2013

The effect of frequent quizzing on student learning in a high school physical science classroom

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THE EFFECT OF FREQUENT QUIZZING ON STUDENT LEARNING IN A HIGH SCHOOL PHYSICAL SCIENCE CLASSROOM

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Natural Sciences

in

The Interdepartmental Program in Natural Sciences

by
Courtney Bailey Norton
B.S., Louisiana State University, 2009
August 2013

Acknowledgements

I would like to extend a heartfelt thank you to my committee chair, Dr. James Moroney. I sincerely appreciate the time and dedication you spent to ensure that my thesis was of the utmost quality. Thank you to Dr. Chris Gregg for your continued patience when it came to the maddening field of statistics. I would also like to extend a thank you to Dr. Bill Doerrler for his time spent in collaboration with the other committee members editing and contributing suggestions to this project.

To my family, without whom this thesis would have been an impossible journey, I cannot thank you enough. All of the encouragement and support you have given me has allowed me to pursue my dream of earning a Master's degree. To my husband, a special thank you for all of the extra hours spent helping out with our baby girl and helping me keep my sanity throughout this program.

I would also like to thank my LaMSTI cohort of 2011. I have learned so much from all of you. I would especially like to thank Jessica Shelton and Rebecca Polk for making the LaMSTI program a memorable experience. Our time spent deliriously discussing statistics, Mastering Biology and chemistry problem sets in the Union will be something I truly miss.

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Abstract

This research explores the effects of frequent quizzing versus no quizzing in a high school Physical Science class. The study population included two freshman level Physical Science Honors classes. The content in this study included Classifying Matter, States of Matter, Atomic Bonding, Motion and Forces and Motion. For each chapter covered one class served as a control group, getting no quizzes, and the other class served as an experimental group, getting frequent quizzes.

Prior to being taught information on the 5 chapters covered in this study, a 15-question pre-test was administered to the students. The information was delivered in the same manner, by lecture and PowerPoints, to both the control and the experimental groups. Upon completion of each section of the chapter, the experimental group took a 10-question quiz. The control group was allowed to review their notes. A post-test was given after covering all of the material for each chapter. The pre-tests and post-tests were generated using software and a question database for choosing questions based on state standards and learning objectives.

Raw gains of the study population from pre-test to post-test were analyzed and compared to determine if the quizzes had increased student knowledge for the chapter. No statistical significance was found between the non-quizzed and the quizzed groups.

Introduction

For decades research has been done to find a way to improve overall student achievement. Studies have been done to evaluate student engagement, assessment, backwards design, student ability, as well as teaching strategies. There have been hundreds of papers published on student engagement, learning styles and use of technology in the classroom. For this thesis I have chosen to take a deeper look into frequent quizzing as an assessment technique to assist teachers and students to evaluate their understanding of a topic. In this study, frequent quizzing will consist of three to four ten-question quizzes given to the students throughout the presentation of a chapter. Frequent quizzing will help establish an informal assessment routine in the classroom. Assessments are an integral component of the learning process. The assessments given throughout a course should be used as a gauge for the student and the teacher to identify critical learning points that can be improved upon. Implementing an effective assessment routine in the classroom has been reported to improve student learning (Van de Walle, 2004). A report from the National Council of Teachers of Mathematics advocated that the use of daily assessment techniques to guide teaching and instructions is an effective practice (NCTM, 1991). A number of reports indicate that this technique will not only improve student learning, but also student responsibility and student engagement.

There have been many studies dating back to the 1920's that show student engagement and student achievement go hand in hand (Deputy, 1929). Engaged students tend to outshine passive learners on an academic level time and time again (Shirvani, 2007). According to a study conducted by Denham and Liberman (1980), student engagement is the second most important factor that affects student learning. So the question that is proposed is how do we increase student engagement? If we can answer this question then student achievement may improve as well. Implementing a frequent quizzing policy in my classroom may result in a considerable increase in student engagement. Quizzing is also a way for a student to assess himself or herself to see what they did or did not completely comprehend before a chapter test comes around. It will also allow students to become more confident in their studies. They will have immediate feedback on their understanding and will feel more prepared for their tests. When students are more comfortable with their understanding of class material they are less anxious when it comes to chapter tests and standardized tests.

My research focused on the impact of frequent quizzing on overall student achievement. In reflecting upon my own educational career, I discovered that the classes that I remembered, the classes I actually gained the most knowledge from were those in which I had frequent exposure to the material. The frequent exposure may have been through recitation sections throughout the week, quizzes, study guides, online assignments and other educational supplements of that nature. These types of exposure to the material made it easier to remember how all of the small parts of the class fit together. The one technique I feel I benefitted the most from was frequent quizzing. Frequent quizzing gave me an incentive to keep up with the course material. It was often times factored in as a portion of the overall final grade. It also allowed me to identify the main concepts of a particular chapter, which in turn made me much more aware of important topics when it came to taking the test. I knew that if I had done well on the quiz, then I had mastered that topic, if I did poorly on the quiz I needed to spend more of my time focused on that material.

Some concerns with taking on the task of quizzing frequently are time management for the teacher who needs to develop quizzes, implement a consistent routine to give the quizzes, collect them, grade them and return them in a timely manner. The other concern with frequent quizzing is student motivation. Students who have never been exposed to frequent quizzing or pre and post testing may be overwhelmed at first. Steps would need to be taken to stay consistent and unwavering to assure that they would adjust to this routine.

Literature Review

"Quizzing works, the Evidence says" according to the U.S. Department of Education in 2012. There have been strong experimental studies that analyzed the "testing effect." There have been several experimental studies examining the effects of this practice for improving K-12 students' performance on academic content or classroom performance.

McDaniel et al (2011) conducted a study in a middle school science class, which tested the effects of quiz frequency and placement within the class. Students were given three multiple-choice quizzes in which some target material was included while other target material was not included. Target material was defined as information that would be on the unit test. The quizzes were given pre-lecture, immediately post-lecture and the day before the unit test. Performance on the unit test comparing quizzed and nonquizzed items was used to determine whether or not quizzing had an effect on their learning. Quizzing increased student understanding on unit exam from 79% to more than 90%; when those are translated into letter grades they go from a C+ to an A- on a typical grading scale (McDaniel et al, 2011). The study showed there was a significant difference between the quizzed items and non-quizzed items on the unit exams in the class.

Henry Roediger and his colleagues conducted an experiment to test the effect of quizzing on long-term recall in a 6th grade social studies class. They examined whether quizzing promoted learning and retention in a middle school social studies class. Roediger et al (2011) stated that a critical goal of education is to learn and retain a set of skills and facts that cover a variety of subjects. They believed that if student's practiced their retrieval skills they would improve. They wanted to research the testing effect using a low-stakes practice such as quizzes. The quizzes would serve not only to enhance retention but also to aid students in differentiating between information they know and information they do not know. When students are aware of what they truly don't understand, they are able to focus on that material when studying.

There have been at least 30 experimental studies on the effects at the collegiate level. Time and time again these experiments have demonstrated the use of frequent assessment leads to an overall improvement in the classroom. It is implied that the reason this can and does improve performance is because the student is constantly being exposed to specific information; therefore, they are fine-tuning their memory recall skills. Another benefit of frequent exposure in the form of quizzes is that it enhances the retention rate of students. They are less likely to forget things that they have been asked to recall over and over again. These two results of quizzing have been discussed and analyzed over and over again in several papers, journals and theses (Department of Education, 2012).

Hosin Shirvani (2009), an Assistant Professor at the University of Texas-Pan American conducted a study on a group of high school sophomores in Texas to test the effect of daily quizzes versus weekly tests. The participants in his study were from a rural community in the southern part of the United States with a population of over 95% Hispanic background. Participants included 38 females and 31 males for a total of 69 students. He focused on two main questions: Did the treatment (daily quizzing) have any significant effects on students' mathematics learning as measured by the final examination as well as did the treatment have any effects on students' homework assignment grade? His study was carried out by one geometry teacher who taught six classes. Shirvani selected four out of the six classes this teacher taught because the other two classes had considerably more students with lower learning levels and more discipline issues. His control and experimental groups were selected randomly. Over a six week period the experimental group was administered a ten-minute quiz every day, while the control group was given a ten-minute worksheet every day. An equal amount of time was spent going over the answers for the worksheets and quizzes. All students were taught from the same textbook, lessons and homework.

This study was the basis for my research. I have modified my procedures based on my own student's needs. Instead of implementing this in a math class, it will be in a physical science course. Instead of daily quizzes in class, my students will take 3 quizzes on each topic covered on a chapter test.

Shirvani and I developed the same hypothesis: frequent quizzing will increase overall student learning and increase test scores. The first test Shirvani ran was to see if the treatment (daily quizzes) had any significant effect on the students' learning as measured by the final exam. The mean on the control group's final examination was 70.41, while the mean of the experimental group's final examination was significantly higher at 77.56. (Shirvani, 2009).

Jeremy Fries (2009) conducted a similar study to determine the effect of frequent quizzing during the course of a semester. He began his research with the intent of determining whether frequent quizzing would help students on chapter tests. Fries' research group was approximately 90 high school algebra students in Lincoln, Nebraska. The classes used in his study included basic Algebra A and Algebra B classes that are designed to take two years to complete. Algebra A classes are taken before Algebra B classes. Fries used two Algebra A sections and three Algebra B sections. His sample population included: 50 males and 39 females, of which 37 were Hispanic students, 47 were Caucasian and 5 were of other race.

Fries used a methodology similar to what I am using to conduct my research. He developed his quizzes through a test program called TestWorks and administered them to his classes frequently. Fries defined frequent quizzes as three times per week. Each quiz had a total of five questions that were printed and given to students to complete in the last 10 minutes of a class period. Quizzes were collected and then he immediately began to discuss them with his classes. He states “the key and vital part to doing frequent quizzes was the immediate feedback students received after taking them” (Fries, 2009).

At the conclusion of his research, Fries felt that the frequent quizzes served several purposes. Not only did it increase the retention rate of the material that was quizzed, but it also served as a tool to catch teacher and student mistakes and it lessened test anxiety. However, Fries did not analyze any quantitative data for his research. His findings were based on qualitative data gathered from student surveys and student interviews throughout the class semester (Fries 2009).

A third recent study was conducted by Frank C. Leeming (2002) of the University of Memphis who investigate an exam-a-day strategy. He is a professor of psychology and conducted his research over four undergraduate level psychology courses: two sections of Learning and Memory (n=49) and two sections of Introductory Psychology (n=143). He compared a control group, which he only gave four tests per semester, and an experimental group, which received an exam every day beginning with the second class meeting. The exam-a-day lasted between ten and fifteen minutes and usually consisted of two short-essay questions and five short-answer questions. After the completion of the exam, he would spend two to three minutes reviewing the correct answers, and then began teaching his material for the next exam. In order to account for the normality’s of life, (i.e. illness, accidents and other situations that may prevent attendance), students were allowed to drop three exam grades.

Leeming analyzed his data by comparing the final semester grades of exam-a-day students to final semester grades of four exams per semester students. In his Learning and Memory sections, Leeming calculated the means of the experimental group’s final semester grades to be 89% with a standard deviation of 8.13 and the control group's final semester grades were significantly lower with a mean of 81% with a standard deviation of 17.61. In Introductory Psychology his experimental group's mean was 80% with a standard deviation of 22.92 and the control group's mean was significantly lower at 74% with a standard deviation of 22.11.

Leeming (2002) was also concerned with the retention rate of his students. He designed another experiment to test the effect of the exam-a-day strategy on retention rates. Students from three sections of Introductory Psychology volunteered to take a two-hour retention test at the end of the course. Forty-eight of the students that volunteered were from the exam-a-day sections and 30 of the volunteers were from sections that only had four exams per semester. To assure that all of the students were exposed to the same information, the same textbook was used to cover the same chapters in the same order in all three sections. The retention test covered material in the first four chapters of the book. Exam-a-day students had taken 13 short exams over the material while the other students had only taken one test.

The retention test was given at least six weeks after any of the material had been covered in the three sections. Special care was taken to design a fair test for all participants. Questions were selected randomly from all three instructors that had taught the course. Students were informed that all test results would remain confidential and have no effect on overall semester grades.

Again, retention test scores were higher for the exam-a-day participants than the control group participants. He then ran an ANCOVA on the retention scores to correct for the differences between the in-class scores. The ANCOVA failed to show a significant difference between the experimental and control groups. Leeming concluded that the better retention scores of the exam-a-day students were due to better learning initially rather than an effect on memory.

While I don't intend on testing or quizzing daily, I am going to use essentially the same process. Instead of comparing final semester grades, I intend on comparing pre-test and post test grades of quizzed and non-quizzed students.

The previous research on frequent quizzing has spanned many different educational levels. There have been studies on high school and college level classes. This study differed from the previous study in that it was conducted on a high school freshmen level Physical Science course. This study is also unique because it will test the effect of frequent quizzing, not daily quizzing.

Materials and Methods

To carry out my research as efficiently as possible, I chose to use two of my ninth grade Physical Science Honors classes at Assumption High School. Assumption High School has an enrollment of 1,029 students. The breakdown of enrollment by grade level is shown in Figure 3.1. The ethnic breakdown of the entire high school is shown in Figure 3.2. As a school, there are 567 students (55.1% of the school population) eligible for free or reduced lunches, which is an indicator of poverty. The teacher to student ratio is 1:15.

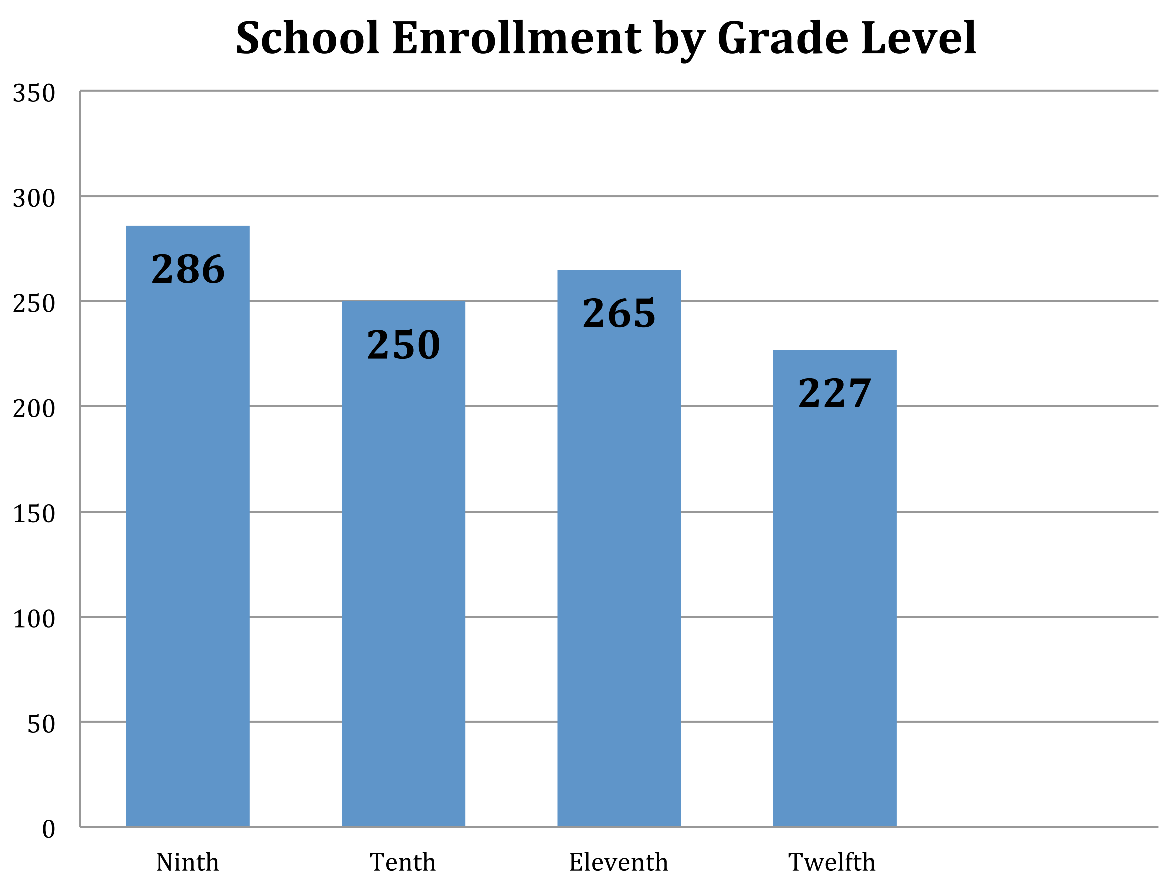

Figure 3.1. School Enrollment by Grade Level
(This graph shows the breakdown of the number of students enrolled in each grade level at Assumption High School.)

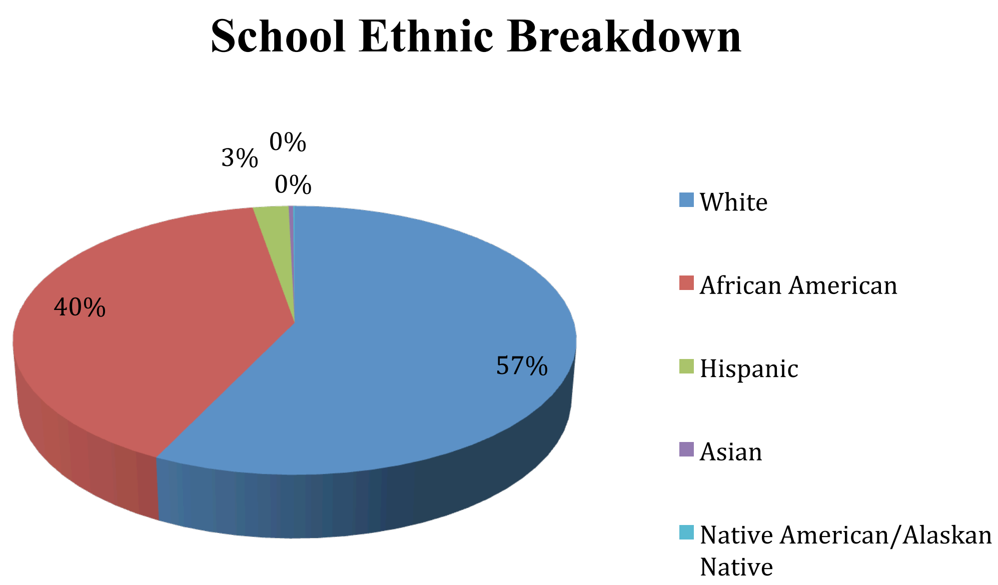

Figure 3.2. School Ethnic Breakdown
(This shows the ethnic breakdown of the entire school population. This was included to better understand how the demographics of the study population related to the total high school population.)

The classes used in the research are both classified as honors classes. The classroom demographics in the Fall of 2012 (August -December) broke down into the following categories: 20 males, 32 females (Figure 3.3); 44 identified as Caucasian, 5 identified as African American and 3 identified as Hispanic (Figure 3.4). There are 19 participants in the class that qualify for free or reduced lunch according the state standards. In order to qualify for free or reduced lunch in Louisiana the primary caregiver must not exceed an annual household income level based on the number of people living in the household.

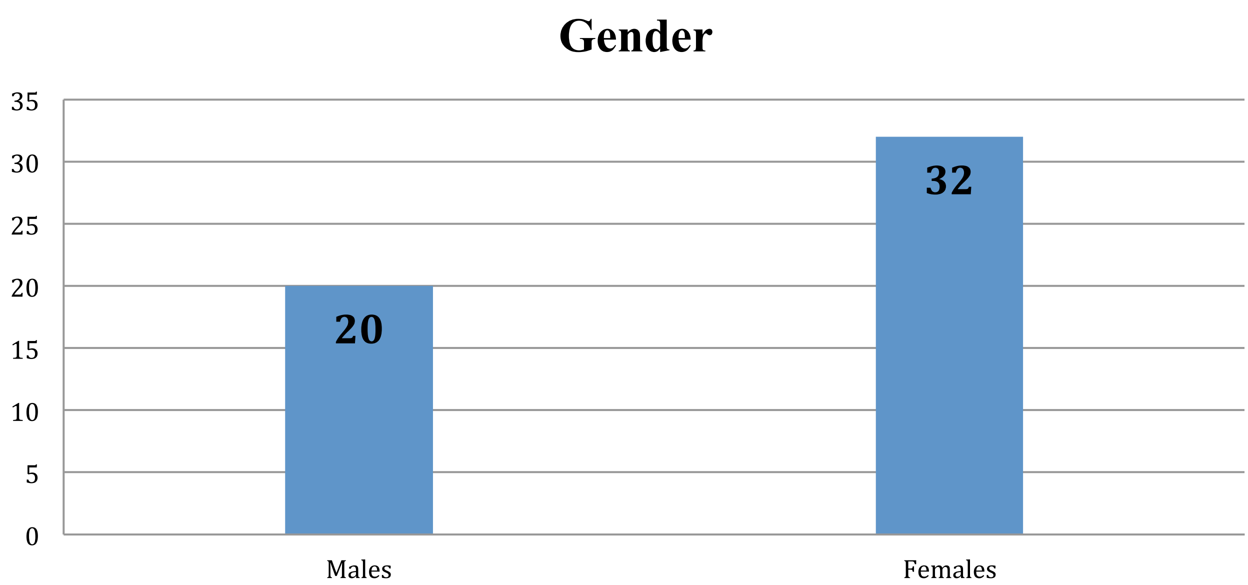

Figure 3.3. Study population broken down by gender.
(This figure was included to better show the breakdown of the study population.)

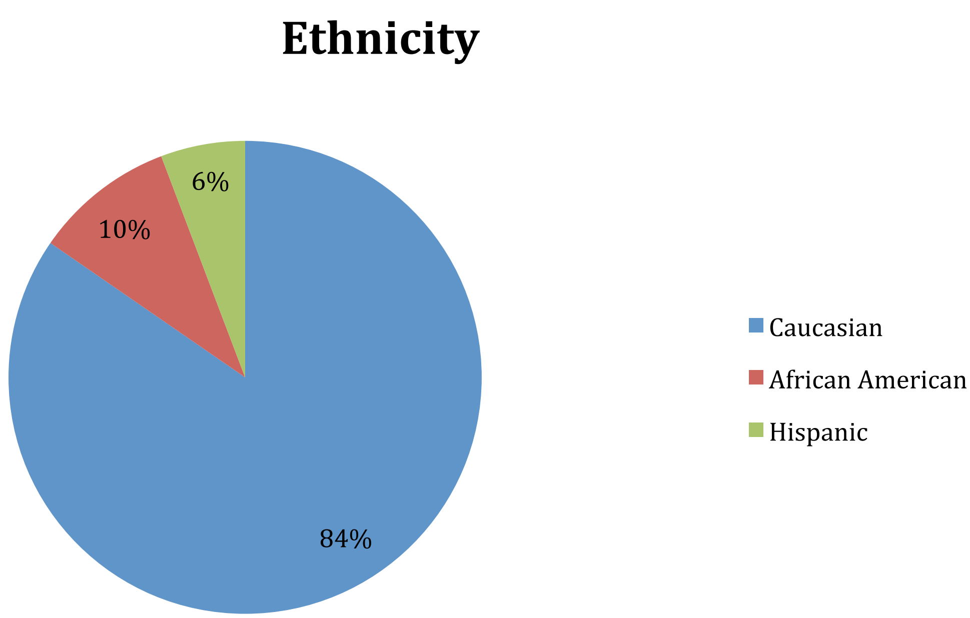

Figure 3.4. Study population broken down by ethnicity.
(This figure was included to better show the breakdown of the study population.)

Two of the students received some form of accommodation such as shortened test, tests read aloud or small group testing because of their status as 504 or 1508 students on their regular class assignments. These students did not receive these accommodations for this study. Students may attain 504 status by meeting the following criteria: A student with a physical or emotional disability, or who is recovering from a chemical dependency, or who has an impairment (i.e. Attention Deficit Disorder) that restricts one or more major life activities. Students with 1508 status meet the following criteria: a diagnosis of autism, specific learning disabilities, speech or language impairments, emotional disturbance, traumatic brain injury, visual impairment, hearing impairment, and other health impairments.

To determine if frequent quizzing was affecting student learning, a standard measuring instrument was developed, the pre and post-test. These tests were created using the EAGLE computer program supplied to Louisiana teachers through the Louisiana Department of Education Website and ExamView Test Generator, a supplemental question bank that is provided by the textbook company, Pearson Prentice Hall. EAGLE is a program that allows teachers to assess whether their students are performing on specific Grade-Level Expectations (GLEs) (http://www.doe.state.la.us/lde/uploads/14990.pdf). ExamView Test Generator is a test questions bank that allows you to choose questions based on state standards and learning objectives. These two programs were used in creating pre and post-tests because they give the creator the ability to select questions based on learning objective alone without seeing the actual question. This was done in an effort to prevent question bias.

Pre and post-test items were selected based on the GLEs that are expected to be covered in the tested chapters as prescribed by the Louisiana Comprehensive Curriculum. Each pre and post-test contained fifteen multiple-choice questions. Examples of pre and post tests can be found in Appendix A. Every new chapter will have a pre-test before the information is presented and a post-test at the close of the chapter. Because the same questions were used in both tests, the pre-tests were collected to ensure test security. The pre-test answers were not reviewed or explained.

The quizzes were developed using the class textbook, Pearson's Physical Science: Concepts in Action Earth and Space Science. The Teacher's Edition of the book came with questions at the end of each section (Wysession et al., 2001). Those questions were included as quiz questions. The teacher chose supplemental questions when the textbook material was not sufficient. These supplemental questions came from online question banks, extra worksheets or workbook questions. Each quiz was approximately 10 questions. Examples of quizzes are given in Appendix B.

Two sections of Physical Science were chosen to be included in this study. Because of small class sizes and time restrictions, each class served as a control and an experimental group. All students took a pre-test at the beginning of the chapter before any of the material was presented to them. The pre-test scores did not affect the average of the student's grade in the class. However, the students did earn participation points for completing the pre-tests. The lecture material was presented to all classes in the same manner. Lectures were presented to the students by PowerPoints supplied by the Physical Science Concepts in Action textbook. Students were required to take split page notes (Appendix C). There was a section of the notes for analysis of the section and a summary by the students.

The students that served as the experimental group received a quiz consisting of five to ten multiple-choice questions from the previous day's material. The students had approximately 10 minutes to complete the quiz. At the conclusion of the 10 minutes, the quizzes were immediately collected and the teacher reviewed the answers. The quizzes were graded and returned to the students the following school day in order for the student to record his or her grade and review any mistakes made. Once the students had time to review the quizzes they were collected again by the teacher. Quizzes did count towards the student's overall semester grade, but the quiz scores were not analyzed in this study. The students serving as the control group began the material for the next section instead of taking a quiz. Table 1 shows the breakdown of chapters that were quizzed for each class. Table 2 shows the progression of events throughout each of the 5 chapters used in this study.

Table 1: Experimental Design*

Block	Non-quizzed Chapters	Quizzed Chapters
2nd	Chapter 3 Chapter 11	Chapter 2 Chapter 6 Chapter 12
4th	Chapter 2 Chapter 6 Chapter 12	Chapter 3 Chapter 11

*Shown above is a synopsis of the experimental design. This was done to better show which material would be used for the control group and the experimental group.

Table 2: Timeline *

	Control Group	Experimental Group
Day 1	Pre-Test Lesson	Pre-Test Lesson
Day 2	Review of notes Lesson	Quiz Lesson
Day 3	Review of notes Lesson	Quiz Lesson
Day 4	Review of notes Lesson	Quiz Lesson
Day 5	Post-Test Chapter Test	Post-Test Chapter Test

* Shown above is the timeline showing the progression of events throughout each chapter.

Once the data was collected, the pre-test and post-tests were analyzed using GraphPad InStat. A Kruskal-Wallis Test (nonparametric ANOVA) with a Dunn's Multiple Comparison's Test was run in order to determine if there was any significant difference between the control and experimental groups. Initially a parametric ANOVA was run but it failed to meet the assumptions of normality based on the Kolmogorov-Smirnoff test. A Mann-Whitney Test was conducted to determine significance of normalized learning gains between pre-tests and post-tests. Normalized gains were calculated in Excel using the formula: (Post-Test Score – Pre-Test Score)/(Perfect Score – Pre-Test Score). The results are shown as a proportion.

The research plan and appropriate forms were submitted to the Louisiana State University Institutional Review Board. The Louisiana State University Institutional Review Board (IRB) approved this research. The IRB number is E6002 (Appendix D). Students and parents or guardians signed and returned consent forms granting use of their data for this thesis. The forms can be found in Appendix E. Student indicator numbers were used to ensure the privacy and anonymity of all students involved in the research process.

Data and Analysis

This project focused on the effects of frequent quizzing in a high school science class. Frequent quizzing is defined as two or three quizzes per chapter. The quizzes are designed to be short, multiple-choice questions that focus on the material covered in the previous days lecture.

The study focused on five chapters (Table 3). The material was covered in sequential order, beginning with chapter 2. Chapter 2: Classifying Matter covered topics such as differentiation between elements, compounds and mixtures. Chapter 3: States of Matter included information on the analysis of phase changes and the Kinetic Molecular Theory. Chapter 6: Chemical Bonding content included the formation and naming of ionic and covalent bonds. Those three chapters focused on the chemistry aspect of Physical Science. Chapters 11 and 12 covered the physics concepts for the class. Chapter 11: Motion focused on the basic topics of speed, velocity, and acceleration. Chapter 12: Forces and Motion covered Newton's Laws of Motion.

Table 3: Content of Study Chapters*

Chapter	Title	Topics Covered
Chapter 2	Classifying Matter	Mixtures, compounds, homogeneous mixtures, heterogeneous mixtures, elements, solution, suspension, colloid
Chapter 3	States of Matter	Phase changes, freezing, melting, sublimation, vaporization, deposition, condensation, gas laws
Chapter 6	Chemical Bonding	Ionic bonds, covalent bonds, naming bonds, polyatomic ions, diatomic molecules
Chapter 11	Motion	Distance, displacement, acceleration, velocity, speed
Chapter 12	Forces and Motion	Newton's 3 Laws of Motion, inertia, centripetal force, friction,

*This table shows a breakdown of the chapters and the topics covered in each chapter.

Each chapter was tested the same way. Before any material was taught a 15-question multiple-choice pre-test was administered. The tests were collected and graded by the instructor. Test answers were not discussed in order to ensure test security. The control group received the information through a series of lectures, PowerPoints, class discussions and worksheets. The experimental group received the chapter information in the same manner, but the day after each section was presented a 10-question multiple-choice quiz was administered. The quizzes were collected and the answers were reviewed. The quizzes were graded by the instructor and returned the next day. After all sections of the chapter had been covered, both the control and the experimental group were given the post-test. The pre-test and the post-test were the same. This method was repeated for each chapter included in this study.

For each chapter that was tested a Kruskal-Wallis Test (nonparametric ANOVA) with a Dunn's Multiple Comparison's Test was run to determine if there was any significant difference between the control and experimental group's raw mean scores. A Mann-Whitney Test was also conducted to determine significance of normalized learning gains between pre-tests and post-tests. An alpha level of 0.05 was set as the criterion to determine significant difference for both the Kruskal-Wallis and Mann-Whitney tests.

The raw mean scores for Chapter can be seen in Figure 4.1. According to the Dunn's Multiple Comparisons Test, there was no significant difference between the control and experimental raw mean scores for the pre-test ($p>0.05$) meaning that the two groups started with the same familiarity with the topic. There was also no difference found after running the comparisons of the control and experimental post-tests ($p>0.05$). As indicated by the graph in Figure 4.1, both the control and the experimental groups showed positive gains from the pre-test to post-test.

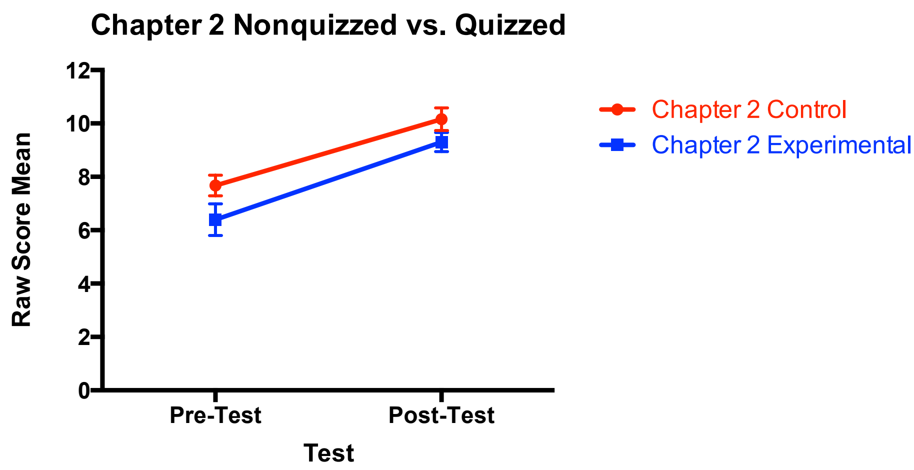

Figure 4.1. Chapter 2 Raw Mean Pre-Test and Post-Test Scores.
[Each point represents the average correct number of responses (out of 15) on both of the assessments, with the standard error. The material tested was from Chapter 2: Classifying Matter.]

After running the Mann-Whitney test, it was determined that there was no statistical difference between the learning gains of the control group (NLG = 0.3408) and the learning gains of the experimental group (NLG = 0.2842). The graph showing normalized learning gains can be seen in Figure 4.2.

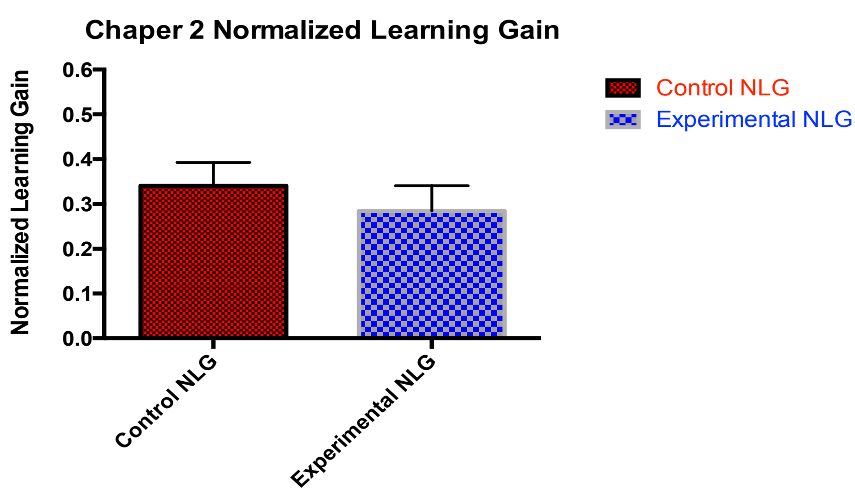

Figure 4.2. Chapter 2 Normalized Learning Gains
(Learning gains were calculated in Excel for each student from pre-test to post-test. The mean of the normalized learning gains was then calculated and analyzed using Instat GraphPad. The learning gain is the proportion of the material learned from pre-test to post-test as assessed by the post-test.)

Chapter 3 raw mean scores can be seen in Figure 4.3. According to the Dunn's Multiple Comparisons Test, there was no significant difference between the control and experimental raw mean scores for the pre-test ($p>0.05$). There was also no significant difference found after running the comparisons of the control and experimental post-tests ($p>0.05$).

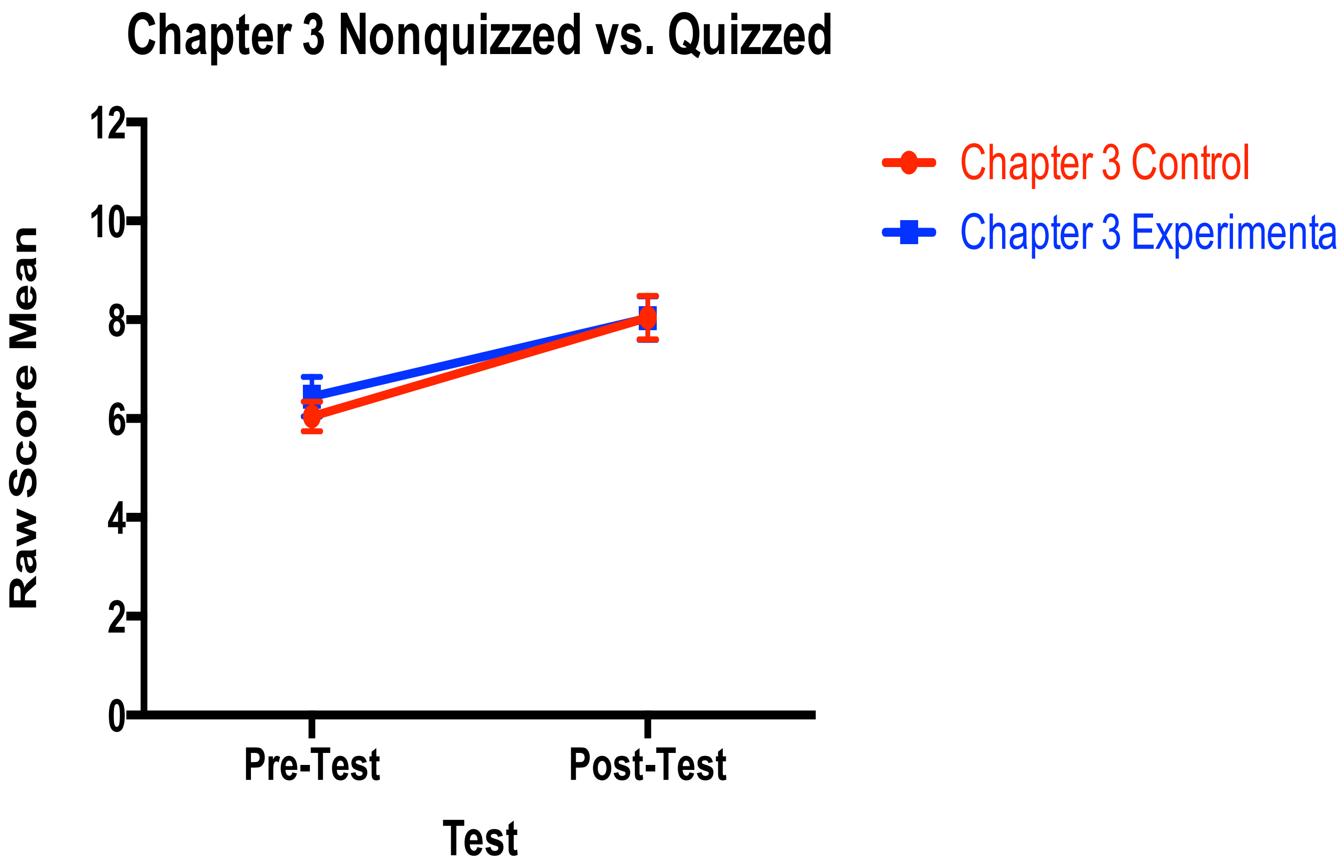

Figure 4.3. Chapter 3 Raw Mean Pre-Test and Post-Test Scores.
[Each point represents the average correct number of responses (out of 15) on both of the assessments, with the standard error. The material tested was from Chapter 3: States of Matter.]

After running the Mann-Whitney test, it was determined that there was no statistical difference between the learning gains of the control group (NLG = 0.2056) and the learning gains of the experimental group (NLG = 0.1630). The graph showing normalized learning gains can be seen in Figure 4.4.

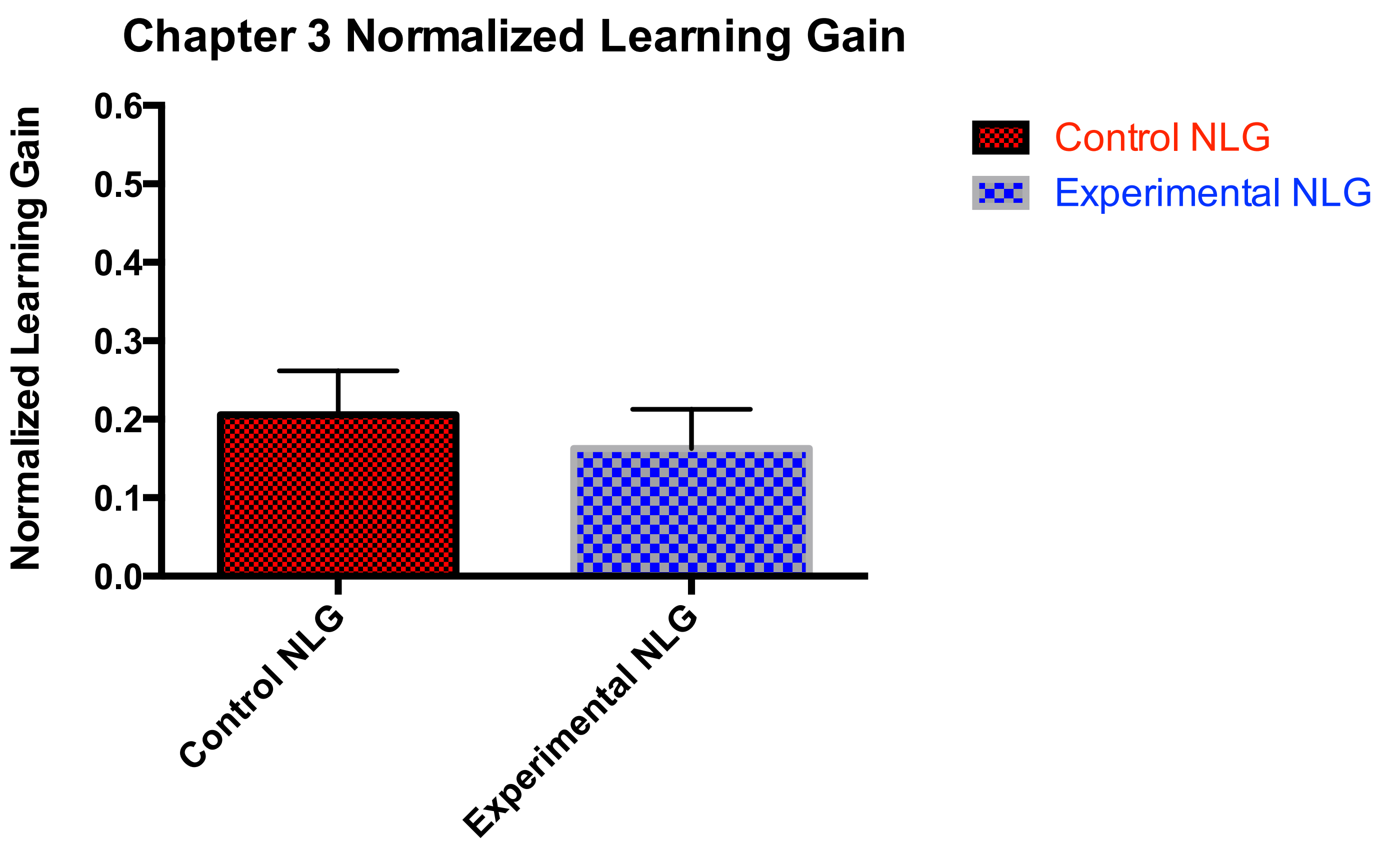

Figure 4.4. Chapter 3 Normalized Learning Gains
(Learning gains were calculated in Excel for each student from pre-test to post-test. The mean of the normalized learning gains was then calculated and analyzed using Instat GraphPad. The learning gain is the proportion of the material learned from pre-test to post-test as assessed by the post-test.)

Chapter 6 raw mean scores can be seen in Figure 4.5. According to the Dunn's Multiple Comparisons Test, there was no difference between the control and experimental raw mean scores for the pre-test ($p>0.05$). There was also no significant difference found after running the comparisons of the control and experimental post-tests ($p>0.05$). Figure 4.5 shows a graph indicating that in Chapter 6, the experimental group gained an average of 4.32 raw points and the control group only gained an average of 3.32 raw points.

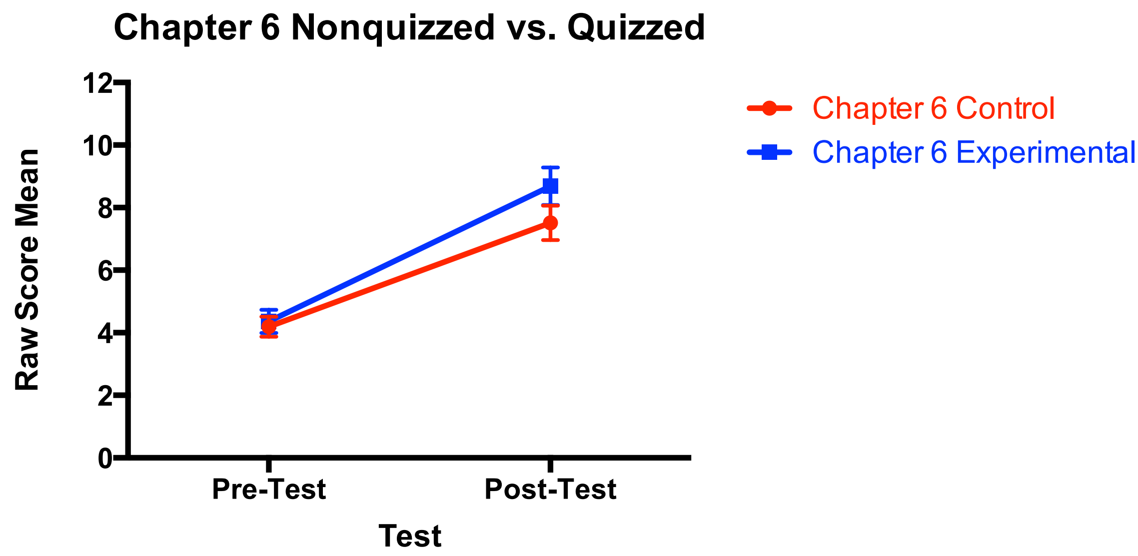

Figure 4.5. Chapter 6 Raw Mean Pre-Test and Post-Test Scores.
[Each point represents the average correct number of responses (out of 15) on both of the assessments, with the standard error. The material tested was from Chapter 6: Atomic Bonding]

After running the Mann-Whitney test, it was determined that there was no statistical significance between the learning gains of the control group (NLG = 0.3045) and the learning gains of the experimental group (NLG = 0.4101) (Figure 4.6).

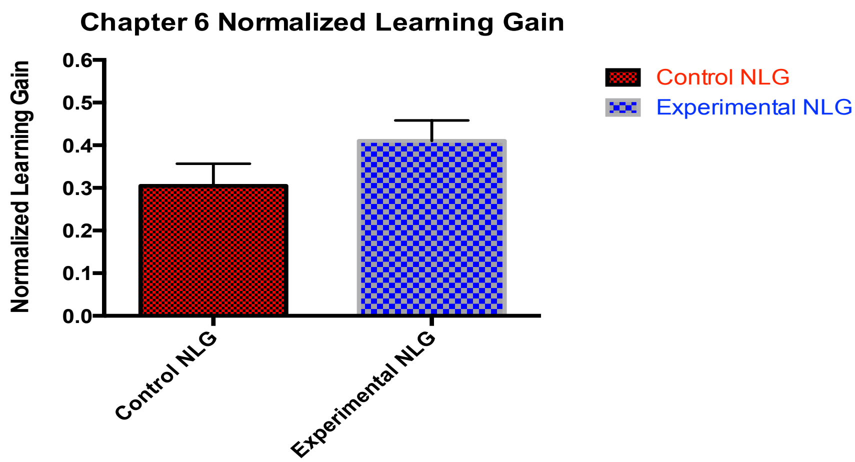

Figure 4.6 Chapter 6 Normalized Learning Gains
(Learning gains were calculated in Excel for each student from pre-test to post-test. The mean of the normalized learning gains was then calculated and analyzed using Instat GraphPad. The learning gain is the proportion of the material learned from pre-test to post-test as assessed by the post-test.)

The raw mean scores for Chapter 11 can be seen in Figure 4.7. According to the Dunn's Multiple Comparisons Test, there was no difference between the control and experimental raw mean scores for the pre-test ($p>0.05$). There was also no difference found after running the comparisons of the control and experimental post-tests ($p>0.05$). In Figure 4.7, the graph is showing that the control group improved their raw scores on average by 3.96 points and the experimental by 3 points.

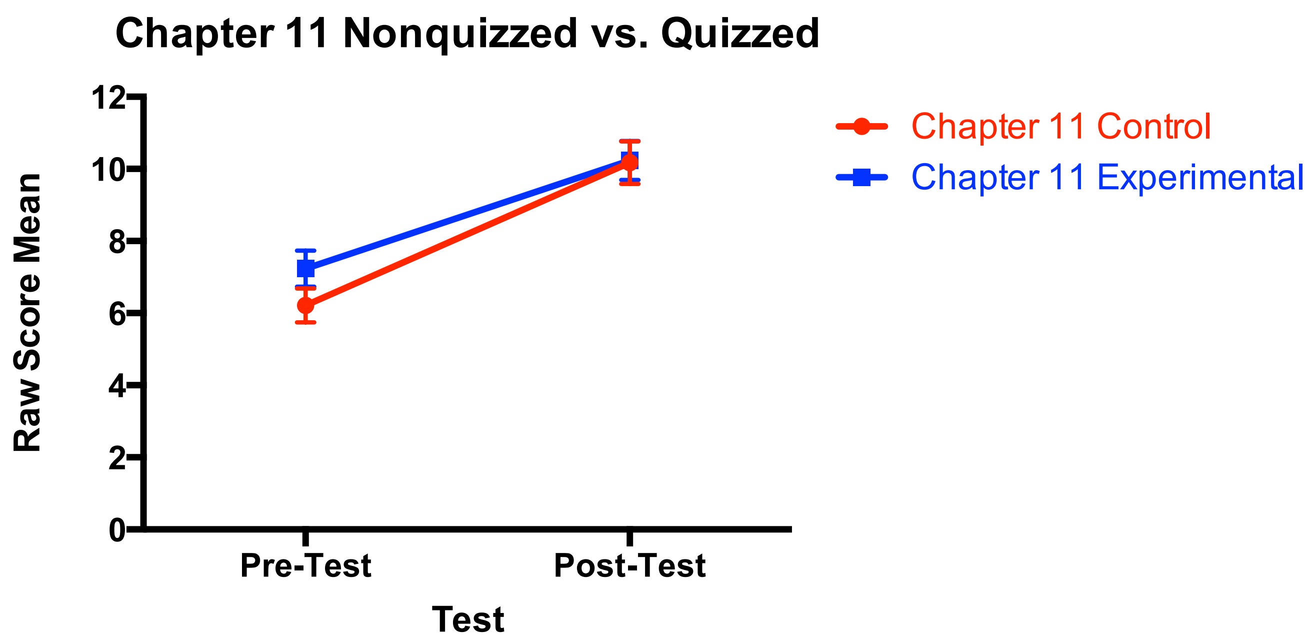

Figure 4.7. Chapter 11 Raw Mean Pre-Test and Post-Test Scores.
[Each point represents the average correct number of responses (out of 15) on both of the assessments, with the standard error. The material tested was from Chapter 11: Motion.]

After running the Mann-Whitney test, it was determined that there was no statistical difference between the learning gains of the control group (NLG = 0.4530) and the learning gains of the experimental group (NLG = 0.3563) (Figure 4.8).

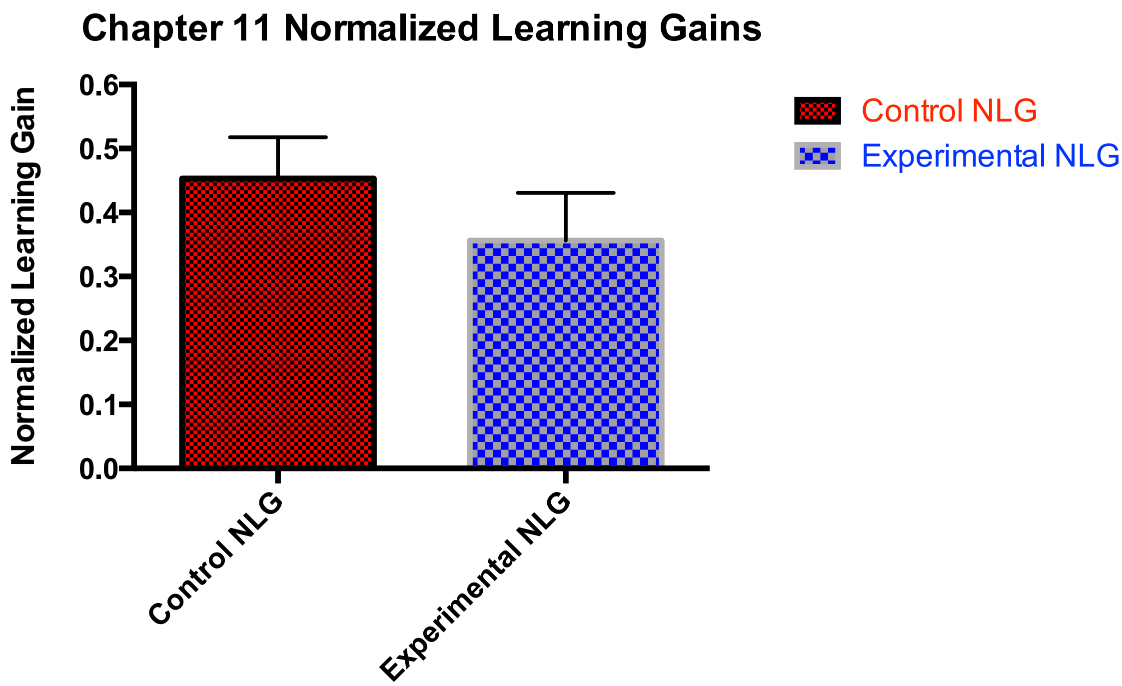

Figure 4.8. Chapter 11 Normalized Learning Gains
(Learning gains were calculated in Excel for each student from pre-test to post-test. The mean of the normalized learning gains was then calculated and analyzed using Instat GraphPad. The learning gain is the proportion of the material learned from pre-test to post-test as assessed by the post-test)

Chapter 12 raw mean scores can be seen in Figure 4.9. According to the Dunn's Multiple Comparisons Test, there was no significance between the control and experimental raw mean scores for the pre-test ($p>0.05$). There was also no significance found after running the comparisons of the control and experimental post-tests ($p>0.05$). In Figure 4.9, the graph shows that the control group showed an increase in raw scores of 1.26 points on average and the experimental group showed an increase in raw scores of 1.04 points on average.

After running the Mann-Whitney test, it was determined that there was no statistical significance between the learning gains of the control group (NLG = 0.1189) and the learning gains of the experimental group (NLG = 0.08341) (Figure 4.10).

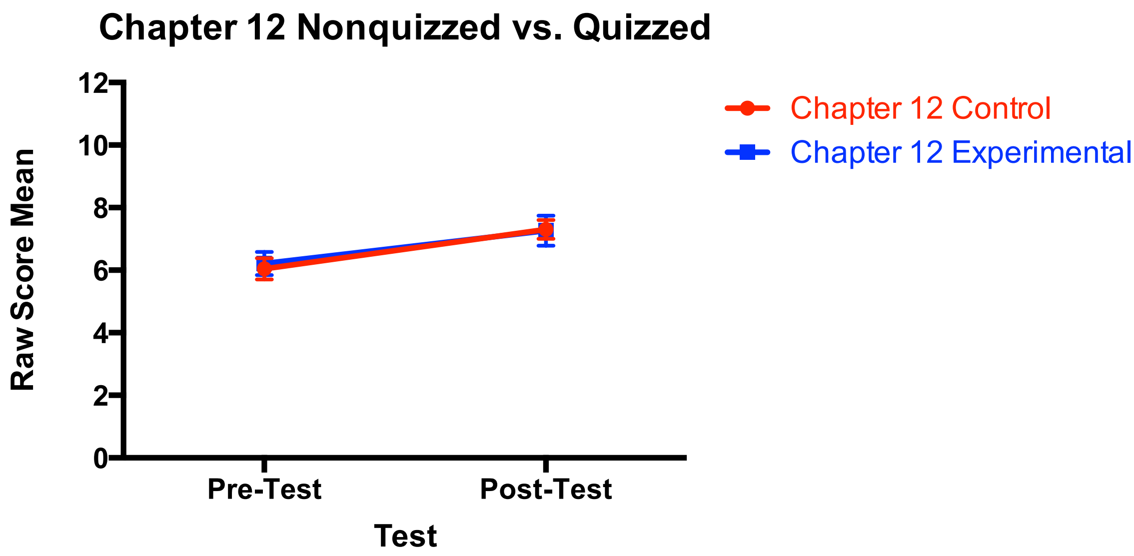

Figure 4.9. Chapter 12 Raw Mean Pre-Test and Post-Test Scores
[Each point represents the average correct number of responses (out of 15) on both of the assessments, with the standard error. The material tested was from Chapter 12: Forces and Motion.]

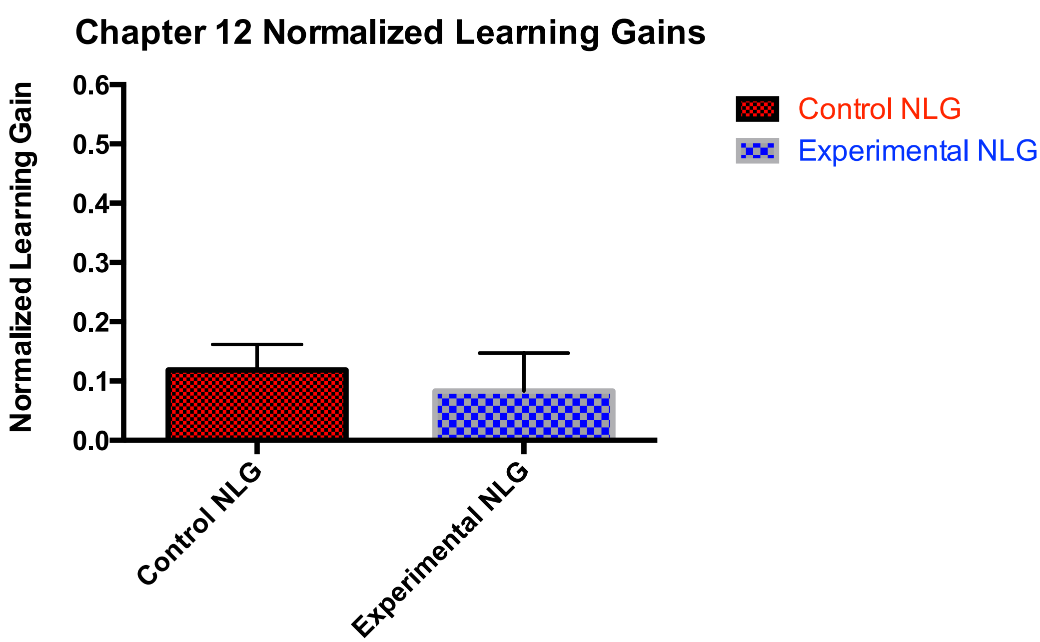

Figure 4.10. Chapter 12 Normalized Learning Gains
[Learning gains were calculated in Excel for each student from pre-test to post-test. The mean of the normalized learning gains was then calculated and analyzed using Instat GraphPad. The learning gain is the proportion of the material learned from pre-test to post-test as assessed by the post-test.]

Conclusion

Overall, statistical analysis shows that there is no difference between the post-test scores of those students that were quizzed and the students that were not quizzed. The normalized gains of the students also showed no statistical difference. When this project began, I was well aware of the fact that more than likely I would not be able to show any statistical significance between the two groups because of the limited number of data points I would be able to collect. When working with such a small number of participants, to show statistical difference, the scores would have needed to be drastically different. Not only were my class sizes small, but also the number of chapters I covered during my research was limited. I believe that both of these factors greatly impeded my ability to detect a significant effect due to my experimental procedure.

While there was no statistically significant gain, there was an overall gain from the pre-test to post-test scores of the experimental group. The trend showed that the frequent quizzing did not lead my students to lose knowledge of the material, which in a high school class is always a positive result.

On a strictly qualitative observation, quizzes helped students succeed in Physical Science. One-on-one interviews were conducted and the overall consensus was that the quizzes were a great tool in helping students distinguish what they knew and what they did not know. When it came time for the students to be part of the control group (a non-quizzed chapter), they often asked if they could get quizzed because it would help them prepare for the test. Students expressed their feelings of ambiguity in the control group. They felt as though they had to spend more time studying because they did not have the quizzes to help them hone in on the material that they did not fully comprehend. Many students turned the quizzes into mini-study guides to direct them to the specific skills they needed to study.

In Shirvani's research, he claimed he saw a significant difference between the scores of the control group and those of the experimental group. I believe he was able to see difference between the two groups because he had a slightly larger study population than I did. He was using almost double the amount of participants that I was (Shirvani, 2009). When comparing my study to Frank Leeming's exam-a-day procedure, he again found significant differences between his control and his experimental group. He was working with a much larger sample population and his study was conducted in a university setting. He also reported that semester grades improved as a result of his exam-a-day procedure (Leeming, 2002).

When comparing my research to the research done by Jeremy Fries in his Algebra classes, we achieved similar results. He did not run any statistics to compare his control groups and experimental groups, but he did report on his qualitative observations. Just as my students did, his students resisted the quizzes early on. In the end, the students eventually came around in his study, as they did in mine. Fries reports that his students claimed to see the benefits of the quizzes and commented "that they felt the quizzes helped them learn the material better and do better on the post-test" (Fries, 2009).

If I were to continue this research in the future, there are some improvements I would make. First, I would establish a good routine of pre-testing and quizzing early on. I believe that beginning my research in Chapter 2 may have hindered my results because the students were not used to taking pre-tests. I would wait until later in the semester to begin, once the students had a well-established pattern for class expectations and work. I would also choose a larger sample population. Working with such a small group of students did not allow me to get a true analysis of whether quizzing really made a difference.

When creating the tools that were used to pre-test the students I would be much more selective. Upon reviewing the pre-/post-tests, some of the questions were too difficult for the students to understand. Some of the topics in the pre-tests were not topics that we spent much time on in class.

Another aspect to consider when analyzing the results of this study is the effect of over-testing students. Some students expressed to me a feeling of "test-burnout." They had to take pre-tests, quizzes, post-tests and chapter tests, on top of all the other tests given in their other classes. While I could not control what goes on in other classes, I think that strictly quizzing, without pre/post-tests would have a more positive impact and would reduce the feeling of over-testing. Another way to combat over-testing would be to simply incorporate the post-test into the chapter test that way the students would not be taking two separate tests on the same day.

I would also conduct a student survey after the research was conducted. While I did not see any statistical difference, I had students verbally relate to me how beneficial the quizzes were. I wish I had gotten the opinions of all students on whether or not quizzes were helpful in the class. Having their insight on exactly what aspects of the quizzing helped them, harmed them or had no impact on them would serve as a huge springboard to assist me in editing the quizzes to make them more beneficial to future classes.

In general, I will continue to use frequent quizzing in my classroom. I feel as though it works as a teaching tool for me, as a teacher, and the students. It is a quick informal assessment that shows whether or not a topic is clearly understood by a student. In physical science, there are so many topics that build off of one another that it is imperative that all of the basics be well understood. Through the quizzing process I was able to assess if a basic building block was comprehended. I also found that when it came time to take the chapter test, the students that had been quizzed on the information were more confident in their ability to pass the test than those students who had not been quizzed. Prior to studying for the test students were acutely aware of the topics they needed to focus on because of their quiz grades. The non-quizzed students felt they needed to focus on the entire chapter when studying because they did not have the guidelines of the quizzes to show them what they comprehended and what they did not.

In a secondary classroom it is so important to give students every opportunity to assess their knowledge that we can. Frequent quizzing is another tool to add to a teacher's repertoire of strategies to help students. Although this research did not show a statistical difference between the two groups, it did not show that this negatively affect students. In my opinion, my students showed less test anxiety when it came time to take the test on the quizzed material. They were much more focused, had more self-confidence and an overall more positive attitude about the quizzed information.

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Appendix A: Examples of Pre-Test and Post-Test Questions

Chapter 2 Pre-Test

1. Jordan has a mixture of two solids that he has to separate. The solids are small granules that are the same size but different colors. She knows that the silver granules are aluminum and the white granules are salt. Which procedure is the **most** reliable way to separate the mixture?

a) Stir the mixture in water and filter.
b) Stir the mixture in alcohol and filter.
c) Pass a magnet over the mixture.
d) Sift the mixture through fine wire mesh.

2. Adam has a solution of an unknown solid dissolved in water. Which method will **best** separate the solid from the water?

a) Filter the mixture using extremely fine filter paper.
b) Allow the water to evaporate from an open air container.
c) Chill the mixture down to 0*C and then filter.
d) Heat the mixture to 100*C and then cool.

3. Which table correctly classifies the substances copper, water, and salt?
a)

Substance	**Classification**
Copper	Element
Water	Compound
Salt	Mixture

b)

Substance	**Classification**
Copper	Element
Water	Compound
Salt	Compound

c)

Substance	**Classification**
Copper	Compound
Water	Element
Salt	Element

d)

Substance	**Classification**
Copper	Compound
Water	Mixture
Salt	Mixture

Chapter 6: Pre-Test/Post-Test

1. Sodium is a very reactive metal that can explode when placed in water. Neon atoms are so stable that they don't react with anything. What is a stable form of sodium and why?

A Na+ because sodium atoms lose one electron to be like neon
B Na+ because sodium atoms gain one electron to be like neon
C Na – because sodium atoms lose one electron to be like neon
D Na – because sodium atoms gain one electron to be like neon

2. In aqueous solution, sodium chloride (NaCl) shows that it is made of sodium ions (Na+) and chloride ions (Cl–). Which statement explains the formation of ions when sodium chloride is formed from sodium and chlorine?

A The sodium atoms each lose an electron and the chlorine atoms each gain an electron.
B The sodium atoms each gain an electron and the chlorine atoms each lose an electron.

Appendix B: Examples of Quiz Questions

Chapter 3: Phase Changes Quiz

1. Which of the following properly describes a phase change?

a. an irreversible chemical change
b. a reversible, physical change
c. both a and b
d. neither a nor b

2. Which of the following describes the behavior of a substance during a phase change?

a. neither absorbs nor releases energy
b. always absorbs energy
c. always releases energy
d. either absorbs or releases energy

3. Which of the following is true of an endothermic phase change?

a. neither absorbs nor releases energy
b. always absorbs energy
c. always releases energy
d. either absorbs or releases energy

4. Which of the following is true of an exothermic change?

a. neither absorbs nor releases energy
b. always absorbs energy
c. always releases energy
d. either absorbs or releases energy

6.2: Covalent Bonding Quiz

1. What attractions hold two atoms in a molecule together?
   a. attraction between ions with opposite charges
   b. attraction between the nuclei of the atoms and shared electrons
   c. attraction between each nucleus and the electrons of the other atom
   d. attraction between the molecule and other molecules

2. Covalent bonds are formed between which types of elements?
   a. metals + nonmetals
   b. nonmetals + nonmetals
   c. metals + metals
   d. any 2 elements on the periodic table

3. Which of the following shows an example of a molecule?
   a. NaCl
   b. $MgBr_2$
   c. H_2O
   d. Na_2O

9. Show how electrons are shared in the following covalent bonds:

   Chlorine + Chlorine

10. . Show how electrons are shared in the following covalent bonds:

   Oxygen + Oxygen

12.3 – Newton's 3rd Law Quiz

1. A stationary figure skater pushes off the boards around an ice skating rink and begins gliding backward, away from the boards. Which law explains why the figure skater moves backward?
   a. the law of conservation of energy
   b. the law of inertia
   c. Newton's second law
   d. Newton's third law
2. A red puck with Velcro on its side is sliding toward a stationary blue Velcro puck of the same mass. The pucks will stick together upon contact. After contact, how will the red puck's velocity compare to its initial velocity? (In this collision the law of conservation of momentum is obeyed, and friction is ignored.)
   a. The red puck's velocity is the same as before.
   b. The red puck's velocity is the same magnitude but in the opposite direction.
   c. The red puck's velocity is half its initial velocity and in the same direction.
   d. The red puck's velocity is double its initial velocity and in the opposite direction
3. According to Newton's Third Law, action and reaction are
   a. equal and in the same direction
   b. equal and in opposite directions
   c. unequal and in the same direction
   d. unequal and in opposite direction

4. What is the momentum of a 15 kg dog running at a velocity of 2m/s?

5. What is the velocity of 100 kg truck with a momentum of 10 kg□

Appendix C: Example of Split-Page Notes

You DO NOT have to write down everything on the slides. Write down KEY points that we go over. Remember, my PowerPoint's are available online at http://mrsnorton.weebly.com

Name:________________

Date:_________________

Topic: **2.1 – Classifying Matter**

Main Ideas	*Supporting Notes*
Why are elements and compounds classified as pure substances?	
How do mixtures differ from pure substances?	
Elements:	
Symbols:	
How do mixtures differ from pure substances?	

Compound:	
Heterogeneous Mixtures	
Homogeneous mixtures:	
What is the main difference among solutions, suspensions and colloids?	
Solutions:	
Suspensions:	
Colloids:	

Summary, Reflection, Analysis

Appendix D: IRB Approval

Application for Exemption from Institutional Oversight

Unless qualified as meeting the specific criteria for exemption from Institutional Review Board (IRB) oversight, ALL LSU research/ projects using living humans as subjects, or samples, or data obtained from humans, directly or indirectly, with or without their consent, must be approved or exempted in advance by the LSU IRB. This Form helps the PI determine if a project may be exempted, and is used to request an exemption.

LSU
Institutional Review Board
Dr. Robert Mathews, Chair
131 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.6792
irb@lsu.edu
lsu.edu/irb

– Applicant,Please fill out the application in its entirety and include the completed application as well as parts A-E, listed below, when submitting to the IRB. Once the application is completed, please submit two copies of the completed application to the IRB Office or to a member of the Human Subjects Screening Committee. Members of this committee can be found at http://research.lsu.edu/CompliancePoliciesProcedures/InstitutionalReviewBoard%28IRB%29/item24737.html

– A Complete Application Includes All of the Following:
(A) Two copies of this completed form and two copies of part B thru E.
(B) A brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts 1&2)
(C) Copies of all instruments to be used.
*If this proposal is part of a grant proposal, include a copy of the proposal and all recruitment material.
(D) The consent form that you will use in the study (see part 3 for more information.)
(E) Certificate of Completion of Human Subjects Protection Training for all personnel involved in the project, including students who are involved with testing or handling data, unless already on file with the IRB. Training link: (http://phrp.nihtraining.com/users/login.php)
(F) IRB Security of Data Agreement: (http://research.lsu.edu/files/item26774.pdf)

1) Principal Investigator: James V. Moroney **Rank:** Professor

Dept: Biological Sciences **Ph:** 578-8561 **E-mail:** btmoro@lsu.edu

2) Co Investigator(s): please include department, rank, phone and e-mail for each
*If student, please identify and name supervising professor in this space
Courtney Norton
LaMSTI Master's Progrma
Graduate Student
225-362-1243
court_norton@yahoo.com

IRB# E6002 LSU Proposal #______
✓ Complete Application
✓ Human Subjects Training

3) Project Title: Louisiana Math ans Science Teacher Institute

Study Exempted By:
Dr. Robert C. Mathews, Chairman
Institutional Review Board
Louisiana State University
203 B-1 David Boyd Hall
225-578-8692 | www.lsu.edu/irb
Exemption Expires: 6/4/2015

4) Proposal? (yes or no) No **If Yes, LSU Proposal Number** ______

Also, if YES, either
○ **This application completely matches the scope of work in the grant**
OR
○ **More IRB Applications will be filed later**

5) Subject pool (e.g. Psychology students) Middle school and ~~high school~~ students
*Circle any **"vulnerable populations" to be used:** (children <18; the mentally impaired, pregnant women, the ages, other). Projects with incarcerated persons cannot be exempted.

6) PI Signature [signature] **Date** 6/1/12 (no per signatures)

**** I certify my responses are accurate and complete.** If the project scope or design is later changes, I will resubmit for review. I will obtain written approval from the Authorized Representative of all non-LSU institutions in which the study is conducted. I also understand that it is my responsibility to maintain copies of all consent forms at LSU for three years after completion of the study. If I leave LSU before that time the consent forms should be preserved in the Departmental Office.

Screening Committee Action: Exempted ✓ Not Exempted ____ Category/Paragraph 1

Reviewer Mathews **Signature** [signature] **Date** 6/5/12

Appendix E: Consent Forms

<u>Parent/Guardian Consent</u>

Parents/ Guardians,

As part of my thesis research for the masters program in which I am currently enrolled, I will be carrying out an action research plan in my science classes. The purpose of the research plan is to test effective teaching strategies. My research is testing the effectiveness of frequent quizzing. Students will take pre/post tests to assess their knowledge at the beginning and end of every chapter. Students will be quizzed on certain topics. The pre/post scores will serve as my data. All student identification and information will be kept confidential. Only the values of the pre/post tests will be used to determine if instructional methods have had any effect. Thank you for your support.

Courtney Norton

I give my permission for Mrs. Norton to use the quiz scores of my child,

________________________________, as anonymous data in her thesis action research plan.

_______________________________	_______________________________
(Parent's name)	(Parent's signature)

Student Assent

I, __________________________________, agree to be in a study to help determine effective ways for my teacher to teach me science content. I will take a pre-test before I am taught the content, and I will take a post-test after I am taught the content. My pre-test scores will not count against me, but I can earn bonus points based on my pre-test performance. My post-test scores will average together to be counted as a test grade. I will be quizzed on some of the subject matter and those grades will average together to be counted as a test grade. I can decide to not participate in the study at any time, and will inform my teacher immediately if I decide to do so.

______________________________	____________	__________________
(Student's signature)	(age)	(date)

______________________________	__________________
(Witness)	(date)

Witness should be present for assent process, and not just for signature.

Vita

Courtney Bailey Norton was born in Shreveport, Louisiana, in 1985. She attended primary and secondary school in Metairie, Louisiana at Crescent City Baptist School until 2004. She attended Louisiana State University and earned her degree in Biological Sciences in May 2009. She entered the Graduate School at Louisiana State University Agricultural and Mechanical College in May 2011 and is a candidate for a Master of Natural Sciences. She has been a high school science teacher in Assumption Parish for the past 4 years. She is currently teaching Physical Science at Assumption High School in Napoleonville, Louisiana.