2010

Effectiveness of Using Inquiry Based Instruction to Increase Students Performance in High School Biology as Bardwell Institute

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The Effectiveness of Using Inquiry Based Instruction to
Increase Student Performance in High School Biology at Bradwell Institute

A Research Study Presented to the Faculty of the Department of
STEM Education and Professional Studies
At
Old Dominion University

In Partial Fulfillment of the Requirements for the
Master of Science Degree

By
Keli L. Blyth
May 2010
This research paper was prepared by Keli L. Blyth under the direction of Dr. John M. Ritz in OTED 636, Problems in Occupational and Technical Studies. It was submitted to the Graduate Program Director as partial fulfillment of the requirements for the Degree of Master of Science.

APPROVED BY:____________________________________ DATE:____________

Dr. John M. Ritz

Advisor and Graduate Program Director
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CHAPTER I

INTRODUCTION

Increased student performance is the number one goal of educators. All teachers, principals, and parents want their students to perform to the highest standards possible. With this goal in mind it is important for new learning styles to be investigated and to discover if there are better ways to teach. For a subject area like science, teachers are responsible for not only educating their students to recite information, but students must also understand the nature of science and be able to apply concepts and determine logical conclusions (Georgia Department of Education, 2006; Virginia Department of Education, 2003).

The area to be studied will be high school biology classes at Bradwell Institute in Hinesville, Georgia. The current pass rate for the standardized biology end of course examination is 75%; this leaves room for improvement. Bradwell Institute biology teachers mainly use the traditional lecture method for teaching their classes. Although teachers are achieving respectable pass rates, new teaching methods must be tried to produce the best learning experience for their students.

The teaching style in which students learn by discovery is called inquiry based learning. This learning style tends to be more enjoyable for the students, because they are actively participating in their learning. This learning style also tends to be more natural for students because human beings naturally learn by discovering the world around them (Education Broadcasting Corporation, 2004). Inquiry based learning is a method that has the potential to achieve higher subject specific student performance (Michel, Carter, & Varela, 2009).
Statement of the Problem

The problem of this study was to determine if student learning was enhanced through the use of inquiry teaching methods in high school biology.

Research Goals

To guide this study the following hypothesis was established:

H_1: Students who are taught biology using the inquiry method of teaching at Bradwell Institute will score higher on a standards based assessment than students who learn from the lecture/laboratory method of teaching.

Background and Significance

The researcher for this study was a former biology teacher for Bradwell Institute. The researcher spent two years working in the biology department and tried to improve the methods that were being used to teach. The researcher was introduced to the idea of inquiry based learning and applied it in the researcher’s classroom. Through using inquiry the researcher noticed a positive increase in students’ attitudes toward their work and it also appeared to have a positive affect on their academic performance. The researcher wondered if there was a statistically significant improvement in the students’ learning.

Past literature showed that there was a need for additional research to see if inquiry teaching methods produced higher levels of learning. The literature had shown that inquiry methods were superior; however, they had mainly focused on students’ attitudes toward the lesson, rather than the actual student performance. Literature calls for inquiry methods of teaching to be compared to traditional methods of teaching by measurable means, like a standard based assessment, instead of observations or
questionnaires (Michel et al., 2009). Additionally, literature showed that when inquiry based learning along with cooperative learning was used compared to traditional lecture methods in collegiate level biology, there was an increase in effective learning by students. This was measured by using a standards based assessment (Ebert-May, Brewer, & Allred, 1997). The proposed research study focuses on the academic affects of using inquiry based teaching methods compared to traditional lecture methods in high school level biology.

The value of this study would be that it could implicate that inquiry based learning is a superior method of teaching. This means that student knowledge obtained by the use of inquiry was greater than that obtained using traditional teaching methods.

Limitations

The limitations for this study were the boundaries to which the conclusions will be drawn:

- The research study was limited to high school biology students at Bradwell Institute in Hinesville, GA.
- The research study was completed in the Spring of 2010.
- The delivery of the lessons by the different biology teachers may be a variable.
- The topic to be taught will be adaptation.

Assumptions

The following was theorized to be true within circumstances of the study:

- Teachers are teaching using the inquiry method for the tested group or the traditional lecture method for the control group.
- Teachers will be teaching to the biology adaptation standard.
• The students have little to no prior knowledge of the adaptation standard being addressed.

• Students will participate in the inquiry based activity.

• Students are learning using the inquiry method.

Procedures

For this study, biology teachers at Bradwell Institute instructed students using an inquiry based method of teaching or the traditional lecture method. Both groups also participate in laboratory activities. Teachers were randomly assigned to teach using either the traditional lecture method or teach using inquiry. Teachers received a lesson plan for either the lecture or inquiry lesson. All students were to master the same standard. Teachers also received all supplies needed for completion of the lesson. Teachers then gave the lesson to their students. Students were then given a common standards based assessment at the conclusion of the instruction. Teachers recorded the student scores keeping those who were taught using inquiry and those who were taught using the lecture method separate. The results were compared using descriptive statistics and a t-test to see if there was a significant difference in student performance.

Definition of Terms

The following terms are defined and used in this study:

• Inquiry Based Learning Method: Teaching by allowing students to seek information by questioning and discovering for themselves (Education Broadcasting Corporation, 2004).
• Active Teaching: Method of teaching in which students are engaged in their learning. It is a broad term that includes methods of instruction that involve inquiry based instruction as well as cooperative learning (Ebert-May et al., 1997).

• Passive Teaching: Method of teaching in which students learn by lecture and are not actively participating in their own learning (Stewart-Wingfield & Black, 2005).

• Traditional Lecture Method: Teaching method in which the teachers talk and present information to students, and students listen (Bonwell & Elison, 1991).

• T-test: statistical test use to compare two means to see if they are significantly different from each other (Urdan, 2005).

Overview of Chapters

Chapter I of this study is an overview of the research proposal. The chapter reviewed the importance of using teaching methods that best help students to gain knowledge. The problem of the study was to determine if student learning was enhanced through the use of inquiry teaching methods in high school biology. It was hypothesized that students who are taught biology using the inquiry method of teaching at Bradwell Institute would score higher on a standards based assessment. The limitations, assumptions, and the techniques that will be used in this study were also covered. Finally, a glossary of technical and key terms was included as well as an overview of the chapters.

Chapter II of this study focuses on the literature and current research relating to the study of inquiry based teaching methods. The literature that is reviewed also covers
research on teaching biology effectively. The reviewed literature and research will support the need for this study.

Chapter III of this research proposal explains the methods and procedures used. The process used to teach students using inquiry based learning or traditional lecture was discussed. The gathering of results and the steps taken to analyze the data, like the t-test, were also detailed.

Chapter IV of this study presented the findings. The results of the data were analyzed. Chapter V of this study is a summary of what was found. Conclusions that can be made from the findings were also included. Recommendations for future work rounds out the chapter.
CHAPTER II

REVIEW OF LITERATURE

In teaching high school biology, it is important for the educator to continually try to improve their teaching methods. This chapter will review the literature to help the researcher become an expert in the content and variables of the study. The literature reviewed was selected based on the variables outlined in the problem of the study. The information that was obtained relates to teaching high school biology, cognitive development, the inquiry based learning method, the traditional lecturing method, methods previously used to collect data, and methods for formulating an assessment. The findings of the variables important to the study are discussed.

Teaching High School Biology

When teaching high school biology, the educator must keep in mind how people learn and effective teaching strategies. The field of science allows for students to understand not only information, but how the information arose through the use of experimentation (Virginia Department of Education, 2003). Currently, high school science is typically taught by the use of the traditional lecture method. There is a call for new active learning teaching techniques, like inquiry based learning, to be used (Shields, 2006). Science teachers must find ways in which students are engaged in lessons that allow students to investigate and gain a positive impression of the learning experience (Stewart-Wingfield et al., 2005).

Science is an important subject for students to understand because it teaches them how to think scientifically. Instead of accepting information, science helps to teach students to question and systematically investigate problems for the truth. The importance
of science is that it allows for investigation and discovery that satisfy the human beings
desire for knowledge and understanding. Science also allows for advancements in the

The way science is currently taught needs to be changed. Educators must be
aware of what they want students to learn and then create lessons in which students will
gain the information. Science education requires for students to not only learn facts, but
to also learn how to apply, analyze, synthesize, and evaluate the information (Georgia
Department of Education, 2006). The methods that are recommended are inquiry based
methods (Ebert-May et al., 1997).

Superior teaching strategies are ones in which students are able to retain
knowledge and apply what they have learned to new applications. For students to find the
value in a lesson, they need to be able to relate the lesson to the real world and their
future careers. Research has shown that students recognize lessons that are experimental
in nature, like inquiry based lessons, to be more useful to their future careers (Stewart-
Wingfield et al., 2005).

When teaching biology, the educators’ goal must be to instruct students so that
they thoroughly understand biology. This means that students are to not only learn the
major biology concepts, but in order to solve problems students must also learn to use the
process of inquiry. By using inquiry based teaching methods in biology, teachers are able
to allow students to actively learn the major biology concepts by investigating for
themselves (Ebert-May et al., 1997).

Biology teachers must also teach so that students gain a positive experience from
their lessons. Students who enjoy the way in which the lesson is presented and the way in
which they are learning will gain more from the lesson and will continue to want to learn. Students who are taught using active course designs, like the inquiry method of teaching, have shown an increased enjoyment in the lesson (Stewart-Wingfield et al., 2005).

Cognitive Development

Educators must be aware of cognitive development or the way in which people learn (Lion, 1998). A good way for educators to acknowledge different levels of cognitive development in their lessons is for them to use Bloom’s Taxonomy. Bloom’s taxonomy is a classification system that recognizes the process that students undergo when learning information and gives educators a tool for measuring the levels of cognitive development that they are reaching with their lessons (Love, 2006).

The classification is split into six levels that range from basic knowledge gaining to higher level thinking. The lowest level is called knowledge, and it describes when the student is remembering facts that they were previously taught. The second level is comprehension, and this describes the students’ ability to understand the significance of the material that they are being taught. The third level is application; this is when the students are able to use the information that they have previously learned in an original way. The fourth level is analysis, and this is when students are able to separate material into ordered parts. The fifth level is synthesis, and it is when students are able to arrange parts into a new whole. The sixth and highest level of the taxonomy is evaluation, and it is when the students are able to critique the significance of the material that they had learned (as cited in Love, 2006).

According to research, the traditional lecture method of teaching typically remains at the lower levels of bloom’s taxonomy. This means that students are not
reaching the higher levels of cognitive development by the traditional method (Lion, 1998). The inquiry based method of teaching allows students to reach the highest levels of Bloom’s taxonomy. Students are reaching the higher levels of cognitive development when taught using the inquiry method of teaching (Mysliwiec, Dunbar, & Shibley, 2005).

Inquiry Based Learning Method

The inquiry based learning method is a teaching technique in which teachers allow students to learn through discovery. Inquiry based learning demands that students are actively participating in their own learning (Education Broadcasting Corporation, 2004). Research shows that active teaching methods, like inquiry, are found in the personal opinion of most students to be more useful (Stewart-Wingfield et al., 2005).

Inquiry based methods allow for students to interact with their surroundings, ask questions, and draw conclusions by thinking critically and logically (National Science Teachers Association, 2004). Inquiry based learning especially lends itself to teaching science courses because of its investigative nature. Science courses require students to learn the scientific method and perform scientific inquiries. Inquiry based learning builds on the required scientific curriculum and elevates the cognitive development of students to the highest levels of bloom’s taxonomy (Mysliwiec, 2005; Shields, 2006).

The National Science Teachers Association posted a position statement on scientific inquiry, which said, “understanding science content is significantly enhanced when ideas are anchored to inquiry experiences” (p. 1). The association also recommended that all educators need to make inquiry based learning the focus of their science classes (National Science Teachers Association, 2004).
According to both the Georgia and Virginia state standards for biology, students are required to obtain higher levels of cognitive development by not only observing and recalling information, but also by analyzing and evaluating (Georgia Department of Education, 2006; Virginia Department of Education, 2003). Inquiry based methods allow for higher levels of cognitive development to be reached by students (Mysliwiec, 2005).

Traditional Lecture Method

The traditional lecture method of teaching is the most common method used in education. The lecture method is when educators teach students by telling them the information. The students are then expected to absorb and retain the information. The traditional lecture method allows for educators to teach large amounts of information in a relatively short amount of time (Stewart-Wingfield et al., 2005).

When the traditional lecture method is used, students learn passively. This means that students are not actively involved in their own learning. Students are expected to learn the material by listening to the instructor and the students give little feedback to the instructor (Stewart-Wingfield et al., 2005). When students are gaining knowledge passively, they may learn the information, but they may only retain the information for a short time (Ebert-May et al., 1997).

Students who learn passively through lecture are typically only retaining facts. Students are not learning how to apply knowledge. The students’ cognitive knowledge obtained through the use of the traditional lecture method will typically be on the lower levels of Bloom’s taxonomy (Lion, 1998). The traditional lecture method has not shown any advantage in student performance when compared to other teaching methods (Stewart-Wingfield et al., 2005).
Methods for Collecting Data

Methods that have been used to collect data on differing teaching methods include how the groups of students being taught the different teaching methods were separated, the delivery of the differing teaching techniques, the assessment of the students, and the analysis of the results. Previous research randomly split students into groups within the same class and taught the class subgroups using the different teaching methods (Casamassa, 1998). Researchers also taught the same group of students using the different teaching methods at different times (Carlson, 2009). Other researchers randomly assigned different classes to be taught the different teaching techniques (Ebert-May et al., 1997).

The groups were taught their specific teaching method for a period of time, ranging from a lesson or an entire course. To reduce extraneous variables the experimental groups were taught either in separate areas or at different times (Carlson, 2009; Casamassa, 1998; Ebert-May et al., 1997).

The students were also assessed to find the superior teaching method. Assessments included student interviews, surveys, field observations, a behavior checklist, or a formal assessment. The formal assessments included assessments standard to the course that the students were instructed or assessments that were nationally accredited (Casamassa, 1998; Ebert-May et al., 1997).

After the assessments were finished, they could then be statistically analyzed. Previous research used a t-test to compare the results of the two different teaching methods. The different groups’ scores were also analyzed to find if the results could be repeated and applied to a larger population (Casamassa, 1998). The t-test is a test used for
comparison studies in which the mean of two independent variables can be obtained (Urdan, 2005).

Methods for Formulating an Assessment

When formulating an assessment, it is important to recognize the objectives that are being assessed. Assessments based on the standards of the course objectives have been used to assess the knowledge gained by students (Casamassa, 1998; Ebert-May et al., 1997).

Summary

In Chapter II, Review of Literature, various sources were examined to increase the level of understanding about the variables outlined in the problem statement. The literature review covered the importance as well as methods of teaching high school biology. The review discussed cognitive development to give background into how students learn. The two teaching methods that are being compared, inquiry based learning method and traditional lecture method, were discussed in detail. Previous methods used by researchers who were studying a similar comparison were also discussed. The literature reviewed allowed for the researcher to become an expert in the study. In Chapter III the methods and procedures used in this particular study will be detailed.
CHAPTER III

METHODS AND PROCEDURES

In Chapter III, the methods and procedures used in this particular study are detailed. The research study that was performed was experimental research. The population, research variables, instrument design, classroom procedures, methods of data collection, and the statistical analysis are all discussed.

Population

The population of this research study was high school students attending Bradwell Institute and enrolled in biology for the spring 2010 semester. The majority of the students were in tenth grade. The majority of the students attending Bradwell Institute are from the surrounding rural community or the nearby military post, Fort Stewart. In the research study, a total of 128 students participated. Forty-three students were in the control group and 85 students were in the experimental group.

Research Variables

The only purposefully used variables of this study were the teaching method employed by the educator. Other variables have been minimized to try to increase the validity of the research. The independent variables of this study are the traditional lecture method and inquiry method of teaching. The resulting dependent variable of the study was the knowledge gained by the students.

Instrument Design

A standards based assessment was created to gather data on the knowledge gained by the students participating in the study. High school level biology in the state of Georgia has standardized objectives for educators to follow. The state also uses standard
based assessments to assess students’ performance at the conclusion of the biology course. The assessment created for this particular research study is directly measuring the knowledge gained for a specific state standard covering the biology topic of adaptations. The assessment was created by taking questions from a state created inventory directly or by slightly modifying the questions, while retaining the format of the questions. The questions used for the research study were proven to be valid and reliable by the state of Georgia (Georgia Department of Education, 2006; Georgia GPS Edition Coach Standards-Based Instruction Biology, 2008). The assessment used for this particular research study to measure the knowledge gained by the students can be found in Appendix A.

Classroom Procedures

Educators teaching biology for the spring 2010 semester at Bradwell Institute will teach a pre-created lesson on adaptations to their biology class at the beginning of the block class. The educator will teach the lesson by using the traditional lecture method (Appendix B; Appendix C) or by using the inquiry based learning method (Appendix D; Appendix E). The educator will follow every step as outlined in the lesson plan. The lesson will be completed in one day. The standard for this lesson was for students to relate natural selection to changes in organisms, as well as, to relate the changes in organisms to their ability to survive stressful environments. After the conclusion of the lesson, the educator will continue with class as they normally would. During the last 10 minutes of class, the educator will give the standards based assessment to their class (Appendix A). The students will complete the assessment individually and return the assessment to their instructor.
Methods of Data Collection

The methods used to collect the data included the educators grading the students’ assessments, coding the students’ identities, recording the grades and the identities, and returning the data to the researcher. The educators will grade the standards based assessment using the provided key (Appendix A). The educator will then code the names of each student and record the number that they received correct on the assessment on a pre-created Excel sheet (Appendix G). The educator will code the students by first putting a “L” if the traditional lecture method was used or an “I” if the inquiry based learning method was used, followed by a number, one through however many students were in the class. This will insure that the individual student’s identity is protected and the researcher will never have knowledge of the individual students participating in the research study. For example if the educator did the lecture lesson they would grade the assessments and instead of writing the students name, Mary Smith, she could put L1. L for Lecture and 1 for the first assessment graded. The educator will then return the completed Excel sheet to the researcher for statistical analysis (Appendix G; Appendix H).

Statistical Analysis

The results of the standards based assessment were analyzed. First the researcher found the mean score for the traditional lecture method and for the inquiry based method. Next, the scores for the different groups were analyzed using a comparative analysis, a t-test.
In Chapter III of the research study, the methods and procedures were discussed. The study tested to see if the inquiry based teaching method was superior to the traditional lecture method. The study was performed in all Bradwell Institute biology classes for the spring 2010 semester. The specific biology standard that was addressed was adaptations. The biology educators performed either the pre-created inquiry based method or the pre-created lecture method and then assessed their students. The results of the assessments were coded, to protect the students’ identity, and returned to the researcher to be analyzed by a comparative analysis. In Chapter IV of the study the results of the research will be described.
CHAPTER IV

FINDINGS

Data were collected from Bradwell Institute biology classes in Spring of 2010. The classes were taught biology content by using either the traditional lecture method of teaching or the inquiry based teaching method. Students were then tested for their understanding of the content by the use of a standards based assessment. The results of the assessment were then statistically analyzed to find if there was a significant difference between the two sample means. The problem of the study was to determine if student learning was enhanced through the use of inquiry teaching methods in high school biology. The findings are detailed in the following chapter.

Report of Findings

A total of 128 students participated in the study. The control group was taught using the traditional lecture method of teaching and consisted of 43 students. The experimental group was taught using the inquiry based method of teaching and consisted of 85 students. A research goal was established in the form of a hypothesis to guide the study:

$H_1$: Students who are taught biology using the inquiry method of teaching at Bradwell Institute will score higher on a standards based assessment than students who learn from the lecture/laboratory method of teaching.

Statistical Comparisons

The student scores from the standards based assessment were calculated in the form of a raw score and submitted to the researcher. The lowest score a student could have attained was a zero and a perfect score was a ten. The researcher analyzed the data
and found the mean scores for both groups. The students taught using the traditional lecture method of teaching had a mean score of 6.12, or 61.2%. The students taught using the inquiry based method of teaching had a mean score of 6.84, or 68.4%. The raw score and percentage mean can be viewed in Table 1 and Figure 1.

Table 1.

**Raw Score Mean and Percentage Mean for Both Experimental Groups**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean Raw Score</th>
<th>Mean Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inquiry Based Group</td>
<td>6.84</td>
<td>68.40%</td>
</tr>
<tr>
<td>Traditional Lecture Group</td>
<td>6.12</td>
<td>61.20%</td>
</tr>
</tbody>
</table>

Figure 1.

*Mean Scores from Standards Based Assessment*

In addition to finding the mean scores for each experimental group, the researcher implemented the use of a t-test to determine if there was a significant difference between
the two sample means. The t value was found to be 1.477. The degree of freedom was found to be 126, and the researcher found the test to be one tailed because the hypothesis was predictive. The t value was evaluated on the t table of significance. The t value was found to be significant on the .1 level of significance of $p > 1.289$.

Summary

Bradwell Institute biology classes for the spring 2010 semester were split into two experimental groups: a group taught using the traditional lecture method and a group taught using the inquiry method of teaching. Both groups were evaluated by a standards based assessment. The mean scores for the standards based assessment were calculated for both groups. The t-test value was then calculated to find if there was a significant difference between the means of the two experimental groups. The mean score for the standards based assessment was higher for the inquiry based method then that of the traditional lecture method. However, the t-test value showed that there was no statistically significant difference between the two means. Chapter V will summarize the research study, draw conclusions, and make recommendations for future studies based on the findings of the research study.
CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this chapter is to summarize the study and draw conclusions based on the findings. The chapter also includes recommendations for future studies.

Summary

The problem of the study was to determine if student learning was enhanced through the use of inquiry teaching methods in high school biology. A research goal was established in the form of a hypothesis to guide the study:

H₁: Students who are taught biology using the inquiry method of teaching at Bradwell Institute will score higher on a standards based assessment than students who learn from the lecture/laboratory method of teaching.

The study is significant because it shows the effectiveness of teaching using the inquiry method. The study compared the knowledge obtained by students when taught using the inquiry teaching method compared to those taught using the traditional lecture method of teaching. The study investigated the effectiveness of the two teaching methods by teaching students using either method and then giving them a standards based assessment. Past literature has shown that inquiry based teaching methods are superior to traditional teaching methods, but previous research focused on students’ attitudes toward the lesson and not student performance. The literature calls for research investigating the effectiveness of inquiry based teaching methods to be compared to traditional methods of teaching by measurable means, like a standard based assessment (Michel et al., 2009).

There were four limitations in this study. The research study was limited to high school biology students at Bradwell Institute in Hinesville, GA; the research study was
completed in the spring of 2010; the delivery of the lessons by the different biology teachers may be a variable; and the topic to be taught will be adaptation.

High school students attending Bradwell Institute and enrolled in biology for the spring 2010 semester were the population for the study. Most of the students were in tenth grade and were from the surrounding rural community or the nearby military post, Fort Stewart. A total of 128 students participated in the study; 43 students were in the control group and 85 students were in the experimental group.

The instrument used to measure the student knowledge obtained from either teaching method was a standards based assessment. The assessment created for this research study was directly measuring the knowledge gained for a specific state standard covering the biology topic of adaptations. The assessment was created by taking questions from a state created inventory directly or by slightly modifying the questions, while retaining the format of the questions. The questions used for the research study were proven to be valid and reliable by the state of Georgia (Georgia Department of Education, 2006; *Georgia GPS Edition Coach Standards-Based Instruction Biology*, 2008).

Educators teaching biology for the spring 2010 semester at Bradwell Institute collected the data for this study. The educators taught a pre-created lesson on adaptations to their biology class at the beginning of the block. The educators taught a lesson by either using the traditional lecture method or by using the inquiry based learning method. All students were to master the same content. The educators followed the steps outlined in the lesson plan. The lessons were completed in a single class block. After the conclusion of the lesson, the educators continued with class as they normally would.
During the last 10 minutes of class, the educators gave a common standards based assessment to their class. The students completed the assessment individually and then returned the assessment to their educator. Finally, the educators sent the student assessment scores to the researcher to be analyzed.

The results were compared using descriptive statistics and a t-test to see if there was a significant difference in student performance. The researcher found the mean score for the traditional lecture method and for the inquiry based method. Then the scores were analyzed using a t-test to see if there was a significant difference between the scores.

Conclusions

The data that were collected in this research study was used to answer the research goal of the study. The research goal stated:

H_1: Students who are taught biology using the inquiry method of teaching at Bradwell Institute will score higher on a standards based assessment than students who learn from the lecture/laboratory method of teaching.

The experimental group of students was taught using the inquiry based method of teaching and had a mean score on the standards based assessment of 6.84 or 68.4%. This was higher than the control group of students taught using the traditional lecture method of teaching, which had a mean score on the standards based assessment of 6.12 or 61.2%. Although the inquiry based method of teaching had a higher mean score than the traditional lecture method, when the t-test value was calculated (t=1.477) for the data, the means were found to not be significantly different. As a result, the hypothesis that students who were taught biology using the inquiry method of teaching at Bradwell Institute would score higher on a standards based assessment than students who learned
from the lecture/laboratory method of teaching was rejected at the .05 level of significance, \( p > .05 = 1.658 \).

**Recommendations**

Based on the findings of the research study, the researcher recommends:

- To increase the population of the study. The increased population will increase the reliability of the study.
- To improve the testing instrument. The length of the standards based assessment could have increased; this would have increased the validity of the scores.
- To test the students’ knowledge retained by having the students come back after several months and retest to see if the information was retained longer in the inquiry verse the lecture group.
- Perform the study over a longer period of time and create several units where one group is taught using the inquiry method and another group is taught using the traditional lecture method and then compare the retention of the knowledge by comparing the results of the standards based end of course test.
- To perform a study comparing the inquiry based method of teaching and the traditional lecture method of teaching and students knowledge obtained in a content area other than science.
- To perform a study comparing several different teaching methods to the inquiry method of teaching.
- To perform a study where students with special needs are taught using either the inquiry based method of teaching or the traditional lecture method of teaching and
then comparing the knowledge gained to find if there is a significant difference in the knowledge gained by either teaching method.
REFERENCES


Cassamassa, M. (1998). *The effectiveness of active and passive teaching methods on the retention of material taught to the naval intelligence officer’s basic course (NIOBC) students for the period of one week.* Retrieved from Old Dominion University OTS Graduate Research Database.


Appendix A

Standards Based Assessment

Name__________________________________________ Date_____________  Block______________

End of Class Standards Based Assessment

Directions: Circle the best answer. This is a closed note and closed book assessment. Answer the questions to the best of your ability. Remember to think about what we learned in class today.

1. A community of different birds is living in an aquatic environment. Which of the following feet belongs to the bird BEST adapted to survive in an environment in which they need to swim to find food?
   a. clawed feet  
   b. webbed feet  
   c. flat feet with thin toes  
   d. clawed feet with tall legs

2. What would happen to a population that had a large number of white rabbits and a small number of black rabbits that lived in an area that was normally snow covered year round, and then the climate changed so that the ground was now dark with no snow?
   a. the number of white rabbits would decrease  
   b. the population would not change  
   c. the number of white rabbits would increase  
   d. the number of black rabbits would decrease

3. What would happen to the same population of rabbits described in questions number 2, if the climate changed so that the ground was now white with snow again?
   a. the number of black rabbits would increase  
   b. the population would not change  
   c. the number of black rabbits would decrease  
   d. the number of white rabbits would decrease

4. The population of rabbits described in questions 2 and 3, would change because __________.
   a. there would not be a change  
   b. black furred rabbits do not like snow  
   c. white fur is warmer  
   d. predators would find rabbits that did not have camouflage

5. An octopus has the ability to change its coloring depending on its surroundings. Which of the following is the most likely reason for the adaptation?
   a. they can hunt their prey more easily  
   b. they must compete for a mate  
   c. they need to survive the changing season  
   d. they can travel in groups more easily

6. Camouflage helps an organism ability to blend into its surroundings, which of the following is not true about the adaptation camouflage?
   a. predators have difficulty locating the organism  
   b. populations change over time  
   c. organisms are more likely to survive and reproduce  
   d. all of these are true

7. Which of the following adaptations does a cactus have that most likely enables it to live in its environment?
   a. salt-tolerant roots  
   b. leaves reduced to thin, sharp spines minimizing surface area  
   c. specialized leaves that trap insects  
   d. air-filled spaces that take in oxygen for its roots

8. Maple trees enter dormancy, a time when growth and development stops, to
   a. protect itself from freezing during the winter  
   b. move to a new location  
   c. retain water  
   d. none of these

9. Bears enter hibernation, a time when an organism experiences a decrease in activity and body temperature, to
   a. catch up on their sleep  
   b. move to a new location  
   c. survive during times of limited food/resources  
   d. all of these

10. The harmless king snake has the same coloring as the poisonous coral snake. Which of the following is the MOST likely reason for the success of this adaptation?
    a. King snakes need to survive the changing season.  
    b. The food supply is limited.  
    c. Predators will avoid eating the king snakes.  
    d. King snakes must compete for a mate.
Appendix B

Traditional Lecture Method Lesson Plan

Lecture Lesson

Standards: SB4. Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems. a. Investigate the relationships among organisms, populations, communities, ecosystems, and biomes. e. Relate plant adaptations, including tropisms, to the ability to survive stressful environmental conditions. f. Relate animal adaptations, including behaviors, to the ability to survive stressful environmental conditions. SB5. Students will evaluate the role of natural selection in the development of the theory of evolution. d. Relate natural selection to changes in organisms.

Objectives: Camouflage Provides an Adaptive Advantage. Camouflage is a structural adaptation that allows organisms to blend with their surroundings. In this activity, students will discover how natural selection can result in camouflage adaptations in organisms.

Preparation: Set up projector and review the PowerPoint presentation.

Lecture Directions: Present the lecture to the class. Do not print notes off for the students, but do allow them to take notes if they wish. If students ask questions, then tell them the answers.

End of Class Standards Based Assessment:
1. During the last 10 minutes of class pass out the assessment. It is closed notes/book.
2. Please grade the assessments and email me the scores on the attached spreadsheet.
3. When inputting scores into the spreadsheet, please number the students so that their identity is protected. For example if the traditional lecture lesson was taught, then you would grade the assessments and instead of writing the students name, Mary Smith, she could put L1. L for Lecture and 1 for the first assessment graded.

Notes: To help reduce variables, please only lecture. Do not print out notes for students. Students may take their own notes. Please remember to only use the lecture method when teaching this lesson.
Appendix C

Traditional Lecture PowerPoint

Slide 1: Lecture on Adaptation and Natural Selection
Standards:
- SB4. Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems.
- Investigate the relationships among organisms, populations, communities, ecosystems, and biomes.
- e. Relate plant adaptations, including tropisms, to the ability to survive stressful environmental conditions.
- f. Relate animal adaptations, including behaviors, to the ability to survive stressful environmental conditions.
- SB5. Students will evaluate the role of natural selection in the development of the theory of evolution.
- d. Relate natural selection to changes in organisms.

Slide 2: Adaptations
- Traits that improve an organism’s chance for survival and reproduction
- Animals inhabit various regions all over the globe
- Evolved adaptations to allow them to live in stressful environments

Slide 3: Adaptations= Natural Selection
- If an environment changes, certain individuals that are better suited for new environment will survive and reproduce
- Due to natural selection, different traits of a population may emerge
- Populations change over time

Slide 4: An Example of an Adaptation
- Camouflage: Provides an Adaptive Advantage. Camouflage is a structural adaptation that allows organisms to blend with their surroundings.
- If an environment changes, then natural selection will take place and can result in camouflage adaptations in organisms.

Slide 5: Example Continued
- Ex: The peppered moth can either be light colored or dark colored. Before the industrial revolution, light-colored peppered moths were common in England and were found living on tree with light colored bark. After the Industrial Revolution dark-colored peppered moths became more common.
- The population changed because the trees were no longer white due to the pollution. They were now dark in color and the dark moths now blended into the trees. The white moths were no longer camouflaged and were easily found by predators. The moths adapted through natural selection.
Appendix D

Inquiry Based Learning Lesson Plan

Inquiry Based Lesson

Standards: SB4. Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems. a. Investigate the relationships among organisms, populations, communities, ecosystems, and biomes. e. Relate plant adaptations, including tropisms, to the ability to survive stressful environmental conditions. f. Relate animal adaptations, including behaviors, to the ability to survive stressful environmental conditions.

SB5. Students will evaluate the role of natural selection in the development of the theory of evolution. d. Relate natural selection to changes in organisms.

Objectives: Camouflage Provides an Adaptive Advantage. Camouflage is a structural adaptation that allows organisms to blend with their surroundings. In this activity, students will discover how natural selection can result in camouflage adaptations in organisms.

Preparation: Fill Petri dishes with 20 black and 20 white dots. Make enough Petri dishes so that students can work in groups of 2 or 3 depending on the class size.

Inquiry Investigation Directions:
1. Have students go to the lab area and find a partner.
2. Pass out the Petri dishes with 20 black and 20 white dots. If not using black lab tables, then also pass out a large sheet of black paper to perform the investigation on.
3. Pass out the lab sheets.
4. Read through the directions with the class, and have them begin.
5. Guide the students through the class with questioning.

End of Class Standards Based Assessment:
1. During the last 10 minutes of class pass out the assessment. It is closed notes/book.
2. Please grade the assessments and email me the scores on the attached spreadsheet.
3. When inputting scores into the spreadsheet, please number the students so that their identity is protected. For example if an inquiry lesson was taught, then you would grade the assessments and instead of writing the students name, Mary Smith, she could put I1. I for Inquiry and 1 for the first assessment graded.

Notes: Please remember inquiry based learning is when students learn through discovery. So please help guide students in discovering answers for themselves. Do not tell students the answers; guide them to answer questions for themselves. Please only use inquiry learning when teaching this lesson. Help guide the students by asking them questions about what is happening. What would happen to the population over a long period of time? Which organisms are being consumed?
Inquiry Based Learning Activity

Inquiry Investigation:

Inquiry Investigation
Name________________

Materials
1. Petri dish
2. 30 black dots
3. 30 white dots
4. Dark lab table or black construction paper
5. Timer or Clock

Procedure
1. Obtain a Petri dish with 30 black dots and 30 white dots. These dots will represent black and white insects.
2. Scatter both white and black dots on a lab table. Be careful when scattering so the dots won’t fly off the table. If you do not have a lab table, then scatter the dots on a black sheet of paper.
3. Decide whether you or your partner will role-play a bird.
4. The “bird” looks away from the table, then turns back, and immediately picks up the first dot he or she sees.
5. Repeat step 4 for 30 seconds. Record the results in the table below. Complete this three more times without replacing any dots.

Record the number of dots collected in the table below for each trial:

<table>
<thead>
<tr>
<th>Dot Color</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Trial 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Dots</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black Dots</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analysis
1. What color dots were most often collected? _______________________
2. What dots were least collected? _______________________
3. What is the bird doing to the insects? _______________________
4. How does color affect the survival rate of insects? _______________________
5. What might happen over many generations to a similar population? _______________________

_______________________________________________________
Answer Key for Standards Based Assessment

Appendix F

Key for End of Class Standards Based Assessment

Directions: Circle the best answer. This is a closed note and closed book assessment. Answer the questions to the best of your ability. Remember to think about what we learned in class today.

1. A community of different birds is living in an aquatic environment. Which of the following feet belongs to the bird BEST adapted to survive in an environment in which they need to swim to find food?
   a. clawed feet    b. webbed feet    c. flat feet with thin toes    d. clawed feet with tall legs

2. What would happen to a population that had a large number of white rabbits and a small number of black rabbits that lived in an area that was normally snow covered year round, and then the climate changed so that the ground was now dark with no snow?
   a. the number of white rabbits would decrease    b. the population would not change    c. the number of white rabbits would increase    d. the number of black rabbits would decrease

3. What would happen to the same population of rabbits described in questions number 2, if the climate changed so that the ground was now white with snow again?
   a. the number of black rabbits would increase    b. the population would not change    c. the number of black rabbits would decrease    d. the number of white rabbits would decrease

4. The population of rabbits described in questions 2 and 3, would change because __________.
   a. there would not be a change    b. black furred rabbits do not like snow    c. white fur is warmer    d. predators would find rabbits that did not have camouflage

5. An octopus has the ability to change its coloring depending on its surroundings. Which of the following is the most likely reason for the adaptation?
   a. they can hunt their prey more easily    b. they must compete for a mate    c. they need to survive the changing season    d. they can travel in groups more easily

6. Camouflage helps an organism ability to blend into its surroundings, which of the following is not true about the adaptation camouflage?
   a. predators have difficulty locating the organism    b. populations change over time    c. organisms are more likely to survive and reproduce    d. all of these are true

7. Which of the following adaptations does a cactus have that most likely enables it to live in its environment?
   a. salt-tolerant roots    b. leaves reduced to thin, sharp spines minimizing surface area    c. specialized leaves that trap insects    d. air-filled spaces that take in oxygen for its roots

8. Maple trees enter dormancy, a time when growth and development stops, to
   a. protect itself from freezing during the winter    b. move to a new location    c. retain water    d. none of these

9. Bears enter hibernation, a time when an organism experiences a decrease in activity and body temperature, to
   a. catch up on their sleep    b. move to a new location    c. survive during times of limited food/resources    d. all of these

10. The harmless king snake has the same coloring as the poisonous coral snake. Which of the following is the MOST likely reason for the success of this adaptation?
    a. King snakes need to survive the changing season.    b. The food supply is limited.    c. Predators will avoid eating the king snakes.    d. King snakes must compete for a mate.

Answers: 1. b; 2. a; 3. c; 4. d; 5. a; 6. d; 7. b; 8. a; 9. c; 10. c; Record the student scores on the spreadsheet and email to keliblyth@gmail.com. THANK YOU!!!
Spreadsheet Directions for Student Assessment Results

**Spreadsheet for Student Assessment Results:**

- **Teacher Name:** __________________
- **Lesson Taught:** _______  (Inquiry or Lecture or If you taught both between different blocks, then please note that)

<table>
<thead>
<tr>
<th>Student #</th>
<th>Score</th>
<th>Student #</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Examples:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1</td>
<td>4</td>
<td>These students were taught using the lecture method.</td>
<td></td>
</tr>
<tr>
<td>L2</td>
<td>5</td>
<td>inquiry method.</td>
<td></td>
</tr>
<tr>
<td>I1</td>
<td>5</td>
<td>These students were taught using the lecture method.</td>
<td></td>
</tr>
<tr>
<td>I2</td>
<td>5</td>
<td>inquiry method.</td>
<td></td>
</tr>
</tbody>
</table>

**Directions:** Please input a student # and the **number correct** on the assessment for their score. Please input this information for each student in your class that completed the lesson and the assessment. **Thank you so much for your help!**
Dear Bradwell Institute Biology Teachers,

I would like to determine if student learning is enhanced through the use of inquiry teaching methods in high school biology. I need your help in finding the superior teaching method. The study will require you to perform a teaching method and then assess the students. The research is experimental, and will be used in the completion of my thesis.

The subject for both of the lessons will be adaptations, specifically camouflage, and will touch on natural selection. On the following pages are lessons for the inquiry based lesson or the lecture lesson. Please get together and split up who will teach the lesson using inquiry and who will teach the lesson using lecture. Try to make it so that about half of the students are in the inquiry group and half in the control lecture group.

Please teach the lesson at the beginning of the block and then have the students complete a short standards based assessment at the end of the block. Grade the assessments and record the results of the assessment on the Excel spreadsheet for student assessment results. Please email me the spreadsheet.

Thanks again for all your help!

Sincerely,

Keli L. Blyth

keliblyth@gmail.com
101 B Running Ave.
Fort Benning, GA 31905