4%) in favor of the experimental group is also reflected in the summary Table (4.12) below where, on average, students in the experimental group scored slightly higher (31.92) than the students in the control group (31.44). Similar findings exist at the post-time test where 49% of experimental groups students responded in agreement with all the attitude subscale items compared to 44% for the control group students. This 5%
difference in favor of the experimental group is also confirmed in a small difference in the groups’ means between the experimental (33.20) and control (32.28) group students.

Finally, an opposite picture is present at the follow-up test times where approximately 28% of the students in the control group responded in agreement with the subscale items compared to 27% for students in the experimental group. This 1% difference in favor of the control group translates to a small (.36) difference in groups’ means also in favor of the control group. Figure (4.9) below graphically presents these small differences in responses to the attitude subscale over the three time points between the experimental and control groups. Table (4.12) provides us with basic summary statistics of students’ attitude toward scientific inquiry for the two groups (experimental and control) for each of the three test time points (pre, post and follow-up).

Table 4.12 Summary Statistics of Students’ Attitude Towards Scientific Inquiry for the Experimental and Control Groups Across the Three Test Time Points

<table>
<thead>
<tr>
<th>Experimental Vs Control</th>
<th>Pre-test</th>
<th>Post-tests</th>
<th>Follow-up test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>Mean</td>
<td>31.44</td>
<td>32.28</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation</td>
<td>11.39</td>
<td>10.84</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Experimental Group</td>
<td>Mean</td>
<td>31.92</td>
<td>33.20</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation</td>
<td>10.87</td>
<td>9.67</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

One can obtain a student’s score by dividing the current score by 10, which results in a score that ranges from 1- 5. For example, by dividing the means by 10 for the control group, at each time point, from table (4.12) above we obtain the values 3.14, 3.23, and 3.25 respectively. These values indicate students’ responses on average hover around slightly higher than the neutral response on Likert’s scale with very small difference between the time points. Similarly, by dividing the means by 10 for the experimental
group, at each time point, from table (4.12) above we obtain the values 3.19, 3.32, and 3.22 respectively. These values indicate students’ responses on average hover around slightly higher than the neutral response with very small difference between the time points as well as when they are compared to the means for the control group.

Checking the Assumptions for the Analysis

The three major assumptions, which are required to be valid, unbiased, and consistent for the test, are independent observations, normal distribution of the dependent variable and the homogeneity of variance. The researcher addressed the first assumption of independent observations in the achievement analysis section. The next two sections provide validation for the other two assumptions of normality and homogeneity of variance.

*Normality assumption.* Using the thresh point of $\pm 3.29$ as one check for the normality assumption, Table (4.13) displays the measures of skew and kurtosis with their standard errors for students’ attitude toward scientific inquiry subscale distribution within each of the experimental and control groups as well as within the three test time points (pre, post and follow-up). The largest absolute standardized value of the skew measure is found for the experimental group at the post-test time where it is equal to $\frac{-71}{.46} = -1.54$. Similarly, the largest absolute standardized value of the kurtosis measure is found for the control group at the follow-up test time where it is equal to $\frac{-87}{.90} = -.96$. These standardized values of skew and kurtosis are much smaller than the thresh point of $\pm 3.29$ to declare the distribution of students’ attitude toward scientific inquiry subscale as being non-normal.
Table 4.13 Statistics for Skew and Kurtosis Indexes for Students’ Attitude Towards Scientific Inquiry Distribution

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Control Std. Error</th>
<th>Experimental Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-test</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skew</td>
<td>-.09</td>
<td>-.02</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-.82</td>
<td>-.84</td>
</tr>
<tr>
<td><strong>Post-test</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skew</td>
<td>-.29</td>
<td>-.71</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-.84</td>
<td>-.25</td>
</tr>
<tr>
<td><strong>Follow-up test</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skew</td>
<td>-.02</td>
<td>-.45</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-.87</td>
<td>-.57</td>
</tr>
</tbody>
</table>

*Homogeneity of variance assumption.* Validating the assumption of homogeneity of variance covariance for the multivariate analysis of variance analysis is achieved by using Box’s M tests. *Box’s M = 20.49* with *F*-test value $F(6, 16693) = 3.18, p = .00* that is statistically significant, indicating that the homogeneity of variance covariance assumption has not been met. The Pillai’s trace and its associated F-tests for the multivariate analysis of variance is used.

Multivariate Analysis of Variance Results

The F-test from the multivariate analysis for the interaction between the test time factors and the group factor, as shown in Table (4.14), is statistically significant $[F(2, 47) = 4.31, P = .02, \text{partial } \eta^2 = .16]$ at an alpha level of .05. The observed power of the F-test for the interaction effect is relatively high with a value of 0.72.

Table 4.14 Multivariate Analysis of Variance F-Test of the Interaction Between the Test Time Points and Groups

<table>
<thead>
<tr>
<th>Effect</th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
<th>Partial $\eta^2$</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tests</td>
<td>2</td>
<td>7.19</td>
<td>.00</td>
<td>.23</td>
<td>.92</td>
</tr>
<tr>
<td>Tests* Group</td>
<td>2</td>
<td>4.31</td>
<td>.02</td>
<td>.16</td>
<td>.72</td>
</tr>
<tr>
<td>Error (Tests)</td>
<td>47</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The significance of the interaction between groups and test times indicates that the difference in students’ attitude toward scientific inquiry scores between the experimental and control group significantly depends on any particular test time point that we are interested in. In fact, the analysis reveals different patterns of change in the students’ attitude toward scientific inquiry over test time points for both the experimental and control group. The pattern is also different from the ones we observed for the other two subscales; attitude toward enjoyment of science and attitude toward adoption of science. Figure (4.9) below clearly illustrates the significance differences in students’ attitude toward scientific inquiry scores between students in experimental and control groups, where these differences significantly change over the three test time points. At the pre-test, students in the experimental group, on average, showed a higher level of attitude toward scientific inquiry than the students in the control group. At the follow-up test, students in the control group showed a higher score in attitude toward scientific inquiry scores than the experimental group.

By computing the effect size, the researcher found statistically significant differences in the pre-test point for the benefit of the experimental group. The effect size was 0.08, which is practically just 3.19% higher than the control group. Also, by computing the effect size the researcher found statistically significant differences in the post-test point for the benefit of the experimental group. The effect size was 0.04, which is practically just 1.60% higher than the control group. Finally, by computing the effect size, the researcher found statistically significant differences in the follow-up point for the benefit of the control group. The effect size was 0.03, which is practically just 1.20% higher than the experimental group.
Figure 4.9. Differences in students’ attitude toward scientific inquiry between experimental and control groups across test time points.

Students’ Attitudes Towards Scientific Inquiry Trend Over Time

Because of the significant interaction effect of the group membership and test time points on students’ attitude toward scientific inquiry, the researcher ran a polynomial contrasts that will allow the reader to understand the trend in students’ attitude toward science for each group. The polynomial contrasts test the significance of the linear and quadratic trends within each group. Table (4.15) presents the tests for these contrasts for both experimental and control groups. Results presented in Table (4.15) and Figure (4.9) indicate that experimental group students show a mixed significant change in their attitude toward the scientific inquiry over the three test time points.

The linear \([F(1, 24) = .66, P = .43, \text{Partial } \eta^2 = .03]\) happened to be statistically insignificant, yet the quadratic \([F(1, 24) = 7.15, P = .01, \text{Partial } \eta^2 = .23]\) contrast is statistically significant. On average, as a linear trend there is small insignificant overall change (0.24) from the pre-test (31.92) to the follow-up test (32.16) for the experimental
group students’ attitude toward scientific inquiry. When we introduce the post-test scores in the trend, we see that there is a noticeable increase in average students’ attitude toward scientific inquiry at the post-test time to 33.20, and then a drop down to 32.16 at the follow-up test time. This increase at the post-test time followed by the drop down at the follow-up test time in students’ attitude toward scientific inquiry is statistically significant as presented by the significant test of the quadratic contrast.

When examining the trend in students’ attitudes toward scientific inquiry for the control group, the researcher found a different picture where the linear trend \([F_{(1, 24)} = 13, P = .00, \text{Partial } \eta^2 = .35]\) is statistically significant, yet the quadratic \([F_{(1, 24)} = 1.24, P = .28, \text{Partial } \eta^2 = .22]\) contrast is statistically insignificant. Figure (4.9) above shows that there is a small, yet significant, upward linear trend in the level of students’ attitude toward scientific inquiry for the control group. Students’ attitudes toward scientific inquiry on average increased from 31.44 on the pre-test to 32.52 on the follow-up test. Further, the researcher noticed that while average scores for students’ attitude toward scientific inquiry for both the post-test (32.28) and the follow-up test (31.52) are higher than the pre-test (29.92) average scores, the difference between the follow-up test scores and the post-tests scores is relatively small (0.24) leading to an insignificant quadratic trend. This relative consistency in students’ attitude toward scientific inquiry for the control group caused the quadratic trend to be statistically insignificant.
Table 4.15 *Polynomial Contrasts for Students’ Attitude Towards Scientific Inquiry Over Test Times*

<table>
<thead>
<tr>
<th>Group</th>
<th>Contrast</th>
<th>Df</th>
<th>F</th>
<th>Sig.</th>
<th>Partial η²</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tests</td>
<td>Linear</td>
<td>1</td>
<td>.66</td>
<td>.43</td>
<td>.03</td>
<td>.12</td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>1</td>
<td>7.15</td>
<td>.01</td>
<td>.23</td>
<td>.73</td>
</tr>
<tr>
<td>Control</td>
<td>Linear</td>
<td>1</td>
<td>13.00</td>
<td>.00</td>
<td>.35</td>
<td>.93</td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>1</td>
<td>1.24</td>
<td>.28</td>
<td>.05</td>
<td>.19</td>
</tr>
<tr>
<td><strong>Error (Tests)</strong></td>
<td>Linear</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Students’ Adoption of Scientific Attitudes Subscale Analysis

Addressing the subscale of students’ attitude toward adoption of science in the second research question presented earlier, the researcher restated the associated hypothesis to test and address the effect of interaction between groups (experimental and control) and test times (pre-test, post-test and follow-up test) on students’ attitude toward adoption of science subscale.

*Ho:* Mean Differences in students’ adoption of scientific inquiry scores between students taught science using Jigsaw as a cooperative learning instructional strategy (experimental group) and students taught science using the traditional strategy (control group) does not significantly change over test times (pre, post and follow up).

The above hypothesis tests the interaction effect between the two teaching method strategies for science and the test time factors on students’ attitude toward adoption of science with a similar 2 by 3 mixed analysis design used in analyzing students’ attitudes of the combined scales.
The count table above shows that 38% of the experimental group students responded in agreement with all the items in the adoption subscale which is slightly higher than 35% for the students in the control group at the pre-test time point. This small difference of (3%) in favor of the experimental group is also reflected in the summary Table (4.17) below where, on average, students in the experimental group scored (30) which is slightly higher than the students in the control group (29.92). Oppositely, findings exist at the post-time test where 42% of the control group students responded in agreement with all the adoption subscale items compared to 35% for the experimental group students. This 7% difference in favor of the control group is also confirmed in a small difference in the groups’ means between the control (31.32) and experimental (29.64) group students.

Finally, the reverse has occurred at the follow-up test times where approximately 28% of the students in the experimental group responded in agreement with the adoption subscale items compared to 22% for students in the control group. This 6% difference in
favor of the experimental group translates to a small (.84) difference in group means also in favor of the experimental group. Figure (4.10) below graphically presents these small differences in responses to the adoption subscale over the three time points between the experimental and control groups. Table (4.17) provides us with basic summary statistics of students’ attitude toward adoption of science for the two groups (experimental and control) for each of the three test time points (pre, post and follow-up).

Table 4.17 *Summary Statistics of Students’ Adoption of Scientific Attitude for the Experimental and Control Groups Across the Three Test Time Points*

<table>
<thead>
<tr>
<th>Experimental Vs Control</th>
<th>Pre-test</th>
<th>Post-tests</th>
<th>Follow-up test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>Mean</td>
<td>29.92</td>
<td>31.32</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation</td>
<td>11.46</td>
<td>9.80</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Experimental Group</td>
<td>Mean</td>
<td>30.00</td>
<td>29.64</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation</td>
<td>10.58</td>
<td>9.49</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

Once again one can obtain a student’s score by dividing the score by 10, which results in a score that ranges from 1- 5. For example, dividing the means for the control group by 10, at each time point, from table (4.17) above we obtain the values 2.99, 3.13, and 3.07 respectively. These values indicate students’ responses on average hover around the neutral response on Likert’s scale with very small difference between the time points. Similarly, dividing the means for the experimental group by 10, at each time point, from table (4.17) above we obtain the values 3.00, 2.96, and 3.16 respectively. These values indicate students’ responses on average hover around the neutral response of Likert’s scale with very small difference between the time points as well as when they are compared to the means for control group.
Checking the Assumptions for the Analysis

The three major assumptions, which are required to be valid, unbiased, and consistent for the tests, are independent observations, normal distribution of the dependent variable and the homogeneity of variance. The researcher addressed the first assumption of independent observations in the achievement analysis section. The next two sections provide validation for the other two assumptions of normality and homogeneity of variance.

*Normality assumption.* Absolute standardized values of the skew and kurtosis that exceed the value ±3.29 suggest a violation of the normality assumption. Table (4.18) displays the measures of skew and kurtosis with their standard errors for students’ attitude toward adoption of science subscale distribution within each of the experimental and control groups as well as within the three test time points (pre, post and follow up). The largest absolute standardized value of the skew measure is found for the experimental group at the pre-test time where it is equal to \( \frac{-30}{\sqrt{46}} = -0.65 \). Similarly, the largest absolute standardized value of the kurtosis measure is found for the experimental group at the pre-test time where it is equal to \( \frac{-92}{\sqrt{90}} = -0.10 \). These standardized values of skew and kurtosis are much smaller than the thresh point of ±3.29 to declare the distributions of students’ attitude toward adoption of science subscale as being non-normal.
Table 4.18 *Statistics for Skew and Kurtosis Indexes for Students’ Attitude Towards Adoption of Scientific Attitude Distribution*

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Control</th>
<th>Experimental</th>
<th>Control</th>
<th>Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skew</td>
<td>-01</td>
<td>-01</td>
<td>.46</td>
<td>.46</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-78</td>
<td>-56</td>
<td>.90</td>
<td>.90</td>
</tr>
<tr>
<td>Post-test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skew</td>
<td>-23</td>
<td>-14</td>
<td>.46</td>
<td>.46</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-50</td>
<td>-51</td>
<td>.90</td>
<td>.90</td>
</tr>
<tr>
<td>Follow-up test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skew</td>
<td>-04</td>
<td>-05</td>
<td>.46</td>
<td>.46</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-88</td>
<td>-91</td>
<td>.90</td>
<td>.90</td>
</tr>
</tbody>
</table>

*Homogeneity of variance assumption.* Validating the assumption of homogeneity of variance covariance for the repeated measure analysis is achieved by using Mauchly’s test of the sphericity assumption. Mauchly’s W test value = .98 of sphericity shows an approximate chi-square test value $[\chi^2(2) = 1.10, P = .58]$ that is statistically insignificant, indicating that the sphericity assumption has been met and one can safely proceed with the repeated measure analysis.

Repeated Measurement Analysis Results

The F-test from the repeated measure analysis for the interaction between the test time factors and the group factor, as shown in Table (4.19), is statistically significant $[F(2, 96) = 6.851, P = .002, \text{partial } \eta^2 = .125]$ at an alpha level of .05. The observed power of the F-test for the interaction effect is relatively high with a value of 0.914.

Table 4.19 *Repeated Measures F-Test of the Interaction Between the Time Points and Groups*

<table>
<thead>
<tr>
<th>Effect</th>
<th>Df</th>
<th>F</th>
<th>Sig.</th>
<th>Partial $\eta^2$</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tests</td>
<td>2</td>
<td>8.72</td>
<td>.00</td>
<td>.15</td>
<td>.97</td>
</tr>
<tr>
<td>Tests*</td>
<td>2</td>
<td>10.41</td>
<td>.00</td>
<td>.18</td>
<td>.99</td>
</tr>
<tr>
<td>Group Error</td>
<td>96</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Tests)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The significance of the interaction between groups and test times indicate that the difference in students’ attitude toward adoption of scientific attitudes scores between the experimental and control group significantly depends on any particular test time points that we are interested in. In fact, the analysis reveals a different pattern of change in the students’ attitude toward adoption of scientific attitudes over test time points for both the experimental and control group. Figure (4.10) below clearly illustrates the significance differences in students’ attitude toward adoption of scientific attitudes scores between students in experimental and control groups, where these differences significantly change over the three test time points.

Students in the experimental group, on average, showed the same level of attitude toward adoption of scientific attitude as the students in the control group before (pre-test) taking the science course. After taking the science course (post-test), students in the control group showed a higher attitude toward adoption of scientific attitude scores than the experimental group. Difference in attitude toward adoption of scientific attitude scores for the experimental group became higher than the scores for the control groups. By computing the effect size, the researcher found statistically significant differences in the post-test point for the benefit of the control group. The effect size was 0.17, which is practically 6.75% higher than the experimental group. Also, by computing the effect size the researcher found statistically significant differences in the follow up point for the benefit of the experimental group. The effect size was 0.07, which is practically just 2.79% higher than the control group.
Because of the significant interaction effect of the group membership and test time points on students’ attitude toward adoption of science, I ran a polynomial contrasts that will allow us to understand the trend in students’ attitude toward science for each group. The polynomial contrasts test the significance of the linear and quadratic trends within each group. Table (4.20) presents the tests for these contrasts for both experimental and control groups. Results presented in Table (4.20) below and Figure (4.10) above showed that experimental group students showed significant change in their attitude toward the adoption of scientific attitude over the three test time points. Both the linear \( F(1, 24) = 15.19, P = .00, \text{Partial } \eta^2 = .39 \) and the quadratic \( F(1, 24) = 10.16, P = .00, \text{Partial } \eta^2 = .30 \) contrasts were statistically significant.

On average, as a linear trend there is an overall increase in the experimental group students’ attitude toward the adoption of scientific attitude scores from 30.00 at the pre-
test time to a 31.56 at the follow-up test time. When we introduce the post-test scores in the trend, we see that there is a drop in average students’ attitude toward adoption of scientific attitude at the post-tests time to 29.64, and then an increase to 31.56 at the follow-up test time. This decrease at the post-test time and then an increase at the follow-up test time in students’ attitude toward adoption of scientific attitude is statistically significant as presented by the significant test of the quadratic contrast.

When examining the trend in students’ attitudes toward adoption of scientific attitude for the control group, the researcher also found that both the linear [F(1, 24) = 4.57, P = .04, Partial \( \eta^2 = .16 \)] and the quadratic [F(1, 24) = 7.79, P = .01, Partial \( \eta^2 = .25 \)] contrasts are statistically significant. Figure (4.10) shows that there is a small, yet significant, upward linear trend in students’ attitude toward adoption of scientific attitude for the control group. Students’ attitudes toward adoption of scientific attitude on average increased from 29.92 on the pre-test to 30.72 on the follow-up test. It is important to notice here that even though this linear increase is statistically significant, the size of this change from the pre-test to the follow-up test (0.80) is relatively small. This is reflected in the effect size (Partial \( \eta^2 \)) of 0.16. Further, we notice that while average scores for students’ attitude toward adoption of scientific attitude for both the post-test (31.32) and the follow-up test (30.72) are higher than the pre-test (29.92) average scores, the average score for the follow-up test is lower than the post-test average scores leading to a significant quadratic trend. This concaved down quadratic trend for the control group is opposite to the one we found for the experimental group, which is concaved up. This fluctuation in control group students’ attitude toward adoption of scientific attitude turned out to be statistically significant.
Table 4.20 *Polynomial Contrasts for Students’ Attitude Over Test Times*

<table>
<thead>
<tr>
<th>Group</th>
<th>Contrast</th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
<th>Partial $\eta^2$</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Tests</td>
<td>Linear</td>
<td>1</td>
<td>15.19</td>
<td>.00</td>
<td>.39</td>
<td>.962</td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>1</td>
<td>10.16</td>
<td>.00</td>
<td>.30</td>
<td>.86</td>
</tr>
<tr>
<td>Control Tests</td>
<td>Linear</td>
<td>1</td>
<td>4.57</td>
<td>.04</td>
<td>.16</td>
<td>.54</td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>1</td>
<td>7.79</td>
<td>.01</td>
<td>.25</td>
<td>.76</td>
</tr>
<tr>
<td>Error (Tests)</td>
<td>Linear</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Quadratic</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Enjoyment of Science Lessons Subscale Analysis

Addressing the subscale of students’ attitude toward enjoyment of science lessons in the second research question presented earlier, the researcher restated the associated hypothesis to test and address the effect of interaction between groups (experimental and control) and test times (pre-test, post-test and follow-up test) on students’ attitude toward enjoyment of science subscale.

$Ho$: Means Difference in students’ attitude toward enjoyment of science lessons scores between students taught science using Jigsaw as a cooperative learning instructional strategy (experimental group) and students taught science using the traditional strategy (control group) does not significantly change over test times (pre, post and follow up).

The above hypothesis tests the interaction effect between the two teaching method strategies for science and the test time factors on students’ attitude toward enjoyment of science lessons with a similar 2 by 3 mixed analysis design used in analyzing students’ attitude of the combined scales.
Table 4.21 Enjoyment of Science Lessons Subscale Items Counts and (%) for Disagree (D), Neutral (N) and Agree (A) for Experimental and Control Groups Across Test Time Points

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Control Group</th>
<th>Post-test</th>
<th>Follow-up</th>
<th>Experimental</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>D N A</td>
<td>D N A</td>
<td>D N A</td>
<td>D N A</td>
<td>D N A</td>
<td>D N A</td>
<td>D N A</td>
<td>D N A</td>
</tr>
<tr>
<td>3</td>
<td>7 6 12</td>
<td>9 6 13</td>
<td>9 6 13</td>
<td>10 10 7</td>
<td>10 7 10</td>
<td>10 7 10</td>
<td>10 7 10</td>
<td>10 7 10</td>
</tr>
<tr>
<td>6</td>
<td>9 5 11</td>
<td>6 7 10</td>
<td>6 7 10</td>
<td>6 7 10</td>
<td>6 7 10</td>
<td>6 7 10</td>
<td>6 7 10</td>
<td>6 7 10</td>
</tr>
<tr>
<td>9</td>
<td>13 8 4</td>
<td>9 10 4</td>
<td>9 10 4</td>
<td>9 10 4</td>
<td>9 10 4</td>
<td>9 10 4</td>
<td>9 10 4</td>
<td>9 10 4</td>
</tr>
<tr>
<td>12</td>
<td>11 7 7</td>
<td>7 8 10</td>
<td>7 8 10</td>
<td>7 8 10</td>
<td>7 8 10</td>
<td>7 8 10</td>
<td>7 8 10</td>
<td>7 8 10</td>
</tr>
<tr>
<td>15</td>
<td>7 5 13</td>
<td>4 4 13</td>
<td>4 4 13</td>
<td>4 4 13</td>
<td>4 4 13</td>
<td>4 4 13</td>
<td>4 4 13</td>
<td>4 4 13</td>
</tr>
<tr>
<td>18</td>
<td>4 6 15</td>
<td>2 2 12</td>
<td>2 2 12</td>
<td>2 2 12</td>
<td>2 2 12</td>
<td>2 2 12</td>
<td>2 2 12</td>
<td>2 2 12</td>
</tr>
<tr>
<td>21</td>
<td>6 4 14</td>
<td>10 6 16</td>
<td>10 6 16</td>
<td>10 6 16</td>
<td>10 6 16</td>
<td>10 6 16</td>
<td>10 6 16</td>
<td>10 6 16</td>
</tr>
<tr>
<td>24</td>
<td>9 11 5</td>
<td>6 4 13</td>
<td>6 4 13</td>
<td>6 4 13</td>
<td>6 4 13</td>
<td>6 4 13</td>
<td>6 4 13</td>
<td>6 4 13</td>
</tr>
<tr>
<td>27</td>
<td>12 6 5</td>
<td>10 4 14</td>
<td>10 4 14</td>
<td>10 4 14</td>
<td>10 4 14</td>
<td>10 4 14</td>
<td>10 4 14</td>
<td>10 4 14</td>
</tr>
<tr>
<td>30</td>
<td>10 6 9</td>
<td>8 8 10</td>
<td>8 8 10</td>
<td>8 8 10</td>
<td>8 8 10</td>
<td>8 8 10</td>
<td>8 8 10</td>
<td>8 8 10</td>
</tr>
<tr>
<td>total</td>
<td>88 67 95</td>
<td>73 75 102</td>
<td>77 75 88</td>
<td>77 75 88</td>
<td>77 75 88</td>
<td>77 75 88</td>
<td>77 75 88</td>
<td>77 75 88</td>
</tr>
</tbody>
</table>

Similar to the previous two subscales (attitude toward scientific inquiry and adoption of science), the count table above shows that 45% of the experimental group students responded in agreement with all the items in the enjoyment of science lessons subscale, which is slightly higher than 38% for the students in the control group at the pre-test time point. The small difference of (7%) between the two groups in favor of the experimental group is also reflected in the summary Table (4.22) below where, on average, students in the experimental group scored (32) which is slightly higher than the students in the control group (30.52). Similar to the adoption of scientific attitude subscale, opposite findings exist for the enjoyment of science lessons subscale at the post-test time where 41% of the control group students responded in agreement with all the enjoyment of science lessons subscale items compared to 36% for the experimental group students. This 5% difference in favor of the control group is also confirmed in a small difference in the groups’ means between the control (31.96) and experimental (30.28) groups students.
Finally, difference in counts and percentages at the follow-up tests time were extremely small (1 count in favor of the control group) that approximately equal to 0%. This negligible difference translates to a (.04) in groups means difference in favor of the control group. Figure (4.11) below graphically presents these small differences in responses to the enjoyment subscale over the three time points between the experimental and control groups. Table (4.22) provides us with basic summary statistics of students’ attitude toward enjoyment of science lessons for the two groups (experimental and control) for each of the three test time points (pre, post, and follow up).

Table 4.22 Summary Statistics of Students’ Attitude Towards Enjoyment of Science Lessons for the Experimental and Control Groups Across the Three Test Time Points

<table>
<thead>
<tr>
<th>Experimental Vs Control</th>
<th>Pre-test</th>
<th>Post-tests</th>
<th>Follow-up test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>Mean</td>
<td>30.52</td>
<td>31.96</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation</td>
<td>12.17</td>
<td>10.13</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Experimental Group</td>
<td>Mean</td>
<td>32.00</td>
<td>30.28</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation</td>
<td>10.13</td>
<td>11.38</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

Similar to the previous subscales, one can obtain a student’s score by dividing the score by 10, which results in a score that ranges from 1- 5. For example, dividing the means of the control group by 10, at each time point, from table (4.22) above we obtain the values 3.05, 3.20, and 3.16 respectively. These values indicate those students’ responses on average hover around the neutral response on Likert’s scale with a very small difference between the time points. Similarly, dividing the means for the experimental group by 10, at each time point, from table (4.22) above we obtain the values 3.2, 3.03, and 3.16 respectively. These values indicate students’ responses on average hover around the neutral response of Likert’s scale with very small difference.
between the time points as well as when they are compared to the means for control group.

Checking the Assumptions for the Analysis

The three major assumptions, which are required to be valid, unbiased, and consistent for the tests, are independent observations, normal distribution of the dependent variable and the homogeneity of variance. The researcher addressed the first assumption of independent observations in the achievement analysis section. The next two sections provide validation for the other two assumptions of normality and homogeneity of variance.

**Normality assumption.** Absolute standardized values of the skew and kurtosis that exceed the value ±3.29 suggest a violation of the normality assumption. Table (4.23) below displays the measures of skew and kurtosis with their standard errors for students’ attitude toward enjoyment of science lessons subscale distribution within each of the experimental and control groups as well as within the three test time points (pre, post and follow-up). The largest absolute standardized value of the skew measure is found for the experimental group at the pre-test time where it is equal to $\frac{-29}{46} = -0.63$. Similarly, the largest absolute standardized value of the kurtosis measure is found for the experimental group at the pre-test time where it is equal to $\frac{-1.06}{90} = -0.018$. These standardized values of skew and kurtosis are much smaller than the thresh point of ±3.29 to declare the distributions of students’ attitude toward enjoyment of science subscale as being non-normal.
Table 4.23 Statistics for Skew and Kurtosis Indexes for Students’ Attitude Towards Enjoyment of Science Lessons Distribution

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Control</th>
<th>Experimental</th>
<th>Control</th>
<th>Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skew</td>
<td>-.18</td>
<td>-.15</td>
<td>.46</td>
<td>.46</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-1.00</td>
<td>-1.01</td>
<td>.90</td>
<td>.90</td>
</tr>
<tr>
<td>Post-test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skew</td>
<td>-.25</td>
<td>-.03</td>
<td>.46</td>
<td>.46</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-.49</td>
<td>-1.02</td>
<td>.90</td>
<td>.90</td>
</tr>
<tr>
<td>Follow-up test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skew</td>
<td>-.29</td>
<td>.02</td>
<td>.46</td>
<td>.46</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-.70</td>
<td>-1.06</td>
<td>.90</td>
<td>.90</td>
</tr>
</tbody>
</table>

Homogeneity of variance assumption. Validating the assumption of homogeneity of variance covariance for the multivariate analysis of variance analysis is achieved by using Box’s M tests. Box’s $M = 38.19$ with F- test value $F(6, 16693) = 5.93$, $p = .00$ that is statistically significant, indicating that the homogeneity of variance covariance assumption has not been met. The Pillai’s trace and its associated F-tests for the multivariate analysis of variance are used.

Multivariate Analysis of Variance Results

The F-test from the multivariate analysis for the interaction between the test time factors and the group factor, as shown in Table (4.24), is statistically significant [$F(2, 47) = 11.58$, $P = .00$, partial $\eta^2 = .33$] at an alpha level of .05. The observed power of the F-test for the interaction effect is relatively high with a value of 0.99.

Table 4.24 Multivariate Analysis of Variance F-Test of the Interaction Between the Test Time Points and Groups

<table>
<thead>
<tr>
<th>Effect</th>
<th>Df</th>
<th>$F$</th>
<th>Sig.</th>
<th>Partial $\eta^2$</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tests</td>
<td>2</td>
<td>2.98</td>
<td>.06</td>
<td>.11</td>
<td>.55</td>
</tr>
<tr>
<td>Tests* Group</td>
<td>2</td>
<td>11.58</td>
<td>.00</td>
<td>.33</td>
<td>.99</td>
</tr>
<tr>
<td>Error (Tests)</td>
<td>47</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The significance of the interaction between groups and tests time indicates that the difference in students’ attitude toward enjoyment of science lessons scores between the experimental and control group significantly depends on any particular test time point that we are interested in. In fact, the analysis reveals a different pattern of change in the students’ attitude toward enjoyment of science lessons over test time points for both the experimental and control group. Figure (4.11) below clearly illustrates the significance differences in students’ attitude toward enjoyment of science lessons scores between students in experimental and control groups, where these differences significantly change over the three test time points.

Students in the experimental group, on average, showed higher level of attitude toward enjoyment of science lessons as the students in the control group before (pre-test) taking the science course. After taking the science course (post-test), students in the control group showed higher attitude toward enjoyment of science lessons scores than the experimental group. The attitude toward enjoyment of science lessons score for the experimental group became almost equivalent to the scores for the control groups at the follow-up test. By computing the effect size, the researcher found statistically significant differences in the pre-test point for the benefit of the experimental group. The effect size was 0.13, which is practically 5.17% higher than the control group. Also, by computing the effect size the researcher found statistically significant differences in the post-test point for the benefit of the control group. The effect size was 0.15, which is practically 5.96% higher than the experimental group.
Figure 4.11. Differences in students’ attitude toward enjoyment of science lessons between experimental and control groups across test time points.

Students’ Attitudes Towards Enjoyment of Science Lessons Trend Over Time

Because of the significant interaction effect of the group membership and tests times points on students’ attitude toward enjoyment of science, the researcher ran a polynomial contrasts that will allow the reader to understand the trend in students’ attitude toward science for each group. The polynomial contrasts tests the significance of the linear and quadratic trends within each group. Table (4.25) presents the tests for these contrasts for both experimental and control groups. Results presented in Table (4.25) bellow and Figure (4.11) above showed that experimental group students showed a significant change in their attitude toward the enjoyment of science lessons over the three test time points. The linear \([F(1, 24) = .68, P = .42, \text{ Partial } \eta^2= .03]\) happened to be statistically insignificant, yet the quadratic \([F(1, 24) = 108.06, P = .00, \text{ Partial } \eta^2= .43]\) contrast is statistically significant.

On average, as a linear trend there is small insignificant overall downward change (-.40) from the pre-test (32.00) to the follow-up test (31.60) in the experimental group.
students’ attitude toward the enjoyment of science lessons. When we introduce the post-test scores in the trend, we see that there is a noticeable drop in average students’ attitude toward enjoyment of science lessons at the post-tests time to 30.28 and then an increase to 31.60 at the follow-up test time. This decrease at the post-test time and then an increase at the follow-up test time in students’ attitude toward enjoyment of science lessons is statistically significant as presented by the significant test of the quadratic contrast.

When examining the trend in students’ attitudes toward enjoyment of science lessons for the control group, the researcher found that both the linear \( F_{(1, 24)} = 5.67, P = .03, \text{Partial } \eta^2 = .19 \) and the quadratic \( F_{(1, 24)} = 6.58, P = .02, \text{Partial } \eta^2 = .22 \) contrasts are statistically significant. Figure (4.11) above shows that there is a small yet significant upward linear trend in students’ attitude toward enjoyment of science lessons for the control group. Students’ attitudes toward enjoyment of science lessons on average increased from 30.52 on the pre-test to 31.64 on the follow-up test. It is important to notice here that even though this linear increase is statistically significant, the size of this change from the pre-test to the follow-up test (0.80) is relatively small. This is reflected in the effect size (Partial \( \eta^2 \)) of 0.16. Further, the researcher noticed that while average scores for students’ attitude toward enjoyment of science lessons for both the post-test (31.96) and the follow-up test (31.64) are higher than the pre-test (29.92) average scores, the average score for the follow-up test is lower than the average score for the post-test leading to a significant quadratic trend. This concaved down quadratic trend for the control group is opposite to the one we found for the experimental group, which is
concaved up. This fluctuation in control group students’ attitude toward enjoyment of science lessons turned out to be statistically significant.

Table 4.25 Polynomial Contrasts for Students’ Attitude Towards Enjoyment of Science Lessons Over Test Times

<table>
<thead>
<tr>
<th>Group</th>
<th>Contrast</th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
<th>Partial $\eta^2$</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>Linear</td>
<td>1</td>
<td>.68</td>
<td>.42</td>
<td>.03</td>
<td>.12</td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>1</td>
<td>18.06</td>
<td>.00</td>
<td>.43</td>
<td>.98</td>
</tr>
<tr>
<td>Control</td>
<td>Linear</td>
<td>1</td>
<td>5.67</td>
<td>.03</td>
<td>.19</td>
<td>.63</td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>1</td>
<td>6.58</td>
<td>.02</td>
<td>.22</td>
<td>.69</td>
</tr>
<tr>
<td>Error (Tests)</td>
<td>Linear</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quadratic</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chapter Summary

In this chapter I presented the analysis of the study. The analysis consists of two main parts: the analysis of the achievement test and the analysis of the attitude toward science scale. The analysis of the attitude toward science scale also consists of two main parts, which are the general analysis of the whole scale and the analysis of the sub scales separately. The separate subscales are: the attitude toward scientific inquiry, the adoption of scientific attitudes, and the enjoyment of science lessons.

The analysis showed that there is a significant growth on the students' achievement for the benefit of the experimental group who taught the content by using jigsaw method as one of the cooperative learning strategies. On the other hand, the general analysis of the attitude toward science scale showed that students in the experimental group, on average, showed a very slight higher attitude scores than students in the control group before taking the science course. After taking the science course, students in the control group showed a very slight higher attitude scores than the
experimental group. Difference in attitude score between the experimental and control
groups became insignificant at the follow-up measurement where the control group
scored slightly higher than the experimental group. Change in the attitude measure
overtime was very small for both the experimental and control groups have no practical
significance even when it is statistically significant.

In addition, the analysis of the attitude toward scientific inquiry subscale showed
that students in the experimental group, on average, showed higher attitude scores than
students in the control group before and after taking the science course. At the follow-up
time point, students in the control group showed higher attitude subscale scores than the
experimental group. The analysis of the other two subscales showed higher attitude
scores on the benefit of the control group. Similar to the total attitude scale, the change in
the three individual subscales overtime was very small for both the experimental and
control groups have no practical significance even when it is statistically significant.
CHAPTER V
DISCUSSION AND RECOMMENDATIONS

This chapter reviews the main results and considers future implications of the study. The chapter discusses the research questions and findings, implications of the study, limitations of the study, and recommendations for future research.

Research Questions and Findings

The purpose of this study was to investigate the impact of the Jigsaw cooperative learning instructional strategy on science achievement and attitudes toward science among male Saudi Arabian high school students enrolled in an environmental science class. Jigsaw was used to teach a textbook chapter on biodiversity and conservation.

The study was guided by two main questions: (a) What is the impact of using Jigsaw as a cooperative learning instructional strategy in a Saudi Arabian high school science classroom on male students’ achievement? and (b) What is the impact of using Jigsaw as a cooperative learning instructional strategy in a Saudi Arabian high school science classroom on male students’ attitudes toward science and specifically their attitude toward scientific inquiry, adoption of scientific attitudes, and enjoyment of science lessons?

The study also was guided by two research hypotheses: (a) There is no significant difference in achievement at the three test points for the experimental group using the Jigsaw as a cooperative learning instructional strategy compared with the control group
and (b) There is no significant difference in attitude scores at the three test points for the experimental group using the Jigsaw as a cooperative learning instructional strategy compared with the control group.

Jigsaw and Achievement

Results of the study support the emerging body of research that suggests that cooperative learning in general, and Jigsaw in particular, is an effective teaching strategy of improving student achievement (Alghamdi & Gillies 2013; Ahuja, 1994; Ajaja, 2010; Altun, 2015; Batool & Parveen 2012; Demirci, 2010; Drakeford, 2012; Hasanin, 2002; Hong, 1986; Phillips, 2010; Salem, 1998). Students in the experimental group who were taught the content by using Jigsaw as one of many cooperative learning strategies scored higher than students in the control group who were taught the same content by traditional instructional methods. The reasons behind the achievement gains in the current study’s experimental group are discussed below.

The students appeared to like Jigsaw as a cooperative learning strategy. They showed a high level of self-esteem while working cooperatively in their assigned groups. Dickinson (1994) noted, “cooperative learning enhances children’s ability to construct knowledge as they engage in discovering new ideas with each other. In addition, it enhances students’ self-esteem and helps teachers with classroom management” (p. 20).

The use of K-W-L charts enhanced the students’ ability to preserve information and perform better on both the achievement post-test and the follow-up test. These results match the findings of Riswanto and Lismayanti (2014), who noted that K-W-L charts played a motivational role in empowering the students’ ability to make achievement gains. Siribunnam and Tayraukham (2009) found that students who used K-W-L charts
had better analytical-thinking skills than students who used a conventional study method because K-W-L charts required students to use and refine their reading and thinking skills. For example, students had to acknowledge what they were thinking as well as analyze how they think, check what they were thinking, and adjust their thinking to be suitable for the topic and the situation.

The freedom that students in experimental group enjoyed during the cooperative learning activities encouraged them to achieve more compared to the control group. This result matches the findings of Eilks (2005), which showed that about 40% to up to more than 60% of the students he studied made positive statements concerning cooperative learning. For example, the students often said that they liked working in small groups, cooperative learning improved the atmosphere in the classroom, and that they liked working together with all of the students or with some students with whom they previously had little contact. Some students said that the freedom to search different sources was very important to them because they were responsible for what they learned and for what their classmates learned. Other students mentioned that cooperative learning made the lesson more attractive for them and that all of the students were included in the learning process.

Cultural pedagogy plays a major role in a tribal society such as the one involved in the current study. In a tribal society, students like to work cooperatively to gain knowledge and build relationships just as they work cooperatively in most social activities. This observation matches the findings of Kose (2010), who noted that students who work together in small groups learn better, retain more information, and build better relationships with classmates and members of the group.
From a motivational perspective, cooperative learning—especially the Jigsaw strategy used in the current—improved the students’ achievement. This outcome may be linked to Slavin’s (1987) finding that people working together toward a common goal can accomplish more than people working by themselves. This kind of group motivation to accomplish a common goal, Slavin (1987) noted, is a hallmark of cooperative learning strategies and has been found to be instructionally effective in secondary school.

From the social-constructivist approach, Vygotsky (1978) asserted that learning is a social activity. In this regard, it is notable that cooperative learning has allowed educators to structure a more student-centered environment by allowing students to learn through interaction with their peers. In such settings, Vygotsky noted, teachers have seen greater educational achievement among their students. Likewise in the current study, the social interaction among students in cooperative learning groups enhanced their academic achievement.

Scale of Attitudes Towards Science

In the current study, a general analysis of the scale measuring students’ attitudes toward science showed that students in the experimental group, on average, had higher attitude scores than students in the control group before taking the science course. After taking the science course, students in the control group had higher attitude scores than the experimental group. The difference in the two group’s attitude scores, however, was insignificant on the follow-up measurement, as the control group scored only slightly higher than the experimental group. The similarity in scores indicates that although the students in the experimental group worked cooperatively, took an active role in learning, and had better achievement results, their attitudes did not change in a positive direction.
Further analysis of the attitude data showed that students in the experimental group did not experience a significant change in attitude toward science at most of the three attitude assessment points. These results match those of Demirici (2010), who found that students who were taught science by teachers using a conventional learning approach developed a more positive attitude about the science lesson than students in a cooperative learning classroom.

In the same way, a study by Chiu (2002) showed that students in a team situation did not demonstrate significantly better skills or attitudes than students in an individual-learning environment. In addition, Hasanin (2002) found no significant differences in students’ attitudes when he compared a control group who used an individual-learning strategy with an experimental group who used Jigsaw as a cooperative learning strategy. Most of the studies presented in the literature, however, emphasized the positive effect of cooperative learning in general and Jigsaw in particular on students’ attitudes toward science (Ahuja, 1994; Ajaja, 2010; Ajaja and E jovwoke, 2010; Akcay, Yager, Iskaner, & Turgut, 2010; Hong, 1986; Kose, 2010; Maxfield, 2011; Phillips, 2010; Salem, 1998).

The analysis of separate subscales showed slight differences in the attitude scale. One example is attitude toward scientific inquiry. The study results showed significance differences in attitude subscale scores between students in the experimental and students in the control group. These differences changed significantly at the time of the follow-up assessment. Students in the experimental group, on average, had higher attitude scores than students in the control group before and after taking the science course. On the follow-up assessment, students in the control group had higher attitude subscale scores than students in the experimental group. The experimental group was slightly higher on
the post-test attitude scores with no significant change on the students’ attitudes toward scientific inquiry; however, the lower score for this subscale at the follow-up time was disappointing.

In the same way, the analysis of the adoption of scientific attitude subscale showed significant differences in scores for students in experimental compared with scores for students in the control group. Students in both groups started about the same in their average adoption of scientific attitude subscale scores. Students in the experimental group, on average, scored much lower than the students in the control group at the post-test time. This difference changed significantly at the follow-up time, creating a none-ordinal interaction between the groups and time. Students in the experimental group, on average, had higher adoption of scientific attitude scores at the follow-up time than the students in the control group. This result is unpredictable and creates an abnormal trend for the attitude change patterns; however, the number of students who participated in this study is not large enough to produce strong indications of change. Moreover, the length of the study was not sufficient to show more realistic results.

Finally, the analysis of the students’ enjoyment of science lessons subscale showed significance differences between the scores of students in experimental and the scores of students in the control group over time. Students in the experimental group, on average, had higher score on the enjoyment of science lessons subscale at the pre-test time than the students in the control group. Differences at the post-test time changed. Students in the experimental group, on average, scored lower than students in the control group. This difference between the two groups drastically disappeared at the follow-up time, as both groups, on average, scored about the same.
The analysis of enjoyment of science lessons further showed that students in the control group enjoyed the traditional lessons slightly more than the students in the experimental group enjoyed the lessons presented with the Jigsaw strategy. The lack of available resources may have affected the results of this subscale. In addition, most of the students participating in this study had never used Jigsaw as a cooperative learning instructional strategy, which made them unfamiliar of this kind of teaching method. That unfamiliarity likely is reflected in their lower scores on the attitude scale.

Students also did not like having to write their thoughts on the K-W-L charts. While enthusiasm for using the charts was at the beginning of the study, that enthusiasm dwindled to the point where most of the students refused to use them. It then became necessary to insist that the students continue using the charts. From a teacher’s perspective, the K-W-L charts did improve the students’ achievement though not their attitudes toward the enjoyment of the science lessons.

It is worth noting that after making the random assignments for the Jigsaw groups, students in two out of the five groups complained about the group to which they had been assigned. Students in these two groups wanted to move to another group so they could work with relatives or students from their own tribe. The students were reminded several times that changing the groups was not possible because the random assignment needed to be maintained. The students also were told that changing groups would affect the results of the study and that the rules of the study required that they remain in the same group until the last day of the study. Students in these two groups were not among the students who received an award for best presentation or highest test scores. The students’
lack of engagement in the Jigsaw process may be among the factors that affected the results of the attitudes toward science scale.

Conclusion

The findings of this study support the use of Jigsaw as a cooperative learning strategy to increase student achievement relative to the outcome achieved with traditional instructional methods. Students in the study’s Jigsaw groups scored significantly higher on assessments measuring their mastery of the environmental science class subject matter. This research showed significant growth in student achievement when Jigsaw was the cooperative learning instructional strategy used in the classroom.

Unlike the achievement results, the attitude results did not reach a level of significance. For example, the attitude results showed only a small positive increase in attitudes toward science among students in the control group compared with the change in attitudes among students in the experimental group. The analysis of separate attitude subscales showed different patterns of fluctuation among the three attitude assessments. In general, students’ attitudes toward science did not change on the three assessments in terms of the overall scale and in terms of the attitude subscales. Scores for all of the attitude subscales were at or near the neutral level.

Implications of the Study

The most important implication of this study is that it showed for the first time the importance of using the Test of Science Related Attitudes (TOSRA) for Saudi Arabian high school students. TOSRA, which was developed and validated in Australia and the United States (Fraser, 1981), measures students’ attitudes toward science after they have
studied scientific content with a different kind of instructional method. The test has three levels with three subscales each.

Although the Jigsaw strategy was time-consuming, the results from studying the use this kind of teaching method are valuable. This study can serve as a model for the integration of K-W-L charts with Jigsaw as a cooperative learning instructional strategy for the purpose of increasing student learning and getting higher achievement scores. In addition, the integration of social constructivism with science teaching in secondary school in Saudi Arabia requires the development and application of a higher level of thinking when creating the content for an environmental science class. The learning tasks and activities should be created and designed to ensure alignment with the social life of Saudi Arabian students and the learning objectives of the class. One of the most important suggestions is to use Jigsaw as a cooperative learning strategy in the teaching process. The formation of Jigsaw groups requires a combination of students working in multiple groups and at multiple levels. This strategy would emphasize the role of social constructivism in Saudi Arabian society.

Limitations of the Study

In any study, limitations affect the degree of generalization that can be derived from the results. The following are some of the limitations that may affect the findings of this study:

- The population of students in this study consisted of two 11th-grade science classes of 25 students each for a total of 50 students. Because the sample size is small, it may not be possible to generalize the results from this study to all 11th-grade students in Saudi Arabia.
• This study was intended mainly for male high school students and only those in Saudi Arabia. Only males were included because of the segregation between boys and girls in all school grades.

• The assessments of academic achievement and attitudes toward science are based on the quality of the instruments that were used.

• Responses to the scale measuring attitudes toward science could have been influenced by the students’ emotions at the time the assessments were administered.

• The tribal culture in Saudi Arabia inclines students to work with other students who belong to the same tribe rather than work with students from different tribes.

• Students in the control group had two more days of instructions than the experimental group did for the first lesson because students in the experimental group had learn the Jigsaw strategy before they could start the class lessons. The Jigsaw training used two days that otherwise could have been spent on classroom instruction. The experimental group instruction aligned with that of the control group during weeks 3 and 4.

Recommendations for Future Research

Students should be taught how to use K-W-L charts. To make the charts more valuable to students, teachers should use the charts to direct the students’ learning. In this study, the three models were combined into one model to make it easy for students to use the charts. Further research to investigate the power of using K-W-L charts to improve student achievement in different instructional settings is highly recommended.
Increased attention should be given to using cooperative learning in Saudi Arabia, as the strategy is one of the most compatible teaching methods for students at the high school level. More studies using Jigsaw and other cooperative learning strategies should be conducted to investigate additional implications of this kind of instructions. Enrolling more participants in such studies would provide better indications of the value of using cooperative-learning strategies such as Jigsaw.

Further research with a longer time frame is needed for the study of attitudes toward science in Saudi Arabia. The scales used to measure attitudes toward science should be expanded for more in-depth exploration of students’ attitudes toward different instructional methods. Studies should be conducted to determine whether longer periods between the three attitude-assessment points would yield more trustworthy results. A longer period is recommended because changes in attitudes may not happen quickly.

Researchers should attempt to replicate the current study’s methodology. The study focused primarily on final student outcomes with limited focus on the learning processes that occur during the different phases of the Jigsaw strategy. Future studies should focus on understanding how various questioning techniques and the scientific-thinking methodology affect learning processes and the products related to the use of Jigsaw as a cooperative learning instructional strategy.

Chapter Summary

This chapter discussed the major findings used to answer the research questions regarding students’ achievement and their attitudes toward science. The findings support the use of Jigsaw as a cooperative learning strategy to increase student learning compared to a traditional-instruction control group. Students in Jigsaw groups scored significantly
higher on achievement assessments than a control group after both groups received instruction on the topic of biodiversity and conservation in an environmental science class. The research showed significant growth in achievement among the students using the Jigsaw cooperative-learning instructional strategy.

On the attitude scales, the study showed slightly normal growth in the control-groups students’ attitudes toward science compared with the experimental group. The analysis of attitude subscales showed different patterns of fluctuation at the three points of assessment. In general, students’ attitudes toward science at the three assessments essentially did not change in terms of either the overall scale or the subscales. The scores were at or near the neutral level for all subscales. The chapter concluded with a statement of the main implications of the study, the study’s limitations, and recommendations for further research.


Alghamdi, R., & Gillies, R. (2013). The impact of cooperative learning in comparison to traditional learning (small groups) on EFL learners’ outcomes when learning English as a foreign language. *Asian Social Science, 9*(13), 19.


Hasanin, B. (2002). The impact of using cooperative learning on the development of students’ achievement and attitudes towards science in the fourth grade. *Cairo Press, 38*(2), 110-123.


Weinburgh, M. H. (2000). Gender, ethnicity, and grade level as predictors of middle school students’ attitudes towards science.


APPENDICES
APPENDIX A
HUMAN SUBJECT APPROVAL
IRB APPROVAL LETTER

Office of Research Administration

NOTICE OF APPROVAL

Date: May 17, 2016
To: Abdulrahem Alghamdi,
Curricular & Instructional Studies
From: Sharon McWhorter, IRB Administrator
IRB Number: 20160608
Title: What Attitudes were Developed by Saudi Arabian High School Students in a Cooperative Learning Instructional Science Lesson

Approval Date: May 17, 2016

Thank you for submitting your IRB Application for review. Your protocol represents minimal risk to subjects and matches the following federal category for exemption:

☑ Exemption 1 – Research conducted in established or commonly accepted educational settings, involving normal educational practices.

☐ Exemption 2 – Research involving the use of educational tests, survey procedures, interview procedures, or observation of public behavior.

☐ Exemption 3 – Research involving the use of educational tests, survey procedures, interview procedures, or observation of public behavior not exempt under category 2, but subjects are elected or appointed public officials or candidates for public office.

☐ Exemption 4 – Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens.

☐ Exemption 5 – Research and demonstration projects conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine public programs or benefits.

☐ Exemption 6 – Taste and food quality evaluation and consumer acceptance studies.

Annual continuation applications are not required for exempt projects. If you make changes to the study's design or procedures that increase the risk to subjects or include activities that do not fall within the approved exemption categories, please contact the IRB to discuss whether or not a new application must be submitted. Any such changes or modifications must be reviewed and approved by the IRB prior to implementation.

Please retain this letter for your files. This office will hold your exemption application for a period of three years from the approval date. If you wish to continue this protocol beyond this period, you will need to submit another Exemption Request. If the research is being conducted for a master's thesis or doctoral dissertation, the student must file a copy of this letter with the thesis or dissertation.

☐ Approved consent forms enclosed

OHIO'S POLYTECHNIC UNIVERSITY
Uniting the Arts & Humanities with Science & Technology

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APPENDIX B

LETTER FROM THE DEAN OF COLLEGE OF EDUCATION TO
THE DEAN OF SCIENTIFIC RESEARCH AT ALBAHA UNIVERSITY

سعادة عميد البحث العلمي

السلام عليكم ورحمة الله وبركاته.

نعتذر عن التأخير في الاتصال بكم، تخصصاًضايف، فقد قمنا بتفعيل البرنامج التعليمي ونحوه. ومع ذلك، فقد استخدم النظام التعليمي على تحصل الطلاب على مادة الادارة والاقتصاد نحو المدى بالمملكة العربية السعودية.

عذراً، ومن منطلق التعاون فيما يخدم الميدان التربوي. نأمل من سعادة تطبيق التشفير تسهيل مهمة الترميز بطريقة آمنة على مستوى الدراسة.

مبارك الباحة.

شكرًا لتعاطيفكم، ومثلكم.

عميد مكتب التربوية

د. صالح بن أحمد دخيل
APPENDIX C

LETTER FROM THE DEAN OF SCIENTIFIC RESEARCH

TO THE DIRECTOR OF ALBAHA SCHOOL DISTRICTS
APPENDIX D

LETTER FROM THE SCHOOL DISTRICT

TO THE PRINCIPAL OF AL SARWAT HIGH SCHOOL

المكرم/ قائد مدرسة السروات الثانوية

السلام عليكم ورحمة الله وبركاته

بناءً على خطاب وكيل الجامعة للدراسات العليا والبحث العلمي بجامعة الباحا رقم 271214443 وتاريخ 6/9/2014 بشأن رغبة الباحث / عبدالمعتم بن حسن الفاخمي ، بتطبيق أداة حبه المشروع / أثر استخدام التعليم التفاعلي على تحصيل الطلاب واتجاههم نحو العلوم في المملكة العربية السعودية.

عليك أعلم منحكم تسهيل مهمة الباحث بتقديم أداة الدراسة على أنه يؤثر على المستوى التحصيلي للطلاب أو الإخلال بسير العملية التعليمية وذلك خلال أسبوعين من بداية الفصل الصيفي.

والسلام عليكم ورحمة الله وبركاته ..

المدير العام للتعليم بمدينة الباحا

سعيد بن محمد مخالص الزهراني
APPENDIX E

THE K-W-L SHEETS

What do I already know about the topic?

Name:          Date:

Topic:

Directions: After getting your specific topic, think about what you know about the topic. Write at least 5 things you know about it.

<table>
<thead>
<tr>
<th>What do I know?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
</tr>
<tr>
<td>5.</td>
</tr>
</tbody>
</table>
What do I NEED to know about the topic to be an expert?

Name:          Date:

Topic:

Directions: After you reviewing the “What do I know about the topic?” worksheet, think about what you need to know. Write at least 5 things you need to know about the topic to be an expert.

<table>
<thead>
<tr>
<th>What do I want to know?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
</tr>
<tr>
<td>5.</td>
</tr>
</tbody>
</table>
Directions: After you became an expert in your topic, think about what you have learned. Write at least 5 things you have learned about your topic.

<table>
<thead>
<tr>
<th>What have I learned?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
</tr>
<tr>
<td>5.</td>
</tr>
</tbody>
</table>
What have the group learned?

Name of group: ___________________________ Date: ___________________________

Topics: ___________________________

Directions: As a group, think about what you have learned today. Write at least 5 things you have learned from each other today.

<table>
<thead>
<tr>
<th>What have the group learned?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
</tr>
<tr>
<td>5.</td>
</tr>
<tr>
<td>KWL</td>
</tr>
<tr>
<td>:---</td>
</tr>
<tr>
<td>ما تعلمته</td>
</tr>
<tr>
<td>ما أريد أن أعرفه</td>
</tr>
<tr>
<td>ما أتعلم</td>
</tr>
</tbody>
</table>

(الخطاط)
APPENDIX F

THE COOPERATIVE LEARNING RUBRIC

Cooperative Learning Project Rubric

Name: ------------------------------- Date: -------------------------------

Project Title: ---------------------------------------------

<table>
<thead>
<tr>
<th></th>
<th>Exceptional</th>
<th>Admira</th>
<th>Acceptable</th>
<th>Not Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Organization</td>
<td>Extremely well organized; logical format that was easy to follow; flowed smoothly from one idea to another and cleverly conveyed; the organization enhanced the effectiveness of the project</td>
<td>Presented in a thoughtful manner; there were signs of organization and most transitions were easy to follow, but at times ideas were unclear</td>
<td>Somewhat organized; ideas were not presented coherently and transitions were not always smooth, which at times distracted the audience</td>
<td>Choppy and confusing; format was difficult to follow; transitions of ideas were abrupt and seriously distracted the audience</td>
</tr>
<tr>
<td>Presentation Length</td>
<td>5 + minutes</td>
<td>3-4 minutes</td>
<td>1-2 minutes</td>
<td>Did not present</td>
</tr>
<tr>
<td>Presentation Design</td>
<td>Text, color, images, contrast, etc. were excellent: well organized or correlated with topic</td>
<td>Text, color, images, contrast, etc. were satisfactory: somewhat organized or correlated with topic</td>
<td>Text, color, images, contrast, etc. were unsatisfactory: were not organized or correlated with topic</td>
<td>Text, color, images, contrast, etc. were not presented</td>
</tr>
<tr>
<td>Information</td>
<td>Information was fully understood: it was well organized and clearly presented.</td>
<td>Information was somewhat understood: most information was complete one portion is not logically organized.</td>
<td>Information was not fully understood: some information was clear and logically sequenced.</td>
<td>Information was not understood: information was incomplete and unclear.</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Presentation speaking</td>
<td>Student used a clear and loud voice and pronounced words / terms correctly</td>
<td>Spoke somewhat soft and unclear and pronounced some words / terms incorrectly</td>
<td>Spoke unclearly and soft and did not pronounce any words / terms correctly</td>
<td>Did not participate</td>
</tr>
<tr>
<td>Presentation Mechanics</td>
<td>Was engaging, provocative, and captured the interest of the audience and maintained this throughout the entire presentation; great variety of visual aids and multimedia; visual aids were colorful and clear</td>
<td>Was well done and interesting to the audience; was presented in a unique manner and was very well organized; some use of visual aids</td>
<td>Was at times interesting and was presented clearly and precisely; was clever at times and was organized in a logical manner; limited variety of visual aids and visual aids were not colorful or clear</td>
<td>Was not organized effectively; was not easy to follow and did not keep the audience interested; no use of visual aids</td>
</tr>
</tbody>
</table>

Total grade is (24)


Final Grade: ( ) Comments:
APPENDIX G

THE INSTRUCTIONS OF EXPERIMENTAL GROUP

**Jigsaw instructions Sheet**

With your home group start by reading the topic you have been given and fill out the K sheet

Share the information in your K sheet with your friends, then fill out the W sheet

Open the folder and read the instructions with your groupmates, then move to your experts’ group

Read, discuss, look for information in different resources and share information with your expert groupmates, then draw a conclusion

Go back to your home group in order to explain your piece of information to the whole group

After listening to all groupmates in the home group, discuss with them what information should be presented in the final project
Fill out the L sheet, and then work cooperatively with your groupmates on the final project

Present your part in the final project presentation
الملكة العربية السعودية
وزارة التعليم
الإدارة العامة للتعليم بمنطقة الباحة
ثانوية السروات

عزيزي الطالب

السلام عليكم ورحمة الله وبركاته وبعد:

يقوم البحث بعمل دراسة للحصول على درجة الدكتوراه في مجال تدريس العلوم بعنوان "أثر استخدام التعليم التعاوني على تحصيل الطلاب في مادة التربية البيئية واتجاهاتهم نحو العلوم في المملكة العربية السعودية". ومن ضمن الأدوات التي يستخدمها البحث للحصول على بيانات يتم استخدامها بغض النظر عن الاختيار الذي بين يديك والذي سوف يساهم في إنجاز هذا البحث.

أماك مجموعة من الأسئلة في علم البيئة والمناظر الموضوعات التي تمت دراستها في الفصل الرابع بعنوان التنوع الحيوي والمحافظة عليه. المرجو منك عزيزي الطالب الإجابة على الأسئلة بعناية حيث تشمل الأسئلة على خمسة عشر سؤالًا من نوع ضع علامة صح أو خطأ،ية مبتدأ العيارات المحددة وكذلك خمسة عشر سؤالًا آخر من نوع اختصار الإجابة الصحيحة.

جميع الأسئلة واضحة وومباشرة وتقيس قدرتك التحصيلية في فصل التنوع الحيوي والمحافظة عليه.

إجاباتك محل تقدير ودرجات هذا الاختبار سوف تستخدم لأغراض الدراسة فقط.

هذا الاختبار مكون من اعتاق من قبل مختصين وتم التحقق من صدقته وثباته وسلامته للتطبيق.

عدد الأسئلة الإجمالي (30) سؤالًا ونسبة الاختبار (45) دقيقة.

شكرا لتعاونك وأتمنى لك التوفيق.

الباحث: عبدالمجيم حسن الرياش
جامعة الباحة - كلية التربية
قسم المناهج وطرق التدريس

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السوال الأول: أجب بعلامة (٠) أو (١) أو (٢) أو (٣) أو (٤) أمام العبارات التالية:

١. التنوع الحيوي مهم لسلامة الغلاف الجوي.
٢. هناك ثلاثة أنواع من التنوع الحيوي: الوراثي، وأنواع، والنظم البيئي.
٣. التنوع الحيوي قيمة اقتصادية مباشرة فقط.
٤. من مهم المحافظة على التنوع الحيوي بوصفه مستودع لحفظ الجينات الوراثية التي يمكن أن تحتاج إليها في المستقبل.
٥. توفر لنا الأنظمة البيئية السليمة فوائد كثيرة، أعلى من استخدام التقنيات.
٦. معدل انقراض أنواع الحالية مرتفع بصورة طبيعية.
٧. الأنواع التي تعزى في الجزر ليست أكثر عرضة للانقراض من الأنواع التي تعش في الأماكن الأخرى.
٨. تاريخياً، أدى استغلال الإنسان الجائر لبعض الأنواع إلى انقراضها.
٩. أنشطة الإنسان تجاه البيئة غالبًا ما ينتج عنها نقص في التنوع الحيوي.
١٠. هناك نوعان من الموارد الطبيعية:هما موارد المتزنة وغير المتزنة.
١١. أدى الطرائق لاستخدام الموارد الطبيعية في تنوع البيئة.
١٢. تدور النفايات لا يساعد في حفظ التنوع الحيوي في العالم.
١٣. تحوي مواقع التنوع الحيوي الساخنة عددًا كبيرًا من الأنواع المستوطنة المهيئة بالانقراض.
١٤. نستخدم تقنيات لإعادة استصلاح التنوع الحيوي في النظام البيئي، وآلية البيوية، والزيادة البيوية.
١٥. منذ عام ١٩٥٠ تم وضع العديد من التشريعات لحماية البيئة.

السوال الثاني: اختر الإجابة الصحيحة بوضع دائرة على الخلاط المقابل لها فيما يلي:

١. من أنواع الإنسان التي ينتج عنها نقص في التنوع الحيوي:
   ب. تدمير الموطن البيئي.
   ج. إدخال أنواع غير أصلية.
   د. جميع ما سبق.
   ا. إطلاق الملوثات.

٢. ما الذي يمثل القيمة الاقتصادية مباشرة للتنوع الحيوي:
   ب. الحماية من الفيضان.
   ج. الطعام.
   د. الأدوية.
   ا. الملايين.

٣. عندما تقوم بإزالة الأشجار من الأراضي الخاصة بك ووضع طبقة من الإسفلت فإن ذلك يكسب بما يسمى:
   ب. الاستغلال الجائر.
   ج. تدمير الموطن البيئي.
   د. لا شيء مما سبق.
   ا. الجزء الموطن البيئي.

٤. احترام الوقود الأخضر يطلق أكاسيد الكبريت وآكاسيد النتروجين في الجو وذلك بدوره ينتج:
   ب. التضخم الحيوي.
   ج. الإثراء الغذائي.
   د. جميع ما سبق.
   ا. المطر الحمضي.

٥. تعالج المصانع الفضلات الكيميائية باستخدام طبقات من القصب، وبعد ذلك نوع من:
أ. حفظ الأنواع
ب. المعالجة الحيوية
c. زيادة الحيوية
d. لا شيء مما سبق

6. تصنف الكوارث التي تحدث على الأرض وتؤثر على التنوع الحيوي على أنها:
أ. كوارث طبيعية
ب. كوارث بفعل الإنسان
ج. كوارث طبيعية بسبب بها الإنسان
d. جميع ما سبق

7. ينتج عن العواصف الرملية تغيير كبير في الطقس وذلك لأن العواصف الرملية تقوم ب:
أ. حجب أشعّة الشمس
ب. زيادة الرطوبة
ج. ذوبان الثلوج
d. جميع ما سبق

8. عندما تتعارض أجزاء الموطن البيئي فانياً نذكاً:
أ. ندعم التنوع الوراثي
ب. ننوه البيئة
ج. نقل الأمراض سهولة
d. جميع ما ذكر في أ وب

9. يعتبر نبات البروسوس المستورد الذي أدخل إلى المملكة العربية السعودية دليل على:
أ. الأنواع الدخيلة
ب. الإثراء الغذائي
c. التضخم الحيوي
d. المصادر المحدودة

10. من أسباب انقراض النمر العربي في المملكة العربية السعودية ما يلي:
أ. التزايد السريع في عدد السكان
ب. الاستغلال الجائر
ج. صيد النمور وفرائسها غير المنظم
ج. جميع ما سبق

11. تعتبر الأنواع التي تعيش في الجزر أكثر عرضة للانقراض وذلك نتيجةً ل:
أ. صغر حجم الجماعة الحيوية
ب. عدم وجود مفترسات طبيعية لها
ج. ما ذكر في أ و ب
d. لا شيء مما سبق

12. يحتوي نبات توسنت جينات مقاومة لتكرير من الأمراض الفيروسية التي تسبب نبات النمرة لذلك فهو يمثل:
أ. القدرة الاقتصادية المباشرة
ب. القدرة الاقتصادية غير المباشرة
ج. القيمة العلمية والجمالية
d. جميع ما سبق

13. ينتج عن تجزئة الموطن البيئي مشاكل بيئية وذلك بسبب أنه:
أ. بقاء عدد الأنواع
ب. نقل الأنواع
ج. نقل مفاوضات الأراضي
d. جميع ما سبق

14. تعتبر التنمية المستدامة إحدى الطرق للاستفادة من الموارد الطبيعية وهي تحقق:
أ. المحافظة على سماحة البيئة
ب. حفظ الموارد
ج. حفظ الأنظمة البيئية
d. جميع ما سبق

15. تسمى عملية إدخال مخلوقات حية مفترسة طبيعية إلى نظام بيئي مختل ب:
أ. الركود الحيوي
ب. المعالجة الحيوية
c. الإثراء الحيوي
d. الاستصلاح الزراعي
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APPENDIX I

EXAMPLES OF THE ACHIEVEMENT TEST QUESTIONS

THE ENGLISH VERSION

Objective 1: Student has to describe the three types of biodiversity (Knowledge)
- True or false question: There are three types of biodiversity, which are genetic diversity, species diversity, and ecosystem diversity (   ).

Objective 2: Student has to summarize the direct and indirect economic value (Comprehension)
- True or false question: Healthy ecosystem provide us with benefits at a higher cost than using technologies (   ).
- Multiple-choice question: Which one of the following options represents the indirect economic value of biodiversity: (Comprehension)
  A. Food          B. Clothes
  C. Medicine       D. Flood protection

Objective 3: Student has to describe the threats to biodiversity (Knowledge)
- True or false question: Historically, the overconsumption of some species has led to their extinction (   ).

Objective 4: Student has to analyze the factors that threaten biodiversity (Analysis)
- Multiple-choice question: The burning of fossil fuels led to the emission of sulfur dioxide and nitrogen oxides in the atmosphere, which in turn produced:
  A. Acid rain       B. Bio inflation
C. Food enrichment   D. All the above

- Multiple-choice question: Disasters that occur on Earth and affect biodiversity are classified as

A. Natural disasters   B. Man-made disasters

C. Natural disasters caused by man   D. All the above
APPENDIX J

THE ATTITUDE SCALE TOWARDS SCIENCE

THE ARABIC VERSION

المبحث العربية السعودية
وزارة التعليم
إدارة التعليم بالمملكة العربية
ثانوية المرؤود

عزريم الطالب

سلام عليكم ورحمة الله وبركاته وبعد:

يقوم الباحث بعمل دراسة للحصول على درجة الدكتوراه في مناهج وطرق تدريس العلوم يعنوان "ثر استخدام التعليم التقاني على تحصيل الطلاب في مادة التربية الدينية واتجاهاتهم نحو العلوم في المملكة العربية السعودية" ومن ضمن الأدوات التي استخدمها الباحث للحصول على بيانات تم استخدامها بغرض البحث هذا المقياس الذي يبين فيه الذي سوف يساهم في إنجاز هذا البحث.

أماك مجموعات الأمثلة التي تقيس الاتجاهات نحو العلوم، المرجو منك عزيزي الطالب الإجابة على المقياس باختيار العبارة المناسبة من مقياس الدرج والتي تعبر عن الاتجاهات نحو الجملة التي تقيس الاتجاه نحو شيء محدد.

مثال: أنا أحب مادة العلوم:

 موافق بشدة موافق غير موافق غير موافق بشدة

إجابةك محل تفكير ونتائج هذا المقياس سوف تستخدم لأغراض دراسة فقط.

هذا المقياس متقن أعد من قبل مختصين وتم التحقق من صداقته وثباته وملائمةه للتطبيق.

عدد فقرات المقياس (20) فقرة والزمن اللازم لإتمامه يعتمد على سرعة استجابتك.

شكرًا لتعاونك واتمنى لك التوفيق.

الباحث: عبدالممتع حسن الدين القدامي

جامعة الباحة - كلية التربية
قسم المناهج وطرق التدريس

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قيد دائرة حول الإجابة الذي يمثل رأيك. إذا أردت أن تغير إجابتك وضع علامًا (خطًا) واحذري إجابة أخرى:

1. أفضل أن أعرف لماذا تحدث الأشياء نتيجة لعمل تجاري أكثر من مجرد أن أخبر بها. موافق بشده موافق غير متأكد غير موافق بشده
2. أنا أسس دعم بقراءة الأشياء التي لا توافق أفكاري السابقة. موافق بشده موافق غير متأكد غير موافق بشده
3. تعتبر دروس العلوم مهمة. موافق بشده موافق غير متأكد غير موافق بشده
4. الحصول على المعلومة من قبل المعلم أفضل من الحصول عليها من إجراء تجربة. موافق بشده موافق غير متأكد غير موافق بشده
5. لا أحب إعادة إجراء التجربة للتأكد من النتائج. موافق بشده موافق غير متأكد غير موافق بشده
6. لا أحب دروس العلوم: موافق بشده موافق غير متأكد غير موافق بشده
7. أفضل إجراء التجربة أكثر من القراءة عنها. موافق بشده موافق غير متأكد غير موافق بشده
8. أنا متحمس لمعرفة العالم الذي نعيش فيه: موافق بشده موافق غير متأكد غير موافق بشده
9. ينبغي للمدرسة أن تزيد من حرص العلوم الأساسي. موافق بشده موافق غير متأكد غير موافق بشده
10. أنا ملئ إلى الموافقة مع بعض الناس للحصول على ما أريد أكثر من أن أجري تجربة لذلك: موافق بشده موافق غير متأكد غير موافق بشده
11. اكتشاف أشياء جديدة ليس ذو أهمية. موافق بشده موافق غير متأكد غير موافق بشده
12. حرص العلوم ممل بالنسبة لي: موافق بشده موافق غير متأكد غير موافق بشده
13. أفضل أن أحصل على المعلومات عن طريق عمل تجربة أكثر من أن أحصل عليها عن طريق المعلم: موافق بشده موافق غير متأكد غير موافق بشده
14. أرغب بالاستماع للأفكار التي تختلف معهم بالأفكار:

موافق بشده موافق غير متأكد غير موافق

15. يعتبر العلوم من أشخاص مثلاً الحضور المعقولية:

موافق بشده موافق غير متأكد غير موافق

16. أفضل إيجاد الأشياء عن طريق سؤال شخص آخر قام بعمل التجربة أكثر من أن أعطى النظر بنفسه:

موافق بشده موافق غير متأكد غير موافق

17. الإستماع للأفكار الأجدية مثلاً بالنسبة لي:

موافق بشده موافق غير متأكد غير موافق

18. تعتبر حضور العلوم مضيعة للوقت:

موافق بشده موافق غير متأكد غير موافق

19. أفضل حل المشكلة عن طريق إجراء تجربة أكثر من مجرد إيجاد الإجابة من شخص ما:

موافق بشده موافق غير متأكد غير موافق

20. في تجارب العلوم أفضل استخدام طرق جديدة لم تستخدم من قبل:

موافق بشده موافق غير متأكد غير موافق

21. أنا حقاً استمتع بحضور حضور العلوم:

موافق بشده موافق غير متأكد غير موافق

22. سؤال المعلم للحصول على الإجابة أفضل من الحصول عليها عن طريق عمل تجربة:

موافق بشده موافق غير متأكد غير موافق

23. أنا ليست على استعداد أن أغير أفكاري عندما تثبت الأدلة بأنها ضعيفة:

موافق بشده موافق غير متأكد غير موافق

24. المواد التي تتناولها دروس العلوم ليست ممتعة:

موافق بشده موافق غير متأكد غير موافق

25. أفضل أن أقوم بتجربة عن موضوع ما أكثر من أن أقرأ عنه في مجلة علمية:

موافق بشده موافق غير متأكد غير موافق

26. في التجارب العلمية تقوم التقارير بنCKER نتائج متوقعة وغير متوقعة على حد سواء:

موافق بشده موافق غير متأكد غير موافق
27. دائماً ما يكون مطلع لدروس العلوم:
موافق بشده موافق غير متأكد غير موافق بشده

28. إخبارك عن الحقائق العلمية أفضل من استنتاجها عن طريق تجربة:
موافق بشده موافق غير متأكد غير موافق بشده

29. لا احب الاستماع لأراء أخرى:
موافق بشده موافق غير متأكد غير موافق بشده

30. استمتع بالذهاب للمدرسة أكثر إذا لم يكن فيها حصص علوم:
موافق بشده موافق غير متأكد غير موافق بشده

شكراً لك أخي الطالب وأتمنى لك التوفيق.
APPENDIX K

THE ATTITUDE SCALE TOWARDS SCIENCE –

THE ENGLISH VERSION

TEST OF SCIENCE-RELATED ATTITUDES (TOSRA)

Barry J. Fraser

DIRECTION

1 This test contains a number of statements about science. You will be asked what you yourself think about these statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

2 All answers should be given on the separate Answer Sheet. Please do not write on this booklet.

3 For each statement, draw a circle around
SA if you STRONGLY AGREE with the statement;
A if you AGREE with the statement;
N if you are NOT SURE;
D if you DISAGREE with the statement;
SD if you STRONGLY DISAGREE with the statement.

Practice Item
0 It would be interesting to learn about boats. Suppose that you AGREE with this statement, then you would circle A on your Answer Sheet.

SA A N D SD

4 If you change your mind about an answer, cross it out and circle another one.

5 Although some statements in this test are fairly similar to other statements, you are asked to indicate your opinion about all statements.
1 I would prefer to find out why something happens by doing an experiment than by being told.

2 I enjoy reading about things which disagree with my previous ideas.

3 Science lessons are fun.

4 Doing experiments is not as good as finding out information from teachers.

5 I dislike repeating experiments to check that I get the same results.

6 I dislike science lessons.

7 I would prefer to do experiments than to read about them.

8 I am curious about the world in which we live.

9 School should have more science lessons each week.

10 I would rather agree with other people than do an experiment to find out for myself.

11 Finding out about new things is unimportant.

12 Science lessons bore me.

13 I would prefer to do my own experiments than to find out information from a teacher.

14 I like to listen to people whose opinions are different from mine.

15 Science is one of the most interesting school subjects.

16 I would rather find out about things by asking an expert than by doing an experiment.

17 I find it boring to hear about new ideas.

18 Science lessons are a waste of time.

19 I would rather solve a problem by doing an experiment than be told the answer.

20 In science experiments, I like to use new methods which I have not used before.

21 I really enjoy going to science lessons.

22 It is better to ask the teacher the answer than to find it out by doing experiments.
23 I am unwilling to change my ideas when evidence shows that the ideas are poor.

24 The material covered in science lessons is uninteresting.

25 I would prefer to do an experiment on a topic than to read about it in science magazines.

26 In science experiments, I report unexpected results as well as expected ones.

27 I look forward to science lessons.

28 It is better to be told scientific facts than to find them out from experiments.

29 I dislike listening to other people’s opinions.

30 I would enjoy school more if there were no science lessons.

Attitude to Scientific Inquiry

1 I would prefer to find out why something happens by doing an experiment than by being told.

2 Doing experiments is not as good as finding out information from teachers.

3 I would prefer to do experiments than to read about them.

4 I would rather agree with other people than do an experiment to find out for myself.

5 I would prefer to do my own experiments than to find out information from a teacher.

6 I would rather find out about things by asking an expert than by doing an experiment.

7 I would rather solve a problem by doing an experiment than be told the answer.

8 It is better to ask the teacher the answer than to find it out by doing experiments.

9 I would prefer to do an experiment on a topic than to read about it in science magazines.

10 It is better to be told scientific facts than to find them out from experiments.
Adoption of Scientific Attitudes

1 I enjoy reading about things which disagree with my previous ideas.
2 I dislike repeating experiments to check that I get the same results.
3 I am curious about the world in which we live.
4 Finding out about new things is unimportant.
5 I like to listen to people whose opinions are different from mine.
6 I find it boring to hear about new ideas.
7 In science experiments, I like to use new methods which I have not used before.
8 I am unwilling to change my ideas when evidence shows that the ideas are poor.
9 In science experiments, I report unexpected results as well as expected ones.
10 I dislike listening to other people's opinions.

Enjoyment of Science Lessons

1 Science lessons are fun.
2 I dislike science lessons.
3 School should have more science lessons each week.
4 Science lessons bore me.
5 Science is one of the most interesting school subjects.
6 Science lessons are a waste of time.
7 I really enjoy going to science lessons.
8 The material covered in science lessons is uninteresting.
9 I look forward to science lessons.
10 I would enjoy school more if there were no science lessons.
Test of Science-Related Attitudes

Answer Sheet

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<th>Year/Class</th>
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<td><strong>NOT SURE</strong></td>
</tr>
<tr>
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<td>A N D SD</td>
<td>29 SA</td>
</tr>
<tr>
<td>2 SA</td>
<td>A N D SD</td>
<td>30 SA</td>
</tr>
<tr>
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<td>A N D SD</td>
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**For Teacher Use Only**

S N I A E L C
<table>
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<th>A</th>
<th>Adoption of Scientific Attitudes</th>
<th>E</th>
<th>Enjoyment of Science Lessons</th>
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</thead>
<tbody>
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<tr>
<td>28 (-)</td>
<td>29 (-)</td>
<td>30 (-)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For positive items (+), responses SA, A, N, D, SD are scored 5, 4, 3, 2, 1, respectively. For negative items (-), responses SA, A, N, D, SD, are scored 1, 2, 3, 4, 5, respectively. Omitted or invalid responses are scored 3.
APPENDIX L

LETTER FROM THE SCHOOL PRINCIPAL INDICATING THE IMPLEMENTATION OF THE STUDY

To whom it may concern,

We hereby certify that Mr. Alghamdi has administered his research tools, which are (Achievement test and Attitude scale) at Al Sarwat High School in the Summer semester. Mr. Alghamdi has attended the environmental science classes and he taught two classes of the 11th graders during the first four weeks of the Summer semester.

We are giving him this statement under his demand without any responsibility.

The principal of Al Sarwat High School:

Ghorm Allah Ahmad Qama'ah
APPENDIX M

THE BIODIVERSITY AND CONSERVATION CHAPTER
تجربة إزالة الأشكال

ما الذي يمكنك من خلالها؟
تعد بعض المناطق الطبيعية مخلوقات حية أخرى من غيرها. وفي هذه التجربة ستعتبر الأعداد الحيوانية للأنواع التي يمكن أن توجد في كل بيئة.

خطوات العمل

1. املأ ظلامة السلامة في دليل التجارب العملية.
2. اختر ثلاثة مواقع في مجتمعك تعرفها تاما: شجرة، مجموعة أشجار، قنا، حقل، منتزة، أو بركة.
3. رتب المواقع ترتيباً تنزلياً من الأكبر إلى الأصغر حسب عدد أنواع الحيوانات أو النباتات التي تتنقل تكتلها هناك.

التحليل

1. عرصف مصطلح التنويع الحيوي بكلماتك الخاصة.
2. وضع كيف احتفلت ترتيب المواقع بسلسل معين.
3. صف الطائرات المختلفة التي تحدد عليها إيجاد عدد الأنواع التي تعيش في كل موضوع بيئة.

لاستنتاج هذا المضموم، وضع المقصود من التنويع الحيوي على المستوي الكبير، وشرح أهميته، ووصف كل من أنواع التنويع الحيوي الثلاثة على الأنسجة الصغيرة، وأعد مثالاً على كل منها.

المطويات

منظمات الأشكال

المشطورة

الخطوة: اقترب الورقة بحيث يكون مكان الثدي الأول إلى الأسفل.
ثم اطلقها إلى ثلاثة أجزاء كما في الشكل الآتي.

الخطوة: افتح الورقة، ثم نقش الطبقة الملونة على طول حد الشبكة، وننكر ثلاثة أنشطة، وكتب عناوين كما في الشكل الآتي.

الخطوة: استخدم هذه المطوية في القسم 1-4. في أثناء دراسة هذا القسم، وضع المقصود من التلوين الحيوي على المستوي الكبير، وشرح أهمية، ووصف كل من أنواع التلوين الحيوي الثلاثة على الأنسجة الصغيرة، وأعد مثالاً على كل منها.
التنوع الحيوي

الأهداف
- تحفظ التنوع الحيوي على الخلفية البيئية وصحية، ويزيد الإنسان بالموارد المباشرة وغير المباشرة.
- يحافظ من البيئة لأجل تأثر الأزمنة في الشبكة الغذائية أو منافعها.
- فحص الأنواع الفردية وغير الفردية.
- التنوع الحيوي.

التنوع الحيوي
- الألفاظ.
- تعريف.
- نكهة.
- تنوع.
- حفاظ.

المجالات الجيدة
- الانتشار.
- التنوع الحيوي:
- التنوع الوظيفي.
- تنوع البيئي.

التنوع الحيوي على ثلاثة أنواع هي: التنوع الوراثي، التنوع الأنواعي، وتون التنوع البيئي.

التنوع الوراثي
- يشمل الجينات المختلفة أو الخصائص الوراثية.
- تنوع genic diversity
- تنوع الحفاظ، تنوع الغذاء، تنوع الفيتو.

التنوع البيئي
- يشمل تنوع البيئة، تنوع النزاعات، تنويع التنوع الحيوي.

التنوع الأنواعي
- يشمل تنوع الأنواع، تنوع الكائنات، تنوع الحياة.

التنوع الفيتو
- يشمل تنوع الفيتو، تنوع النزاعات، تنوع التنوع الحيوي.

التنوع الوظيفي
- يشمل تنوع الوظائف، تنوع النزاعات، تنوع التنوع الحيوي.

التنوع البيئي
- يشمل تنوع البيئة، تنوع النزاعات، تنوع التنوع الحيوي.

التنوع الوراثي
- يشمل تنوع الوراثة، تنوع النزاعات، تنوع التنوع الحيوي.

التنوع الحفاظ
- يشمل تنوع الحفاظ، تنوع الفيتو، تنوع التنوع الحيوي.

التنوع الفيتو
- يشمل تنوع الفيتو، تنوع النزاعات، تنوع التنوع الحيوي.

التنوع الوظيفي
- يشمل تنوع الوظائف، تنوع النزاعات، تنوع التنوع الحيوي.

التنوع البيئي
- يشمل تنوع البيئة، تنوع النزاعات، تنوع التنوع الحيوي.

التنوع الأنواعي
- يشمل تنوع الأنواع، تنوع الكائنات، تنوع الحياة.

التنوع الوراثي
- يشمل تنوع الوراثة، تنوع الفيتو، تنوع التنوع الحيوي.

التنوع الحفاظ
- يشمل تنوع الحفاظ، تنوع الفيتو، تنوع التنوع الحيوي.

التنوع الفيتو
- يشمل تنوع الفيتو، تنوع النزاعات، تنوع التنوع الحيوي.

التنوع الوظيفي
- يشمل تنوع الوظائف، تنوع النزاعات، تنوع التنوع الحيوي.

التنوع البيئي
- يشمل تنوع البيئة، تنوع النزاعات، تنوع التنوع الحيوي.
الشكل 2-1 تجمع أنواع مختلفة من الحيوانات الحية في هذا المكان، وجعله��ًا نباتيًا يتميز بالتغذية.

الشكل 3-4 تبين هذه الخريطة توزيع أنواع مختلفة من الحيوانات الحية في المملكة. عدد أي مواقع تحتوي أكبر عدد من الزواحف.

التنوع الأنواع يتميَّز عدد الأنواع المختلفة ونسبة تواجد كل نوع في المجتمع الحيوي تتنوع الأنواع. species diversity يلاحظ عدد الأنواع المختلفة من المخلوقات الحية في الشكل 2-4. ويمثل هذا الموطن البيئي منطقة ذات مستوى عالٍ في نوع الأنواع، نظرًا لوجود الكثير من الأنواع في موقع واحد. ولكن تنوع الأنواع غير متساوي التوزيع في الغلاف الحيوي. فبدلاً من التنوع كمثّل في المناطق القاطبة إلى الاستوائية، فمساحة بين الشكل 3-4 عدد أنواع المخلوقات الحية التي تنتشر في المملكة. استخدم مفهوم الأنواع لمشاهدة التنوع الحيوي في المملكة.

ماذا قرأت؟ كيف ترتبط التنوع الوراثي وتنوع الأنواع.

الشريحة بالألوان تشير إلى الأنواع في المملكة العربية السعودية.
The Importance of Biodiversity

There are several reasons why biodiversity should be protected. Besides the direct economic value biodiversity provides, it also has many conservation benefits. Direct economic value is the most obvious reason for protecting biodiversity. It includes the value of goods and services that the ecosystem provides, such as clean air and water, pollination of crops, and the production of medicines. Conservation benefits are more intangible and include the protection of genetic diversity, the maintenance of ecosystem processes, and the provision of ecological services that support human well-being. These benefits are often referred to as the "ecosystem services," which are the goods and services that nature provides to support human life. Examples of ecosystem services include the regulation of climate, the decomposition of waste, and the purification of water.
 الناسيجات في العالم يعتمد على بعض الأنواع فقط. والتنوع الزراعي في هذه النباتات قليل، وتعاني المشاكل نفساً التي تعانيها الأنواع ذات التنوع الزراعي المحدود، ومنها نقص مقاومة المرض. وفي الكثير من الحالات تنمو أجناس المحاصيل الفريدة جنبًا إلى جنب في موطنه البيئي الأصلي على نحو واسع، وهذه الأنواع البرية تخدمنا كنموذج ممتاز للنضج الزراعي المركوب فيها، الذي يحتاج إليها لتحسن أنواع المحاصيل المحلية.

فمثلاً، نبات اليوسانت الذي في الشكل 5-4 يندرج تحت نوع نباتات الذرة نفسه، وهو نبات مثالي لأمراض الفيروسات التي نضرر محصول الذرة. ويستخدم هذا النوع البري طور علماء أمراض النبات أنواع ذرة مقاومة للمرض، فله قدرة هذا النوع البري في جميع هذا النوع الزراعي، ومستفيض كذلك القدرة على تطوير أنواع ذرة مقاومة للمرض أيضاً.

إضافة إلى ذلك، بدأ علماء الأحياء معرفة كيف يتم نقل الجينات المحتملة على السطح على وراثة الخصائص من نوع إلى آخر عبر النباتات البرية. وتم إنتاج محاصيل مقاومة لبعض الحشرات مما زاد من قيمتها الغذائية، كما أصبحت أكثر مقاومة للملعقة، ومعظم الأنواع البرية من النباتات والحيوانات تم تحديد وتم تطوير صفاها الزراعي السفیدة لإستغلالها في حال اقراضها، ويزيد هنا من أهمية الأنواع التي ليس لها حالياً قيمة اقتصادية ملحوظة لأن قيمتها الاقتصادية ستزداد في المستقبل.

ماذا قرأت؟ هل لماذا بعد حفظ التنوع مهمًا لتزويج الإنسان بالغذاء؟
تستخدم الأدوية المستخرجة من زهرة الوَلْتَة Catharanthus roseus لعلاج أنواع من سرطان الدم عند الأطفال. نقص قدرتهم على حفظ النمو الحيوي لهما الناحية الطبية.

**تجربة١ - ٤**

**استقص أخطارًا تواجه التنوع الحيوي**

ما هي أخطار البيئة الطبيعية التي تواجه التنوع الحيوي؟ من ت//=؟ تختص هذه الأخطار، وتقضي من خلال جلسة عصفيّة حذرة محتملة يمكن أن تؤدي إلى:

**خطوات العمل**

1. إعاقة الطاقة الخضراء في دليل التجارب العلمية.
2. تجربة مع مجموعة في المختبر عامةً بهذا النوع الحيوي في مجتمعه، وأدرسه كيف أثر في جميع المراحل.
3. يُعدّ نتائج صفيح للتفكير في أطراف يمكن بها إيقاف هذه الأخطار.
4. تُظهر هذه النماذج المتعلقة بالأخطار والحلول المحتملة لها مع طالي صفيح.

**تحليل**

1. ما الذي جزء من المعلومات التي يحتاج إليها طالب المُفاهيم لتعريف هذه الأخطار؟
2. ما النتائج المفيدة التي ما النتائج التي مثالية؟

- 110
الشكل 7-4

الاقتصادية والبيئية

الحيوي والتنوع الحيوي.

وقد سخر الله سبحانه وتعالى لصالح الطبيعة، حيث يمكن أن يحصل الإنسان على الماء الصالح للشرب بكلفة أقل من استخدام آليات التي تعطي الخدمة نفسها.

وبالنسبة لبعض الأشخاص المعنيين، فإن الطبيعة يجب أن تكون الخيار الأول المطلوب في تزويدنا بهذه المصادر، وتشير الأبحاث أن عند حفظ الأنظمة البيئية الصحية والكائنات الحية فإن القوى التي توفرها الأنظمة البيئية ستمكّن أقل كمية من الخدمات التي تقدمها التقنيات.

القيم العلمية والجمالية هناك اعتبارات إضافية للحفاظ على التنوع البيئي والأنظمة البيئية الصحية، بما في ذلك الجمالية، والقيم العلمية، والقيم البيئية، فننصح بالتقدير الشيء جميل أو دواعي المهمة كأنظمة البيئية المبين في الشكل 7-4.

التقييم 1-4

فهم الأفكار الرئيسية

1. التنوع الحيوي مهم لسلامة الغلاف الحيوي.
2. التنوع الحيوي مهم للحفاظ على التنوع الحيوي ثلاث.
3. التنوع الحيوي مهم للحفاظ على التنوع الحيوي.
4. التنوع الحيوي مهم للحفاظ على التنوع الحيوي.
5. التنوع الحيوي مهم للحفاظ على التنوع الحيوي.

الخلاصة

1. التنوع الحيوي مهم لسلامة الغلاف الحيوي.
2. هناك ثلاثة أنواع من التنوع الحيوي: الرقمي، الأنواع، والبيئة.
3. التنوع الحيوي مهم للحفاظ على التنوع الحيوي.
4. التنوع الحيوي مهم للحفاظ على التنوع الحيوي.
5. التنوع الحيوي مهم للحفاظ على التنوع الحيوي.

التفكير النافذ

1. صمّم بدقة عملية لتطوير مشروع بناء في مجتمع معروض للنوع الحيوي، أو طريقة سريعة، مع الأخذ بعين الاعتبار المحافظة على التنوع الحيوي.
2. تنوع النباتات والحيوانات.
3. التنوع الحيوي مهم للحفاظ على التنوع الحيوي.
4. التنوع الحيوي مهم للحفاظ على التنوع الحيوي.
5. التنوع الحيوي مهم للحفاظ على التنوع الحيوي.

المصدر: علم البيئة

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**Axes to Tackle the Threat to Biodiversity**

**Extinction Rates**

The extinction rate has accelerated significantly in recent years. This accelerated extinction rate is driven by human activities, such as deforestation, overfishing, and pollution. These activities not only affect individual species but also impact entire ecosystems.

**Examples of Extinct Species**

- **Ammonite** (Ammendite)
- **Cynognathus**
- **Tribolite**
- **Dimichyys**
- **Grapholites**

**Summary**

Understanding the causes of species extinction is crucial for developing effective conservation strategies. By addressing the root causes of extinctions, we can work towards preserving biodiversity and ensuring the survival of our planet's diverse ecosystems.
*ظهر نقص جدّي وشديد للاختفاء في مجموعات الحيوانات نتيجة منتصف الحروب، ومنذ القرن العشرين أصبح الكثير من أنواعها على حافة الانقراض.*

**جدول 2-4**

<table>
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</table>

**العنوان**

**_factors that Threaten Biodiversity**

*يشير العلماء إلى أن سرعة الانقراض التي تواجهها اليوم تختلف عن الانقراض الجماعي في الماضي. سرعة الانقراض الحالية هي نتيجة لاندماج نوع واحد من المخلوقات الحية حساب الإنسان - Homo sapiens - وقد ظهرت أنواع جديدة بعضها تنتصر على الأنواع الأخرى التي كانت موجودة في الماضي، مما يвлекатель للتنوع الحيوي، إذ إن تغيير الإنسان ظروف الأرض أسرع من التكيف بصعوبات كبيرة للعثر إلى الظروف الجديدة، فيما لا تتفاوت التأثيرات التي تظهر عندن الموارد الطبيعية التي تحتاج إليها. الموارد الطبيعية هي جميع الموارد والمخلوقات الحية التي خلقها الله مصباته وتعالى في الغلاف الحيوي بما فيها: الصخور، والمواقع الأرضية، والفنون الأرضية، والنباتات، والحيوانات، والنباتات، والنسيج الطبي، والغذاء، النشاط، والطاقة الشمسية.*

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لا يوجد نص يمكن قراءته بشكل طبيعي من الصورة المقدمة.
اضطراب المواجهة البيئية Disruption of habitat
قد لا تُمَثِّل المواطنة البيئية بل يحدث فيها اختلال. فمثلاً ظهرت سلسلة أحداث في السنوات من هذا القرن توضح أن نقص أحد أنواع الشعاب المرجانية يؤثر في النظام البيئي. وكما نلاحظ من المخطط المبين في الشكل 10-4 فإن نقص أحد الأنواع يؤثر في النظام البيئي بأكمله. وإذا كان أحد الأنواع دور كبير في النظام البيئي فين هذا النوع حجر الأساسي. فمثلاً نقص مجموعات السمك المختلفة نتيجة لإصبع الطائر يؤدي إلى نقص في عدد أسود البحر وقشة الموال. وقد افترض بعض العلماء أن ظاهرة الاحترار الحراري العالمي تعود إلى الأرض قد لتسبب دورًا في هذا الفقدان، فقد أدت هذه الظاهرة إلى سلسلة تفاعلات داخل النظام البيئي البحر الذي أثر في كثير من الأمور.

الشكل 10-4

تجزئة النظام البيئي Fragmentation of habitat
تُسمى انتخاب النظام البيئي Fragmentation إلى أجزاء صغيرة عن الأرض تجزئة النظام البيئي Fragmentation تجزئة الحيوانات الحالية غالبًا ضمن حدود الأراضي الصغيرة هذه لأنها غير قادرة على البقاء في عبور الحيوانات التي تصلها الإنسان. يؤدي هذا إلى العديد من المشكلات التي تُؤثر في بقاء الأنواع الحية المتنوعة، ومنها:

أولاً: كم أنفس النظام البيئي تجزئة الأراضي الصغيرة فإنها تدعم عددًا أقل من الأنواع. ثانيًا: تقلل التجزئة من فرص تكاثر الأنواع في منطقة ما مع أفراد أخرهم من منطقة أخرى. وهذا بسبب غالبًا ما يقل التنوع الوراثي مع سوء الوقت في حالة تجزئة النظام البيئي. فالأراضي الحيوانية الأصغر والمصغرة ذات التنوع الوراثي الأساسي أقل مقاومة للأمراض أو استجابة لتغيرات الظروف البيئية.
الشكل 11-4: كلما كان حجم الوطن البيئي أكبر كانت نسبة تعرضه لتأثير الحد البيئي أعلى.

التغيرات الجوية، والاستقرار، والملوثات، وتأثيرات التلوث، وعوامل أخرى قد تكون مسببة لهذه الظاهرة. تتميز بعض الحدائق الطبيعية المختارة مثل درج الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفعة، والمناطق المنخفضة. فتفضل هذه الحدائق الطبيعية على حالة درجة الحرارة، والرياح، والرطوبة، والمناخ، والمناطق المرتفع
المحطب: Acid Precipitation

عند احترق الوقود المدعم، ينمصد الكربون إلى الجو، بالإضافة إلى ذلك فإن حرق الوقود يطلق كاسد الهيدروجين إلى الجو.

تتفاعل هذه المركبات مع الماء والمواد الأخرى الموجودة في الهواء، وذلك تكوِّن حمض الكربون وحمض النيتروك، وفي النهاية نستقل هذه الأحماض على السطح الأخضر على صورة مطر، وعند متبقي، وتزيل مع التربة، بيزيل الطري الحمضي الكالسيوم، والبوتاسيوم والمواد المعدنية الأخرى من النبات.

فيجرم النبات من هذه المواد المغلفة، ويعد الحمض أنصه النبات ويقل نموه، الشكل 13-4. ولهذا يكون تركيز الحمض عاليًا جدًا في البحيرات، والأنهار والجداول، بحيث يؤدي إلى موت الأسمام والمخلوقات الحية الأخرى، الشكل 13-4.

الإجابة: Eutrophication

٣. الشكل ٢٠٣-٤.

٤. نفل النبات إذا كان تركيزه عاليًا.

٥. كيف يكون النبات الحمض؟

٦. دراسة عينات أوراق أشجار متسلقة

٧. كيف مجموع النبات الحيوي؟ ليس يمكن تحديد طول حي في العالم، ما يجعل حسب النبات الحيوي صعبًا، إذا لم يتم قمع النبات، فتوفر هذه الرقاق التجربة في منطقته معينة، ويستخدمون هذا الرقاق لقياس النبات الحيوي في منطقته مثالية.

خطة العمل

١. لا تتطلب السلامة في مثل التجربة العملية.

٢. عندما يكون النبات الميزة على جزء من عينات أوراق الأشجار المتسلقة من زاوية تيار معلم، ثم سجلها، ويبحث عن أي نبات غير موجود في الدليل البياني.

٣. سجل ملاحظاتك في ملاحظات بانوات.

٤. حسب مؤشر النوع (ID) استخدام هذه المواد الميزة بين الأنواع المختلفة التي أوحت حسب النبات الذي هو مجموع كل

٥. مؤشر النوع (ID) - عدد الأوراق المميزة × عدد الأوراق الكلي للنوع

التحليل

١. عدد النوع الميزة وتغير الصلاحي التي شاهدها في منطقته.

٢. متغير النبات من خلال أوراقها هل تؤثر؟ إن عدد الأوراق غير الصلاحي على الأوراق الميزة؟ كيف تعرف ذلك؟

٣. هنالك حوالي ما إذا تغير نوع النبات من منطقته خلال المدة ١٠٠ سنة الماضية، وضع ذلك.
الأنواع غير الأصلية (غير المتكاملة) | Introduced species

الأنواع المستخدمة في المواقع وفيرة، والأنواع المستخدمة والمواقع والأعمال والتفاصيل والتفاعلات بين الأنواع في النظام البيئي الأصلي في حالة آسيا، ولكن عند إدخال هذه الأنواع إلى منطقة جديدة تصبح الأنواع المستخدمة (التي تسببت على الأثر البيئي) في غيب مكناها، وغالبًا ما تتكاثر الأنواع المستخدمة بأعداد كبيرة نتيجة نقص الحيوانات المفترسة تصبح أقوى غازية في بيئة المكان. فشجرة البروسوس المستورد هو نوع أطع من المملكolina العربية السعودية لأعد الأشجار الشواور الشائعة في مدن المملكة، ويكاد يكون إستثناء فيها حيث ينتشر في كثير من مناطقها كما الحال في جزر فرسان، الشكل 14-4. يشير هذا الازدهار إلى التخليل السريع المكثف في الندفة فيزي، إلا أنه يسبب أضرار جائحة الداء تلميذ التنميف، وحالياً تجري بعض المحاولات للتخلص من هذه الأنواع أو تقليل حجم انتشارها.

التقويم 2-4

فهم الأسس الرئيسية

1. وضع ثلاثة طرق رئيسية.
2. تحليل الإسلام المتعدد في الجزر الأكبر.
3. اختر أحد الطرق التي تستخدم في التعرف.
4. حدد كيف يؤثر الصيد الزائد في صحة أنواع الحيوانات.

الخلاصة

- معدل ازدياد الأنواع الحالية
- مرتفع بصورة غير طبيعية
- الأنواع التي تعيش في الجزر الأكبر
- عرضة للانقراض
- تاريخياً، أدى استغلال الإنسان
- الجزر لبعض الأنواع إلى انقراضها
- أنقراط الإنسان: إحلال المخلوقات
- تأثير الإنسان: التأثيرات، وتحديد المواقع البيئية، وإدخال
- أنواع غير أصلية ينتج عن النقص

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Conseiving Biodiversity

The primary objective is to educate the general public on the importance of biodiversity conservation and the need for its protection. Biodiversity is a critical aspect of our environment, supporting a wide range of ecological and economic activities. With the increasing human population, the demand for resources has grown, leading to the decline of species diversity. The need for conservation is crucial to maintain ecological balance and ensure the sustainability of our planet.

Natural Resources

Natural resources are crucial for the survival of all life on Earth. They provide the necessary materials for human activities and ecosystem functions. The conservation of natural resources requires a comprehensive approach that addresses both the direct and indirect uses of these resources. It is essential to balance resource extraction with sustainable management practices.

The recent surge in the demand for natural resources has led to unsustainable practices, causing irreversible damage to ecosystems. The preservation of natural resources is vital for the preservation of biodiversity and the overall health of our planet.

Ethical Considerations

Conservation efforts must also consider ethical implications. This includes understanding the rights of indigenous communities and ensuring that their cultural practices and traditions are respected. Ethical considerations are crucial to ensure that conservation efforts are just and equitable for all.

Challenges and Solutions

Conservation efforts face numerous challenges, including political, economic, and social factors. Addressing these challenges requires a multi-disciplinary approach that involves collaboration among scientists, policymakers, and local communities. Solutions include implementing sustainable practices, providing alternative livelihoods, and enhancing public awareness.

Conclusion

Conserving biodiversity is essential for the survival of our planet. It requires a concerted effort from all stakeholders, including governments, NGOs, and individuals. By working together, we can protect our natural resources and ensure a sustainable future for generations to come.
الموارد المتعددة تستخدم الموارد الطبيعية يجب أن تأخذ في الحساب الاختلاف بين مجموعات الموارد الطبيعية وهي: المجددة وغير المجددة. والموارد التي تُستبدل بالموارد المتعددة: الطاقة الشمسية موارد مجددة؛ لأنها لا تتسبب إلى أن يضاء الله، كما تعد بعض الفواكه والشجر، والحيوانات، والسمك، والفلاحة، والزراعة، والعناصر الأخرى نموذجاً مجددة لأنها تستبدل طبيعياً بشكل أسرع مما نستهلكون إذا زاد الغذاء منها فإليها منتهي.

الموارد المتعددة مقابل الموارد غير المجددة، إن الموارد الموجودة على سطح الأرض بكميات محدودة، أو التي تُستبدل بالأعمال الطبيعية خلال فترة طويلة من الزمن تتسم الموارد غير المجددة: ماكروفود الأحفوري والمعادن - ومنها الزيوت المشيرة تعدد من الموارد غير المجددة. كما تعد أنواع المكثفات الحية من المواد المتجددة إلى أن يموت آخر فرد منهم، وهنالك يحدث الاقتراض يصبح النوع غير متجدد لأنه يكون قد فقد لأجل.

ويعد صنف الموارد (متجددة أو غير متجددة) على طبيعة المورد نفسه؛ إذ تعده شجرة واحدة أو مجموعة صغيرة من الأشجار في النظم البيئية كزة موارد متعددة: لأنها يمكن زرع أشجار جديدة أو إعادة إنباتها من البدور الموجودة في النظم، وما زال هناك جزء من الموارد يكفي ليشكل موائداً لأشكال المخزونات الحية التي كانت تعيش فيها. وهذه إنذار للغة كاملاً، كما في الشكل 16-4. فإنها لا تعد موارداً متعددة. فقد فقدت المخزونات الحية التي تعيش في الغابة موطناً بيئياً ولبنى، وفي هذا المجال من الممكن وجود أكثر من موارد طبيعية غير مجددة. لأن تقضي العناصر أو أي من الأنواع الحية. فإذا وجد نوع في هذه الغابة فقط فإليها مسماً إذا فقد موطنه البيئي الوحيد.
المحميات الدولية المحمية

المناطق الدولية المحمية تُخصص حالياً 7% تقريباً من المناطق في العالم بوصفها نوعاً من المحميات، وتاريخياً تم تعدي هذه المناطق المحمية أجزء صغيرة من الموطن البيئي محاطة بمناطق تكثر فيها نشاط الإنسان. وتحيي هذه المناطق المحمية صغيرة فهي تتأثر كثيراً بنشاط الإنسان.

وتعد منظمة الأمم المتحدة نظاماً من المحميات في الغلاف الجوي والمواقع التاريخية العالمية. وفي هذا المجال قامت المملكة بإعداد توطين الطيور، وتُظهر بعض الجوانب منها الوعول وفقدان المحطات، كما أكدت خسائر من التوزيع الطبيعي لل myśli والمتوسطة وبعض أنواع الطيور. كما اهتمت الهيئة الوطنية لحماية الحياة الفطرية بإمكانها بزراعة أشجار العرعر في أثيوبيا، وزراعة نحو 10 آلاف شجرة مجنون، وتمثل الجدول 3-4 المحميات الحياة الفطرية بالمملكة.

محميات الحياة الفطرية في المملكة

<table>
<thead>
<tr>
<th>المنطقة الإدارية</th>
<th>المساحة (كم²)</th>
<th>السنة الإعلان</th>
</tr>
</thead>
<tbody>
<tr>
<td>الجوف</td>
<td>13775</td>
<td>1407 هـ</td>
</tr>
<tr>
<td>تبوك</td>
<td>20445</td>
<td>1407 هـ</td>
</tr>
<tr>
<td>الرياض</td>
<td>2500</td>
<td>1409 هـ</td>
</tr>
<tr>
<td>مكة المكرمة</td>
<td>2109</td>
<td>1409 هـ</td>
</tr>
<tr>
<td>جازان</td>
<td>697.4</td>
<td>1409 هـ</td>
</tr>
<tr>
<td>عسير</td>
<td>9</td>
<td>1409 هـ</td>
</tr>
<tr>
<td>جازان</td>
<td>2200</td>
<td>1410 هـ</td>
</tr>
<tr>
<td>الرياض</td>
<td>11590</td>
<td>1413 هـ</td>
</tr>
<tr>
<td>المدينة المنورة</td>
<td>1960</td>
<td>1415 هـ</td>
</tr>
<tr>
<td>حائل</td>
<td>4262</td>
<td>1415 هـ</td>
</tr>
<tr>
<td>الحدود الشمالية</td>
<td>1160</td>
<td>1415 هـ</td>
</tr>
<tr>
<td>مكة المكرمة</td>
<td>7190</td>
<td>1415 هـ</td>
</tr>
<tr>
<td>الشرقية</td>
<td>2300</td>
<td>1413 هـ</td>
</tr>
<tr>
<td>الباحة</td>
<td>67</td>
<td>1422 هـ</td>
</tr>
</tbody>
</table>

االجمن: إجمالي مساحة المحميات المحمية

<table>
<thead>
<tr>
<th>نوعية مساحة المحميات المحمية</th>
<th>82,715.3 كم²</th>
</tr>
</thead>
<tbody>
<tr>
<td>نسبة مساحة المحميات المحمية إلى مساحة المملكة (%)</td>
<td>4.17%</td>
</tr>
</tbody>
</table>

- الرجوع: 122
Visualizing Biodiversity Hot Spots

مناطق التنوع الحيوي الساخنة

الشكل 18-4 مناطق التنوع الحيوي الساخنة، والملونة باللون الأزرق في الخريطة، هي أنظمة بيئية تكون النوع المستوطن فيها مهدئًا بالافترض. فإذا افترضت هذه الأنواع قبل التنوع الحيوي.

1. مقاطعة كاليفورنيا النزهة
2. غابة مادورا شجر الصنوبر والبلوط
3. أمريكا الوسطى
4. ناميب-شوكو-ماداغاسكا
5. آسيا الاستوية
6. غابات فانواتو تشمل السافانا الأطلسي
7. غابة الأطلسي
8. برجالاو
9. جزر الكاريبي
10. غابات غينيا في أفريقيا الغربية
11. الكاريو البحري
12. منطقة الكاب النزهة
13. ماورو-لاند-بيولا-البوان-ماورا-لاند-هفان-ماورا-لاند-هفان
14. غرب جنوب أستراليا
15. غابات أفريقية الساحلية
16. غابات أفريقية الساحلية
17. غابات أفريقية الساحلية
18. فينالا
19. غابات أفريقية الساحلية
20. غابات أفريقية الساحلية
21. غابات أفريقية الساحلية
22. غابات أفريقية الساحلية
23. جبال وسط آسيا
24. جبال غرب الصين
25. هونغ كونغ
26. مالديف
27. غرب جنوب أستراليا
28. الأمازون
29. غابات فيرودوكسية
30. ليبان
31. بولينيزيا
32. جزر مالديف
33. كاليدونيا الجديدة
34. نيوزيلندا
مناطق التنوع الحيوي الساخنة (Biodiversity hot spots)

أحياء مختصة في المحافظة على البيئة ووقوع حول العالم تمتاز بأعداد استثنائية من الأنواع المصبوغة وهي الأنواع التي توجد فقط في تلك المنطقة الجغرافية ذات المستوى الأعلى في تلك المنطقة. ولقد تسمى المنطقة ساخنة يجب أن تتضمن جميعها من الأنواع المصبوغة، وأولاً يجب أن تكون المنطقة قد فقدت على الأقل 70% من الأنواع الأساسية. وبينما في البيئة الأصلية، ويعتبر التكاثر في البيئة المكشوفة 34 ونسبة الأنواع والأحياء تقريبًا توجد في هذه المواقع النشطة في سطح الأرض، ولكن لم يبق من هذا الموطن البيئي إلا نسخة قليلة.

إن علماء البيئة الذين يرغبون في نشاط هذه المناطق باقشون فكرة أن التركيز على منطقة محددة سيتساقط على أكبر عدد من الأنواع، أما علماء البيئة الآخرون فيدافعون فكرة أن التركيز على مراقبة حفظ الأنواع في هذه الموئل النشط المكافحة للمشكلات الناجمة التي تظهر في الأماكن الأخرى. فبما أن المناخ على المناطق الرطبة يستطيع أن يlayın قليلة، ولكن المناخ الرطب لها أهمية كبيرة، كتون صيد السلم، وتست_within الغابات ووضعها، وتتوفر أماكن لرعاية الأسماك. ويعتقد هؤلاء العلماء أنه يجب الامتثال في المناطق كلها وليس فقط التركيز على مواقع التنوع الحيوي الساخنة.

الممرات بين أجزاء الموطن البيئي

يتركز علماء المحافظة على البيئة على تحضير نموذجية متحركة بين أجزاء الموطن البيئي. فالمرات النشطة في الشكل 19-4 تُسمى بـ "المرات النشطة". ويعتبر مناطق قلة أرض تمتد تم تأسيس من الأنواع، كما تمثل كSmoke maior من التنوع الوراثي. ولكن هذه الممرات لا تعني كهذه لمنطقة "المرات النشطة". ويعتبر هذه المنطقة إلى أخرى، حيث تنتقل الحيوانات النسبية من موقع إلى آخر. وترتفع هذه الطريقة من أثر الجذب البيئي، فالموطن البيئي الكبير هو حد أقل، ولكن غالبًا ما يصعب الحفاظ على الموطن البيئي الوعي.

المرات النشطة (Corridors)

الاستخدام العلمي مقابل

الموانع التي تتيح العلاج

الاستخدام البيئي، عمر جزري

نظام بيئي

استخدام الموانع

الاستخدام المائي

استخدام الموانع

الاستخدام المحافظ

منطقة نموذجية "المرات النشطة" (Corridors)

المرات النشطة (Corridors)

الاستخدام البيئي

استخدام الموانع
استصلاح النظام البيئي

Restoring Ecosystem

أتكون يتم تدمير التنوع الحيوي في منطقة ما، بحيث لا يوجد النظام البيئي الصحي بالموارد الطبيعية والمحافظة على التوازن.$\text{كم}$ صحة أن تزداد الأخطار التي تثير عما إذا لم ي상담 النظام البيئي مع الإنسان عبر صالح الرعاع للزراعة بعد سنوات، وبناء على تطوير النباتات والمصادر الأخلاقية في وضع لا يدعم التنوع الحيوي، وكذلك يلزم المستقبليات لبيع الفطافطة والمواد الكيميائية المستخدمة ما إلى درجة لا تستطيع منها الأنواع التي تعيش هناك البقاء في موطنها.

ولا يرتبط من استمرار الجماعات الحيوية لنشاطها بشكل مباشر، سواء أكانت الكوارث الطبيعية أو فعل الإنسان. القلق 20-4. كما أن جسم المنطقة التي تتأثر وتتنوع الاضطراب المحاولات المحدودة لزم إعادة الاستقرار. ومع ذلك، كان حجم المنطقة المتأثرة أكبر.

كان وفقاً لدراسة استقلاطة المجتمع الحيوي آخر. وستعمل البيئة بطرقتين لتصرف عملية إعادة استصلاح الأنظمة البيئية المتضررة: المحلاة البيئية، والزيادة الحيوية.

يسمى استخدام المخلوقات الحية مثل باتيه النوى أو الفطريات، أو النباتات إزالة المواد السامة من منطقة ملوثة باللواقعة. وقد استخدمت المخلوقات الحية الدقيقة في تحويل النظم التي تتعلق بالزراعة الزراعية في حالة المخلوقات الحية الدقيقة الموجودة وحيوية في النبات هذا الرؤف إلى ثاني أكبر الكربون. وقد وجد العلماء أن إضافة مواد غذائية إلى النبات زاد من سرعة المخلوقات الدقيقة في إزالة ملوثات المنطقة، وبعد عدة أعوام خفض الملوثات في المنطقة انخفضًا كبيرًا.

ويمكن استخدام هذه المخلوقات الدقيقة في أنظمة بيئية أخرى للتخلص من المواد السامة في النبات التي تكون بالمخبأ البيئي.

وستخدم أيضًا بعض أنواع النباتات للتخلص من المواد السامة كالطلائع والرحيق، والنباتات، والمواد الكيميائية العضوية من النباتات المضررة، كما في النبات 21-4. وتتنوع هذه النباتات في النبات الملوثة تفسر المخلوقات السامة في استهلاكها، ويتكون محصول النبات هذا، وبذلك يتم التخلص من المواد السامة في النظام البيئي. إن استخدام المخلوقات الحية جديرًا بالذكر، ولكن لا تُقدّر آمال وأعداد كبيرة على استخدام المخلوقات الحية في إزالة السامة في بعض الأنظمة البيئية المكررة.
التنوع الحيوي المحمي قانونيًا


التقوىم 3-4

الخليصة

1. هناك نوعان من المواد الطبيعية:
   a) المعادن، وغير المعادن.
   b) الطرق للاستخدام المواد الطبيعية في النظام البيئي.

2. هناك طرق لحماية الأنواع المهددة.

3. تحتوي مواقع التنوع الحيوي.

4. ما جائحة بالتنوع الحيوي.

5. إذا كانت مساحة النباتات الصغيرة والصغيرة ونواتجًا.

6. مساحة النباتات الصغيرة والصغيرة ونواتجًا.
العاصفة الرملية

رياح عاصفة بردية بشراب وغيار من قشرة الأرض السطحية المفlake. ويعود العواصف الرملية بأشكال تزحلق الحركات الطبيعية التي تحلّ في تحفة القرن، وهي ظاهرة شائعة تحدث في الكثير من بلاد العالم الصحراوية، ويعارض هذه الجيزة العربية. وتعود العاصفة الرملية عند تولف شرّتين؛ أولهما الرئة الجافة المفكرة العضوية العطاء النباني، وثانيهما الرئة الجافة. وقد يصل ارتفاعها إلى عدة مئات من الأمطار وعرضها إلى ساعات أو مئات الكيلومترات أحياناً، وتختلف درجة تركيزها وفقاً لجهة الرياح وسرعة الرياح وعالية مصدر الرمال.

في تتحرك الرمال؟

كلما كانت الرياح سريعة قلت فترة الرمال على المقاومة، فإذا وصلت الرياح إلى السرعة الحربية تحرك جبات الرمل، وتفتت بسرعة الرياح، وهي تهدأ إذا كان بريق الرياح ضعيف من الناحية الصافية بسبب هذه العواصف النهائية السالكية الصافية لدروي الرياح الذين يعانون من الرياح وحاسمة الألف، والصدار، والأطفال.

وعلى عواصف الرملية أين أيت الله سباحة تتعلق، يصرف بها عادات، ويحكي بها القبورية المبتهلة. قال تعالى: 

(ومَسَايِغُتُنَا مَيَّتَنَا مَيَّتٌ وَمَا ذِئَّبْنَا مَيَّتَنَا) 

وعليها توبيخ أطفالها، وكان صلى الله عليه وسلم إذا استهدفت الرياح يسأل الله تعالى خيراً، وخبر ما أرسلته، ويستعين من شرعاً وشر ما أرسلته.

خدمة المجتمع

خطة عمل استخدم المصادر التعليمية المتاحة في كتابة بحث إضافي حول العواصف الرملية وآثارها البيئية المختلفة. ثم أعمل في مجتمعات مع زملائك لمساعدة هذه الظاهرة.
مختبر البيئة

استقصاء ميداني: كيف يقومون بصحة النظام البيئي من حولك؟

1. باستخدام طريقة التجربة 2-4 أمراً دراسة مسحية للموقع وحاسب مؤشر النشوغ.
2. أبحث عن تأثير المنطقة، وكيف تغيرت منذ أن سكنت فيها.
3. أبحث وأوصي بحلل مساحة للعناية بقطعة الأرض التي تمت بمسحها بشكل بيئي سؤالاً، إعادة إصلاحها وإرجاعها إلى وضعها الأصلي.
4. خطط لتنفيذ عطاق، وما المحددات التي يمكن أن تواجهها?
5. إذا كان هناك تنقيح جديدًا من خطط.
6. حمل لينك التنظيم.
7. لماذا يعد هذا مهمًا؟
8. حدد هند تم توقع أن يتأثر بخططك؟
9. حلماً الأدوار السلبية المعتادة لخططك؟
10. دفعه عنا ل个国家 تقنيات حفظ البيئة يمكن استخدامها في ذلك.
11. احصبه ماذا سيكون مؤشر النشوغ إذا قمت بالتعابير التي أوصيت بها؟
12. هل كان هناك رأي ترادع البيئة؟ وضح إذا كان الجواب نعم أو لا.

المهام والأدوات

- طلاء ماسك من سكك نسخ أو وند طوله 1 m (61).
- فرق ملاحظات.
- دليل ميداني للأنواع التي تعش في المنطقة (نبات، حيوانات، وطيور).
- شريط بلاستيكي ملون (50 m).
- خط (600).
- قلم.

احتياطات السلامة

- تحذر: كل حذر عند مناحفة الحياة البرية، فلا تحاول إحياء أنواع الخفافيش الحية.

خطوات العمل

1. من إلا بطالة السلاسة في دليل التجارب العملية.
2. حدد موقعًا للدراسة، وتؤكد من الاحترام على الأذن من صاحب الموقع لإجازة الدراسة فيه.
3. حدد مساحة في الموقع مقدارها 15 m x 15 m باستخدام أربعة أركان.
4. قسم المساحة التي اختيرت إليها مربعات أبعادها 1 m x 1 m باستخدام 57 وردًا المثيل، ومكون

عند الدراسة.
دليل مراجعة الفصل

المفاهيم الرئيسية

1- أنواع التنوع الحيوي

الإغراق

- الموارد البشريَّة وغير المراَض.
- انخفاض التنوع الحيوي ناتجًا عن التطور البشري.
- هناك ثلاثة أنواع من التنوع الحيوي: البشري، الطبي، والبيئي.
- التنوع الحيوي يعتمد على عملية التطور والبداية والانتهاء.
- من أهم المفاهيم على التنوع الحيوي بوصفه مصطلح فسيولوجي الذي يمكن أن يعكس فيها المستقبل.
- توفر لنا الأنظمة البيئية السلسة بعض القوى ككلية أقل من استخدام الفيتات.

2- أخطار نتائج التنوع الحيوي

الإغراق الأدبي

- نقل محثلين حيويًا في الأنظمة البيئية، وتمشى الدلالات الهادئة إلى أن يخفف التنوع الحيوي له أثار خطرة طولية مدهى في الغلاف الحيوي.
- معدلات الانقراضات الحالية مرتفعة بصورة غير طبيعية.
- الأنواع التي تعاني من أجزاء أكثر عرضة للانقراض.
- تأريخًا، أدى استغلال الإنسان بالغًا لبعض الأنواع إلى الانقراض.
- أنشطة الإنسان، كإطلاق الماشية، والنزاع، والتحوُّل العشوائي، النزاع الداخلي، التنوع الحيوي.

3- المقاومة على التنوع الحيوي

الموارد الجغرافية

- يستخدم الإنسان وسائل مثل تقليل معدل الانقراض وحفظ التنوع الحيوي.
- هناك تنوع نادر من الموارد البيئية المحدودة وغير المحدودة.
- احتواء التربة على استخدام الموارد البيئية في التنمية المستدامة.
- هناك أنظمة عديدة تستعمل فقط التنوع الحيوي في العالم.
- عقود مواقع التنوع الحيوي المتحدة كما هو الحال في التنوع البيئي لها: المجاعة، والزراعة 알غوية.

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APPENDIX N

THE WORKSHEETS OF BIODIVERSITY AND CONSERVATION CHAPTER

كيف نقيس التنوع الحيوي؟

How do we measure biodiversity?

يُعدّ هذه الأدوات المختلفة في منطقة ما مؤشرًا على التنوع الحيوي في تلك المنطقة. ومن مهمّة حماية التنوع الحيوي نظرةً لمساهمته في توازن النظام البيئي. وكلما كان النظام الحيوي متنوعًا كان أكثر استقرارًا، كما تعد الأنظمة البيئية المتنوعة مصدرًا للجمال والنزه.

تستند هذه المختبرات بيانات الكتلة الحيوية ومقطوع الأطر لأربعة مواقع متنوعة في النظام البيئي نفسه، لذا كانت جميع الأطراف نشرًا في هذه المواقع. كما تم قياس الكتلة الحيوية لمدة 11 عامًا، وقد تم تحديد الكتلة الحيوية بوساطة جمع البيانات التي أُخذت من منطقة مساحتها 0.3  m². ثم تحقّفها وقياس كتلتها. وفي هذا المختبر مستخدم يتحليل البيانات وكتابة فرضية تُشرَ الفُضُرُب في التنوع الحيوي للمجتمعات الحيوية في هذه المواقع.

الأهداف

• تحلل بيانات أربعة مواقع تم اختبارها.
• تستنتج أنماط التنوع الحيوي.
• توقع العوامل البيئية التي تؤثر على التنوع الحيوي.

المواد والأدوات

• قلم جبر.
• مسطرة.
• ورق رسوم بياني.
• الأداة الحسابية.
• الإضاءة المارة.
• أداة مراقبة.

الجدول 1

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Source: David Tilman and John A. Downing, Department of Eclogy, Evolution and Behavior, University of Minnesota, 1994

الفصل 4 التنوع الحيوي والمحافظة عليه
3. مُلَّ هذه البيانات بالرسم البياني. وضع الكتلة الحيوية لكل سنة على المحور العمودي إلى اليسار وكمية الهطل على المحور العمودي إلى اليمين. استخدم ألوانًا مختلفة لخطوط كل مجتمع ولونًا خاصًا لكمية الهطل. اختر مقياس رسم مناسب ووضع عنوانًا لكل محور.

البيانات والملاحظات

القص منحنى الرسم البياني في الفرع أدناه.

حلل واستنتج

1. ما نوع المخلوق الحي الذي يتوقع أن يكون الكتلة الحيوية في كل مجتمع؟

2. ما المجتمع الحيوي الأكثر تنوعًا؟ ولماذا؟

الفصل 4 التنوع الحيوي والمحافظة عليه
3. ما العلاقة بين البيانات الهطول والكثافة الحيوية في كل مجتمع حيوى؟ وإلى ماذا يشير ذلك؟

4. ما المجتمع الحيوى الذي حصل فيه أكبر تغيير في الكثافة الحيوية؟ وما المجتمع الحيوى الذي كان له أقل تغيير في الكثافة الحيوية؟ وما أسباب ذلك؟

5. ما المجتمع الحيوى الذي تعافى بسرعة بعد الجفاف؟ وما المجتمع الذي تعافى أقل سرعة؟

6. تحليل الخطأ. ما مصادر الخطأ في هذه التجربة؟

7. ارجع إلى جوابك عن السؤال 2. كيف يؤثر التنوع الحيوى في مجتمع على الاستقرار البيئي؟

توسيع الاستقصاء

1. ما أنواع التغييرات غير الحيوية الأخرى القادمة التي قد تؤثر في مجتمع ما؟ اشرح واحدًا منها وصف كيف يمكن أن يؤثر في كل مجتمع في هذه الدراسة، وكيف يمكن أن يستفيد هذا المجتمع عافيته؟

2. سمت ناحية التنوع الحيوى، ما التأثير الذي يسبب الإنسان في المجتمعات الحيوية التي وصفت في هذه التجربة؟ صممت دراسة تبين أن الإنسان على مجتمع حيوي واحد. ما العناصر التي تستكمل عليها في دراستك؟ يمكن أن تجري دراستك لمدة سنوات؟

الفصل 4 التنوع الحيوي والمحافظة عليه

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مختبر البيئة

استقصاء ميداني: كيف تفهم صحة النظام البيئي من حولك؟

الخضوع للممارسات الزراعية، وإحدي وظائف عالم البيئة المخصصة
في المحافظة على البيئة. إعادة دراسة مصحة لمجلة في
النظام البيئي وتقديم تحليلاً بيئياً للصحة النظام البيئي،
وفي حال اكتشاف مشكلات تستدعي حلولاً ممكناً،
ويتم خفض عمل وطننا.

سؤال: كيف يتم استصلاح نظام بيئي وإعادته إلى وضعه
المنطقي؟

المواجد والأنواع

- علفة من سلوق مكسو أو عشوائيه (1)
- دفتر ملاحظات.
- دليل ميداني للأزهار التي تعيش في المنطقة (نبات،
- حيوان، وفطريات).
- شريط بلاستيكي ملون (50 m).
- خط (600 m).
- قلم.

احتياطات السلامة

تحذير: كل دهوة عند ولاية الحياة البرية، فلا تحاول
إتباع أنواع المخلوقات الحية.

خطوات العمل

1. أشار إلى بيئة البيئة في دليل التجربة العملية.
2. حدد موقع دراسة، وتأكد من الحصول على
الإذن من صاحب الموقع لإجراء الدراسة فيه.
3. حدد مساحة في الموقع مقترحة لينطلق
15 m × 15 m
- باستخدام أربعة أوجه.
4. قم بتحديد المساحة التي أخدتها إلى مربعات أبعادها
1 m × 1 m
- استخدام 57 مربعًا متقاطعًا، وستكون
هذه مساحة عينة الدراسة.
APPENDIX O
THE WEEKLY QUZZES OF BIODIVERSITY AND CONSERVATION CHAPTER
التفكير الناقد
12. وضح لماذا يصعب قياس قيمة الصفات الجمالية للتنوع الحيوي.
13. ضع الفائدة التي يوفرها النظام البيئي في مجتمعك، والتي يجب حمايتها للتأكد من استمرار جودتها.

4-2
مراجعة المفردات
فسر الاختلاف بين كل زوج من المفردات الآتية، ثم فسر كيف ترتبط هذه المفردات بعضها البعض.
14. الانقراض الديموغرافي، الانقراض الجماعي.
15. تجسيم المُوطَن الباري، أثر الحدود البيئية.
16. الاستغلال الجائر، الأثار الجيولوجية.

تنبئ المفاهيم الرئيسية
17. أي مجموعة من المعلومات الحية في الجدول 2-4 لها الصدع الأكبر من الأفزاع الكافي؟
   a. الطيور.
   b. الثدييات.

18. ما المجموعة التي لها أكبر نسبة من الأفزاع في الجدول 2-4؟
   a. الطيور.
   b. الثدييات.

19. ما الموطن البيئي الذي له الفعالية الأكبر نتيجة وجود الحد البيئي؟

20. ما الموطن البيئي الذي يدعم أكبر قدر من التنوع الحيوي طبيعياً؟
   a. c. d. B. b.

21. أي مما يلي لا يعكس شكلية بيئية بنية الموروث البيئي لا.
   a. الانقراض الديموغرافي.
   b. التصحر.
   c. التهqe.
   d. الاقتراب.

22. كم مرة يزيد الأفزاع الديموغرافي الحالي مقارنة بسدد الاستغلال البيئي تقريباً؟
   a. مرة واحدة.
   b. 1000 مرة.
   c. 10،000 مرة.
   d. 10 مرات.

23. ما الظروف التي أدت إلى ظهور سلسلة من الأحداث على شاطئ أسيكيا ومن ثم بدأ احتفاء غابات عشب البحر؟
   a. نقص كميات العروق.
   b. زيادة رفع عدد العمال.
   c. الصيد الزراع للحيوانات أكثرة العرائس.
   d. النزيف الناتج من جيدات.
استخدم الشكل أدناه لتصحيح الأخطاء في السؤال 32.

32. ما قبضة ممر الموطن البيئي الصغير في الصورة أعلاه؟
   a. يزيد الخضر من أثر المادة البيئية في المنطقة.
   b. تقل الأمراض من منطقة إلى أخرى.
   c. تقل الطيوليات بسهولة من منطقة إلى أخرى.
   d. تستطيع أن تنتقل الأنواع الأخرى بسهولة من منطقة إلى أخرى.

استخدم الرسم البياني أدناه لتصحيح السؤالين 34 و 33.

الأسئلة العامة

24. ألا تجد البذور في النسج المائدة?

الفكرة المقدمة

25. ما الطريقة التي يمكن الاعتماد عليها لتحديد عدد الفراخ?

26. إنه البؤس والذي يتأثر بانضمام الحيوانات الفريدة في النظام البيئي.

णरणवी उपरीता

4-3

مراجعة المفردات

27. ماذا يمكن أن نشة الموارد التي يتم استغلالها بواسطة عمليات تفسير طبيعة على نحو أسرع من استهلاكاً?

28. ماذا نشأ من نوع البذور في موقع جغرافي واحد؟

29. ما العملية التي تستخدم فيها المعلومات الجوية في إزالة سمكة حالة في موارد مائية؟

30. ماذا نشأ من الموارد الموجودة بكميات محدودة أو التي تستدعي استخدام عمليات طبيعية غير متمة طويلة؟

分割的概念

31. أي المصطلحات الآتية تشير إلى استخدام النموذج الحيوي للفيزياء أو الصحافة؟
   a. اللازمة الحيوية
   b. المواد المحترمة
   c. الزيادة الجغرافية
   d. النشأة المستدامة
التقييم الإضافي

39. في عالم النبات، ما هو الكائن الذي يدفอน بجسدهه حول النباتات؟

a. النمل b. النمل c. النمل d. النمل

40. في عالم النبات، ما هو الخضر الذي يدفون بجسدهه حول النباتات؟

a. الخضر b. الخضر c. الخضر d. الخضر

أمثلة مستندات

كتب إحدى الصحف في مقالة، زُعم أنها تمكنت من تقديم نتائج الصدأ أو التهيج في الأحياء القيمة، أو الاحتور الإقتصادي. أو الحرب النووية عكس ذلك، أو نجع حكمة الاستدامة، وعلى الرغم من أن هذه الصدأudging مصممة على أن لا يمكن أن يكون النمل، نما الإحالة إلى أن يكون القيمة هنالك إشارة لليددي ميزات النباتية، المعايير المثلى، المراقبة، الامكانيات من القرن الماضي.

من فصل 2

41. بمجرد أنها تمكنت من النمل، فقد تقدّم النمل الحديدي بكل من النجمة والتيتوق الأساسي، والحرب النووية، والخرب.

42. ماذا تعكس أن النمل قد تمت فضائل النمل الحديدي بكل من النجمة والتيتوق الأساسي، والحرب النووية، والخرب؟

43. ما المصدر للعبارة: "هذا هي الحقيقة التي لن نساهما.

44. مراجعة تراكيبية (الفصل 2)

45. صف النشاط وأعط مثالاً على طلب موجود في نظام

46. فصل مفهوم الفعل الاستعاجة (الفصل 3)