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Frequent Quizzing Versus Class Reviews

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FREQUENT QUIZZING VERSUS CLASS REVIEWS

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
Kayla L. Daigle
B.S., Louisiana State University, 2012
August 2015
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ABSTRACT

This study was designed to identify an optimal strategy for increasing high school students’ mastery of science material, by comparing an approach that has been identified as effective in enhancing student learning to an approach commonly used in high school classrooms. Over the course of the 2014/15 school year, the investigator compared two different techniques commonly employed to enhance student understanding. Students in a traditional 10th grade physical science class and students in an honors 10th grade physical science class acted as both the control and experiment groups. The investigator provided a pre-test to determine the students’ prior knowledge of the content. The investigator then proceeded with frequent quizzing or class review at the beginning of the class to test students on the information covered the previous day. After all content was presented, the investigator provided a post-test to measure the amount of knowledge gained throughout the study and determine which, if either, method helped the most. For all chapters for both classes, frequent quizzing led to the same or significantly higher student learning gains.
INTRODUCTION

Need for Change

Education in Louisiana is based on the foundation that all students can achieve a high level of accomplishment, no matter their socioeconomic status. This principle applies also to science education in high schools. Science education in high schools in Louisiana encompasses a sequence of courses exposing students to natural and physical sciences for future post-high school education and employment. The sequence of science courses for high school students often begins with a course in physical science.

High school Physical Science is an introductory course designed to prepare students for future science classes, specifically chemistry and physics. To prepare the students for these higher level classes, it is extremely important that the students learn and understand the material, rather than simply memorizing it. A critical goal of classroom education is learning and retention of the course material, involving not only a large number of facts, but also development of cognitive skills (Roediger et al., 2011). It is very important for the educator to facilitate a deep understanding of the material so the student has a higher probability for success in future classes. In 1956, Benjamin Bloom published the framework that classifies the different levels of student learning. This framework classifies cognitive understanding into six different categories, starting with the most basic level and leading up to the most complex or abstract level. The first, most basic level only requires the student to remember information. The next level requires the student to understand the material. This can be demonstrated many different ways, such as interpreting, comparing, explaining, and summarizing. The third
level requires the student to actually apply their knowledge. The next level is analysis, and this level requires the student to explain how different parts of a topic are related to explain the bigger picture. The sixth, most complex level requires the student to put together all elements in order to create an original product. The highest level requires students to evaluate something and make judgments based on criteria or standards. Bloom’s Taxonomy has been used in classrooms to help teachers both understand the importance of and accomplish this goal of deeper understanding. It is essential that educators bring students past the basic level of knowledge and through high levels of learning, such as analysis and synthesis (Krathwahl 2002).

Procrastination by students is a major impediment to successful mastery of course materials. When given the opportunity to determine their own schedule of studying, students typically postpone much of their course work (Wesp 1986). This poor time management results in students trying to memorize a lot of content quickly, rather than taking the time to learn and understand the material on a level that will allow for longer retention.

In addition to time-management challenges, many high school students are not efficient at self-assessment. Self-assessment requires the student to both evaluate the quality of their thinking while learning and also identify strategies to improve understanding (McMillan, 2008). One important concept to self-assessment requires the student to know an end goal and how close, or far, they are to reaching that goal (Bruce, 2001). Clauss and Geedey (2010) tested the accuracy of student self-assessment based on the different levels of Bloom’s Taxonomy. The results showed that students were able to accurately determine their level of understanding,
the most basic cognitive level on Bloom’s Taxonomy, which encompassed 26% of the exam questions in the study. Students were also more accurate at self-assessment on the higher cognitive levels of analysis, synthesis, and evaluation, which together only encompassed 23% of the exam questions. Students were poor self-assessors at the intermediate levels of comprehension and application, which encompassed over 50% of the exam questions in the study.

Because students are not very good at self-assessment, it is difficult for them to recognize when a study habit is not working which leads to poor study skills. For example, many students read over their notes multiple times in preparation for a test (McDaniel et al., 2007) and are completely astonished when they don’t perform well on the test. Research has shown that repeated reading of material is ineffective on a later test (Callender and McDaniel, 2009) and does not result in efficient learning (Karpicke and Roediger, 2008).

Two strategies to improve student performance were tested in a high school physical classroom, the effect of frequent quizzing and class review. Student learning gains were recorded for each unit. These results were compared for the control group and the experimental group.

**Frequent Quizzing in the Classroom**

There are many different strategies to deal with student procrastination, but one that has been tested multiple times is frequent quizzing. The testing effect has been researched for over a century, starting with Abbott in 1909. Since then, there have been multiple studies evaluating the same technique in many different classrooms with a diversity of students and
circumstances. One study done by Richard Wesp (1986) evaluated students in introductory psychology courses. At Elmira College, one group of his students was allowed to take quizzes at their own pace while the other group was required to take quizzes daily. The daily quizzing procedure was effective in reducing student procrastination and led to higher course grades (Wesp 1986). In a study done in an 8th grade science class, students’ performance on unit exams increased from baseline levels of 79% to levels of more than 90% correct when quizzed frequently. Furthermore, when students were quizzed on certain content, the performance level on that material generally increased to an A-level compared to the C+ level attained when the content was not quizzed (McDaniel et al., 2011). More recently, Norton (2013) applied this concept in her freshman level high school physical science classes. With the honors classes, there were no significant differences between the quizzed chapters and the non-quizzed chapters.

If the principle of transfer appropriate processing (Morris et al., 1977) is applied, it is expected that the best way to improve test performance would be to have students practice the same type of retrieval necessary on that test (Roediger et al., 2011). The best way to do that is to provide quizzes for the students to take regularly.

Class Review

Research has revealed that learning requires active retrieval of material. The students should actively recall material through activities such as teacher-directed quizzes, student-directed rehearsal, or self-assessment (Beesley and Apthorp, 2010). This study utilized this concept and applied it to class review. Class review may also help with struggling learners
because it reinforces the content. Class review also provides an opportunity to give praise to students, which can influence intrinsic motivation (Henderlong and Lepper, 2002) that may be lacking, especially in the traditional class.

Active class review can be helpful at several different stages in the lesson. Review can be done as a class before any content is taught in order to gauge students’ prior knowledge and identify any common misconceptions. Review can also be done in the middle of a lesson, after some content has been presented, to help students understand individual parts of the lesson. Lastly, review can be done at the end of a lesson, after all content has been presented, to make sure students can put all the parts of the lesson together.

In addition to being implemented at several different stages in the lesson, class review can also be executed using many different techniques. The students can work alone to determine an answer, then the class can discuss all of the options afterwards. The students can work in groups to determine the answer, and then have a class discussion. Whether the students work alone or in groups, the review can be done several ways. Class review can be done as a competition, where the individual or the group that gets the correct answer the quickest gets a point. Review can be done in a game format, such as Jeopardy or Wheel of Fortune. Review can be done using white boards or some type of clicker system. Review can be done using colored index cards, which is helpful with being able to quickly see how many students are answering correctly, or even how many students are getting the same incorrect answer. Despite the timing or the technique used, class review can be an extremely helpful tool for both the teacher and student.
Rationale

The present study is designed to compare the effectiveness of two strategies for increasing student learning in a high school physical science class setting. The goal of this study was not to test whether or not frequent quizzing works. It has been shown to work in several studies (McDaniel et al., 2011; Wesp, 1986; Norton, 2013; Abbott, 1909). Because we know that technique is very effective, the goal was to test the success of class review against the success of frequent quizzing. Class time is limited and valuable. Thus, it is important to employ the most effective teaching strategies to maximize student success. To test these strategies, the students were given a pre-test to make sure both the control group and the experimental group have the same level of knowledge prior to the teaching of any content. One group was given quizzes daily, starting after the first day of the material. The other group had some sort of active class review every day. Both groups took the same post-test after the same amount of time has passed, and the results were recorded and analyzed.

In addition, this study was used to determine if males or females benefited more from one technique or the other. Choudhary et al. (2011) determined that males are more achievement oriented, which would cause them to favor quizzes, while females are more socially and performance oriented, which would cause them to favor the reviews. Furthermore, females value feedback more than males do (Correll, 2001) which would motivate the females to do well on the class review, and the boys may not be concerned with negative feedback from performing poorly.
MATERIALS AND METHODS

This research project was conducted at Brusly High School in Brusly, Louisiana. In the fall of 2014, the school had an enrollment of 587 students. The breakdown of gender enrollment by grade is shown in Figure 1. The ethnic breakdown of the school is shown in Figure 2. Forty-two percent of the students qualify for free or reduced lunch.

Figure 1. Gender breakdown by grade level for Brusly High School in the fall of 2014. On the x-axis the grade level and total number of students is shown.

Figure 2. Ethnic breakdown of Brusly High School in the fall of 2014.
Brusly High has class 177 days out of the year, with 18 weeks in the fall semester and 18 weeks in the spring semester. Each day consists of seven classes, each approximately 50 minutes long, and all full credit courses are taken throughout both semesters.

For my research, I used my two physical science classes at Brusly High School. Of the two classes used in the research, one is classified as honors. In order to be classified as honors, the student had to finish 9th grade Biology with an A or B as well as have recommendations from the 9th grade science and math teachers. The honors class consisted of 27 students, all in the 10th grade. There were 15 males and 12 females. The non-honors class also consisted of 27 students, but there were nine juniors in addition to the 18 sophomores. In this class there were 14 males and 13 females. Two of the students in this class are 504 students, who take their tests with a para professional outside of the classroom. 504 students are students with disabilities who are legally required to receive accommodations. These accommodations vary based on the student and his or her disabilities. In addition to these two students, there are three students who receive the accommodation of extended time on exams.

To determine the effectiveness of frequent quizzing and class review, a pre and post-test was developed to standardize the results. Examples of pre- and post-test questions can be found in Appendix A. These tests were teacher-created based on the use of the 12th edition Glencoe Physical Science textbook (2012). The students were given multiple versions of the same test to reduce the chance of dishonesty while taking the tests. The pre-test questions were never reviewed, and the students never found out how they scored on them. The
questions on the pre-test were mixed in with the other questions on the chapter test, and used for the post-test score.

The class review contained the exact same questions as the questions on the quiz, and the types of questions determined the method for review. Examples of quiz and review questions can be found in Appendix B. Most of the time, we used ActiveExpression devices with the questions displayed on the Promethean. The ActiveExpression devices allow the students to submit individual answers using their personal device. The answers are then anonymously shown on the Promethean board, which is the interactive board in all classrooms at Brusly High School. When longer answers or drawing were required, the class review would be done with small white boards that were provided for each student.

During the review, each student was required to answer the question on his/her own. Once all answers were submitted, we would review the answers as a class. There was no penalty for incorrect answers, but the students would lose participation points if they were clearly not putting in any effort. There was also no reward for correct answers, except for the competition between classmates.

Because of small sample size and the academic difference between the two classes, 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 given. The pre-test counted only as a participation grade for the students’ completion. The same content was provided to both classes in the same manner. Lectures were given using a combination of PowerPoint presentations and ActivInspire flipcharts. All lectures included some sort of student
involvement, ranging from Think-Pair-Share questions to students coming up to the board to complete a task.

The students that served as the experimental group participated in a class review, usually using the ActivExpression student response system. Each student was responsible for answering the questions on their own. After each question, we would review the answers as a class. The only points the students received for this review were participation points. The students in the experimental group would lose points if it was obvious that they were not putting effort into answering the questions correctly. The control group received a quiz at the end of each section. There were occasionally two quizzes per section, if the section was long or contained a lot of information. The quizzes were taken at the beginning of class the day after the material was learned. The students then turned in the quiz to be graded by the teacher and then reviewed as a class. After the students received their graded quiz, they were able to keep the quiz in their binder. The quizzes did count towards the course average. Table 1 shows the breakdown of chapters that were either quizzed or reviewed for each class. Table 2 shows the content covered in each chapter. Chapter 3 was completed during the fall semester, and all other chapters were covered in the spring. If a student was absent for the pre-test and was not able to make it up before learning any of the content, the data was excluded from the analysis. If a student missed three or more quizzes in a single chapter, the data was excluded from the analysis. Data from all students with any type of accommodation was included in the analysis.
Table 1. Experimental design. The breakdown of which chapters were quizzed and which were reviewed for the two classes.

<table>
<thead>
<tr>
<th>Class</th>
<th>Quizzed Chapters</th>
<th>Class Review Chapters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honors</td>
<td>Chapter 3, 17</td>
<td>Chapter 16, 18</td>
</tr>
<tr>
<td>Traditional</td>
<td>Chapter 16, 18</td>
<td>Chapter 3, 17</td>
</tr>
</tbody>
</table>

Table 2. Textbook chapter topics for the Glencoe Physical Science (2012) that students were taught and then reinforced by either quizzing or reviews.

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Forces and Newton's Laws</td>
</tr>
<tr>
<td>16</td>
<td>Structure of the Atom, Counting Subatomic Particles</td>
</tr>
<tr>
<td>17</td>
<td>Ions, Ionic Compounds, Covalent Compounds, Lewis Dot Structures</td>
</tr>
<tr>
<td>18</td>
<td>Writing and Balancing Chemical Equations, Polarity</td>
</tr>
</tbody>
</table>

Louisiana State University Institutional Review Board (IRB) reviewed all research plans and appropriate forms. The IRB number is E8822 (Appendix C). Students signed and returned assent forms (Appendix D), and parents or guardians signed and returned consent forms (Appendix E) permitting use of their data for this research. No student names were released during this process, and each student received an anonymous number to ensure privacy.

Once all pre-test and post-test scores were collected, each student’s normalized learning gain for all chapters was calculated using Hake’s (2002) formula, where learning gain is equal to \((\text{Post-test}\% - \text{Pre-test}\%)/(100 - \text{Pre-test}\%)\). Once all normalized learning gains were calculated, an ANOVA with a Tukey post-test was done using GraphPad InStat version 3.1 for Windows, GraphPad Software, San Diego California USA, www.graphpad.com. Figures were plotted using GraphPad Prism, version 6.05. Power for nonsignificant statistical comparisons was calculated with GraphPad StatMate, version 2.0.
RESULTS

Analysis of scores from pre- and post-assessments

For each chapter supplemented with either quizzing or reviews, students were given pre- and post-tests. Each pre-test had a different number of questions, depending on the content covered. Because of the difference in number of questions, the raw scores were converted into percentages for all analyses. In this study, four comparisons were done: comparing the average pre-test and post-test scores, normalized learning gains by class, normalized learning gains by treatment, and normalized learning gains by gender. All comparisons were done using a one way ANOVA with a Tukey post-test.

The scores on the pre-tests ranged from 0% to 50%, and the scores on the post-tests ranged from 13% to 100% (Table 3). As shown in Figure 3 below, both groups showed positive gains from pre-test to post-test for all chapters. Despite the content or treatment, the honors class always had higher post-test scores.

Analysis of normalized learning gains for both traditional and honors classes

Figure 4 shows the mean normalized learning gains for each treatment for all chapters. The mean learning gain for honors Chapter 3 (0.702 ± 0.029 (x̄ ± SEM)) was significantly higher (P < 0.05) than the mean learning gain for the traditional class (0.509 ± 0.035). The mean normalized learning gain for honors Chapter 16 (0.854 ± 0.030) was not different from the mean normalized learning gain for the traditional class (0.726 ± 0.043). The mean normalized
Table 3. Pre- and post-test scores for the honors and traditional students for all quiz and review chapters. The range, mean, standard error of the mean and number of students are shown for the pre- and post-test scores for chapters that were taught using quizzes or reviews.

<table>
<thead>
<tr>
<th></th>
<th>Honors Pre-test and Post-test Results</th>
<th>Traditional Pre-test and Post-test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quiz</td>
<td>Review</td>
</tr>
<tr>
<td></td>
<td>Ch. 3 Pre</td>
<td>Ch. 3 Post</td>
</tr>
<tr>
<td>Range</td>
<td>20% - 40%</td>
<td>50% - 100%</td>
</tr>
<tr>
<td>Mean</td>
<td>28.8%</td>
<td>78.8%</td>
</tr>
<tr>
<td>Standard Error</td>
<td>0.01451</td>
<td>0.02185</td>
</tr>
<tr>
<td>Students (n)</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Review</td>
<td>Quiz</td>
</tr>
<tr>
<td></td>
<td>Ch. 3 Pre</td>
<td>Ch. 3 Post</td>
</tr>
<tr>
<td>Range</td>
<td>10% - 50%</td>
<td>20% - 100%</td>
</tr>
<tr>
<td>Mean</td>
<td>31.3%</td>
<td>66.5%</td>
</tr>
<tr>
<td>Standard Error</td>
<td>0.01918</td>
<td>0.03507</td>
</tr>
<tr>
<td>Students (n)</td>
<td>23</td>
<td>23</td>
</tr>
</tbody>
</table>
Figure 3. Pre- and post-test scores for the chapters taught using reviews or quizzes for the honors (red symbols) and traditional (blue symbols) classes. Mean and standard error of the mean is plotted.

Learning gain for honors Chapter 17 (0.761 ± 0.031) was significantly higher (P < 0.001) than the mean normalized learning gain for the traditional class (0.371 ± 0.043). The mean normalized learning gain for honors Chapter 18 (0.793 ± 0.032) was significantly higher (P < 0.01) than the mean learning gain for the traditional class (0.561 ± 0.058).

Analysis of normalized learning gains for the honors class

There were no differences for any comparisons of normalized learning gains for the honors class (Figure 5). There was no difference comparing the normalized learning gains of one quizzed chapter to another quizzed chapter, comparing the normalized learning gains of one reviewed chapter to another reviewed chapter, or between the normalized learning gains of any of the quizzed chapters and any of the reviewed chapters (Table 5).
Figure 4. The normalized learning gains for each treatment for all chapters for the honors and traditional classes. The mean normalized learning gain and standard error of the mean are shown for reviewed (R) and quizzed (Q) chapters.

Table 4. Statistical outcomes of comparisons of normalized learning gains between the quizzed class and the reviewed class for each of the chapters.

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Comparison</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honors</td>
<td>Traditional</td>
<td>Ch 3</td>
</tr>
<tr>
<td>Traditional</td>
<td>Honors</td>
<td>Ch 16</td>
</tr>
<tr>
<td>Honors</td>
<td>Traditional</td>
<td>Ch 17</td>
</tr>
<tr>
<td>Traditional</td>
<td>Honors</td>
<td>Ch 18</td>
</tr>
</tbody>
</table>

Analysis of normalized learning gains for the traditional class

When examining the results for the traditional class (Figure 6), the normalized learning gains for Chapter 16 (a quizzed chapter) were significantly higher than the normalized learning gains for both Chapters 3 and 17 (review chapters). Normalized learning gains for Chapter 18 (a quizzed chapter) were higher than the normalized learning gains for Chapters 3 and 17, but the
Figure 5. Normalized learning gains for the honors class for all chapters. The mean normalized learning gain and standard error of the mean are shown for reviewed (R) and quizzed (Q) chapters.

Table 5. Statistical outcomes of comparisons of normalized learning gains for the honors class for all chapters.

<table>
<thead>
<tr>
<th>Honors Comparisons using Learning Gains</th>
<th>Treatment</th>
<th>Comparison</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiz vs. Quiz</td>
<td>Ch 3 vs. Ch 17</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>Review vs. Review</td>
<td>Ch 16 vs. Ch 18</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>Quiz vs. Review</td>
<td>Ch 3 vs. Ch 16</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ch 3 vs Ch 18</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ch 17 vs. Ch 16</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ch 17 vs. Ch 18</td>
<td>&gt;0.05</td>
<td></td>
</tr>
</tbody>
</table>

only statistically significant difference was for Chapter 17 (Table 6). The mean normalized learning gain for the first quizzed chapter, chapter 16 (0.726 ± 0.043) was significantly higher (P < 0.01) than the mean normalized learning gain for Chapter 3, a review chapter (0.509 ± 0.035).

The mean normalized learning gain for Chapter 16 was also significantly higher (P <0.001) than
for Chapter 17, another review chapter (0.371 ± 0.043). The mean normalized learning gain for the second quizzed chapter, Chapter 18 (0.561 ± 0.058) was higher, but not statistically different (P > 0.05) in comparison to Chapter 3, a review chapter (0.509 ± 0.035). The mean normalized learning gain for Chapter 18 was higher (P <0.05) than the learning gain for Chapter 17, another review chapter (0.371 ± 0.043).

![Comparison of Quiz vs. Review](image)

Figure 6. Normalized learning gains for the traditional class for all chapters. The mean normalized learning gain and standard error of the mean are shown for reviewed (R) and quizzed (Q) chapters.

### Table 6. Statistical outcomes of comparisons of normalized learning gains for the traditional class for all chapters.

<table>
<thead>
<tr>
<th>Traditional Class Comparisons using Learning Gains</th>
<th>Treatment</th>
<th>Comparison</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiz vs. Quiz</td>
<td>Ch 16 vs. Ch 18</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>Review vs. Review</td>
<td>Ch 3 vs. Ch 17</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>Quiz vs. Review</td>
<td>Ch 16 vs. Ch 3</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ch 16 vs. Ch 17</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ch 18 vs. Ch 3</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ch 18 vs. Ch 17</td>
<td>&lt;0.01</td>
<td></td>
</tr>
</tbody>
</table>
The power of the statistically nonsignificant comparison of quiz versus review mean normalized learning gain for Chapters 18 and 3 was calculated for the traditional class using GraphPad StatMate. With the sample sizes and standard deviations of the two chapters, there is only a ten percent chance of finding a significant difference in the data. A graph of the power is shown in figure 7.

Figure 7. The power of a nonsignificant t-test with sample sizes of 23 and 17 and the observed standard deviations. Delta is the difference between mean normalized learning gains. This was calculated using GraphPad StatMate to determine if the comparison in a completed experiment missed a small effect due to small sample size. The curve shows the computed power of a test to detect various hypothetical differences (delta).

Analysis of normalized learning gains for both teaching techniques by gender

The outcomes of the honors and traditional classes were pooled by teaching technique and analyzed by gender. When comparing the normalized learning gains by gender, there were no differences (P > 0.05 for all comparisons) between the two treatments or the two genders (Figure 7).
Figure 8. Pooled normalized learning gains for males and females using quizzing or reviewing as the additional teaching technique. Number of males in the quizzed group = 54, the number of females in the quizzed group = 36, the number of males in the reviewed group = 52, and the number of females in the reviewed group = 45.

Table 7. Statistical outcomes of comparisons of pooled normalized learning gains for males and females using quizzing or reviewing as the additional teaching technique.

<table>
<thead>
<tr>
<th>Gender Comparisons using Learning Gains</th>
<th></th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Comparison</td>
<td></td>
</tr>
<tr>
<td>Quiz vs. Quiz</td>
<td>Male vs. Female</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Review vs. Review</td>
<td>Male vs. Female</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Quiz vs. Review</td>
<td>Female vs. Female</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Quiz vs. Review</td>
<td>Male vs. Male</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Quiz vs. Review</td>
<td>Male vs. Female</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>
DISCUSSION

Physical science is an introductory course for high school students who are transitioning into higher level science courses, such as chemistry or physics. To develop a teaching strategy which maximizes student success, this study was designed to determine whether frequent quizzing improves student performance more than frequent class reviews in a high school physical science classroom. There has been extensive research on frequent quizzing, including research in 8th grade science classes (McDaniel et al., 2011), 9th grade honors physical science classes (Norton, 2013), and college classes (Wesp 1986). In the 8th grade classes and the college classes, frequent quizzing resulted in significantly higher performance for the assessments used in the studies. In the 9th grade honors physical science classes, frequent quizzing resulted in higher performance, but the results were not statistically significant (Norton, 2013). Two groups of students taking physical science, an honors class and a traditional class were used in the current study.

Overall, both teaching techniques, quizzing and reviewing, showed positive gains from pre-test to post-test for all chapters (Figure 3). The number of students participating in the classes was variable. The number of students participating are shown in Table 3, and there are two instances where the sample size dropped. For the honors class, the participation was lower for Chapter 17 due to absences for school related functions, mainly sports. For the traditional class, the number of students was much lower for Chapter 18, because students either dropped out or just stopped coming to class. Absences were much more of a factor for the traditional class than the honors class.
In examining normalized learning gains, the honors class always had higher normalized learning gains than the traditional class (Figure 4). No matter what the intervention, quizzing or reviewing, when comparing the results of the honors class and traditional class for the same chapter (Table 4), the honors class had significantly higher normalized learning gains for all chapters except Chapter 16, which was a quizzed chapter for the traditional class.

When making comparisons within the honors class (Figure 5), there was no significant difference for any comparisons of normalized learning gains (Table 5). The students in the honors class are more intrinsically motivated than the students in the traditional class. This self-motivation increases class involvement and learning achievement (Wang and Reeves, 2006).

When making comparisons within the traditional class, there were differences between the students’ performance on reviewed versus quizzed material (Table 6). The normalized learning gains for the quizzed chapters were higher than the normalized learning gains for the reviewed chapters (Figure 6). The differences were significant for all a posteriori comparisons, except when comparing Chapter 18 to Chapter 3. To understand this result, the power of the comparison was calculated using the sample sizes and normalized learning gain standard deviations for those chapters (Figure 7). With 80% power, in order to find a statistically significant difference with the given sample sizes, the mean learning gain for the quizzed chapter would have to be 0.23, which is higher than the mean learning gain for the reviewed chapter. Thus, a lack of significant difference in the comparison of Chapters 18 and 3 normalized learning gains may reflect the low power of the statistical comparison.
Nonetheless, the clear outcome of these results is that the traditional students learned more effectively when given quizzes frequently.

Another indication that the quizzes are more effective for the traditional class is seen when comparing all chapters for both classes. Chapter 3 was a quizzed chapter for the honors class, and the learning gain for that chapter was significantly higher than the learning gain for both review chapters for the traditional class. However, the learning gain from that chapter was not significantly higher for either quizzed chapters for the traditional class. Chapter 3 was a reviewed chapter for the traditional class, and the learning gain for that chapter was significantly lower than the learning gain for all chapters for the honors class. This trend is seen for other chapters, with only a few exceptions. Chapter 16 was a quizzed chapter for the traditional class. When comparing Chapter 16 to all chapters for the honors class, the mean learning gain for the honors class was never significantly higher than the mean learning gain for the traditional class. In summary, when the traditional class was quizzed, the difference between the traditional normalized learning gains and the honors normalized learning gains was smaller, and in many cases nonsignificant. When the traditional class was reviewed, the difference was larger and almost, if not every time, always significantly so (Figure 4).

The outcomes of the honors and traditional classes were pooled by teaching technique and analyzed by gender (Figure 7). There were no differences between male and female students or between either teaching techniques analyzed by gender (Table 7). Quizzing and reviewing seem to work equally well with male and female high school students, which was not expected. Because of male tendency to be motivated by achievement (Choudhary et al., 2011)
and to ignore any negative feedback that may cause self-doubt (Correll, 2001), I expected the males to benefit more from frequent quizzing. Because females tend to be socially motivated and value feedback, I expected them to benefit more from the class reviews.

Although the students were not provided an interest survey, they definitely voiced their opinion about the different techniques. As a whole, the students got very excited when it was time to review as a class because they enjoyed the competition, and because they were happy it wasn’t their turn to take quizzes. There was always a unified groan when it came time to take the quizzes at the beginning of the class, and almost every time at least one student would say, “Again?!”. The students failed to realize that frequent quizzing enabled them to get closer to reaching their end goals (Bruce, 2001) of content knowledge and consequently better grades. Because of this, the students provided a prime example demonstrating their inability to self-evaluate (Clauss and Geedey, 2010) and determine which technique is more beneficial for their learning. To extend this research, a student interest survey would be beneficial.

I noticed that both classes prepared more for the quizzes than they did for the review. This was likely because the students’ grades were not affected by the review, but they were affected by the quizzes. Essentially, there was no penalty if the students were not prepared for the review. If this research was conducted again, I would provide some type of incentive for performing well to try to maximize student effort for both techniques. The students could receive a bonus point for every A on a quiz, and the same standards could be applied to the review. The bonus points would not be used in the analysis of the data. The incentive could even be simpler, such as receiving some type of immediate reward (candy, extra bathroom
pass, extra tardy pass, etc.) for getting correct answers. It would also be interesting to apply
the competition aspect of the review to the quizzing. This would require more sections of the
same level classes, but the class with the highest quiz average could receive some type of
recognition. Another extension I would incorporate in a repeated study would be to determine
whether giving quizzes that weren’t graded had the same impact as giving quizzes that are graded.

At the beginning of the study, I was confident that the traditional class would benefit
more from the frequent quizzing due to success in the studies completed by Abbott (1909),
Wesp (1986), and McDaniel et al. (2011). I was uncertain if there would be significant
differences in the honors class due to the study done by Norton (2013), which found no
differences between the students who were quizzed and the students who were not. However,
her ability to detect differences may have been limited by her class sizes and thus a limited
statistical power. Overall, the class that benefited most from frequent quizzing in the present
study was the traditional class. For most of the traditional students, the reasoning behind the
higher normalized learning gains was not that the quizzes combatted procrastination, because
most of the traditional students did not prepare for the quizzes ahead of time. This causes me
to hypothesize that the true reasoning behind the success of frequent quizzing was that the
students were able to practice the same type of retrieval that was necessary on the tests
(Roediger et al., 2011). The honors class likely could have received neither quizzes nor reviews
and still had similar normalized learning gains because of their high level of motivation to
perform well. Using the frequent quizzes in the traditional class not only improved the
students’ performance, but also narrowed the gap between the normalized learning gains for
the traditional class and the normalized learning gains for the honors class. Although class
reviews seem more engaging for the students and are less hassle for the teacher, this study
should encourage other teachers to implement the teaching strategy of frequent quizzing in the
traditional class to improve student learning.


APPENDIX A: EXAMPLES OF PRE- AND POST-TEST QUESTIONS

Chapter 3

1. T/F: Seat belts tighten before locking up to keep you close to the seat you’re in.

2. Which type of friction prevents two surfaces from sliding past each other?
   a. Rolling
   b. Sliding
   c. Static
   d. None of the Above

3. A man hits a golf ball (200 g), which accelerates at a rate of 20 m/s². What amount of force acts on the ball?

Chapter 16

1. T/F: An isotope has the same number of protons but different number of electrons.

2. Who was the first person to suggest the idea of a nucleus?
   a. Democritus
   b. Thomson
   c. Rutherford
   d. Bohr

3. Draw the Lewis Dot structure for water.

4. Complete the following chart with the correct number of protons, neutrons, and electrons.

<table>
<thead>
<tr>
<th>Element Name &amp; Type</th>
<th>Protons</th>
<th>Neutrons</th>
<th>Electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon-14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral Oxygen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral Lithium</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chapter 17

1. The charge on any ionic compound is either positive or negative.

2. Which of the following forms a cation?
   a. Oxygen
   b. Selenium
   c. Potassium
   d. Carbon
3. Write the name or formula for the following compounds. Identify them as ionic or covalent.

<table>
<thead>
<tr>
<th>Formula</th>
<th>Name</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Cu₂S</td>
<td>______________________</td>
<td>_________</td>
</tr>
<tr>
<td>b. ________</td>
<td>Carbon Tetrachloride</td>
<td>_________</td>
</tr>
</tbody>
</table>

Chapter 18

1. T/F: Ammonia (NH₃) is a polar molecule.

2. How many grams are in 7 moles of Cu(CN)₂?
   a. 0.06 g  
   b. 809.13 g
   c. 16.51 g
   d. 725.06 g

3. Balance the following chemical reaction:

   _____ Al(OH)₃ + _____ H₂SO₄ \rightarrow _____ Al₂(SO₄)₃ + _____ H₂O
APPENDIX B: EXAMPLES OF QUIZ AND REVIEW QUESTIONS

Chapter 3

1. You give a shopping cart a shove down the aisle. The cart is full of groceries and has a mass of 18 kg. The cart accelerates at a rate of 3 m/s². How much force did you exert on the cart?

2. An object accelerates at a rate of 12.0 m/s² when a force of 6.00 newtons is applied to it. What is the mass of the object?

3. Which type of friction results in a net force of 0 newtons?

Chapter 16

1. Assuming all of the elements are neutral, fill out the chart with the element name, element symbol, number of protons, neutrons, and electrons.

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Element Symbol</th>
<th>Protons</th>
<th>Neutrons</th>
<th>Electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubidium</td>
<td></td>
<td>16</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>Nitrogen-20</td>
<td></td>
<td>9</td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

2. Isotopes have the same number of ____________, but different number of ________.
   a. protons; electrons  
   b. protons; neutrons  
   c. neutrons; protons  
   d. neutrons; electrons

3. The atomic mass tells you the number of __________________________.
   a. protons  
   b. neutrons  
   c. electrons  
   d. a & b  
   e. All of the Above

Chapter 17

1. Circle the elements that will make anions.

   Chlorine   Neon   Potassium   Copper   Oxygen

30
2. For each of the following compounds, write the formula or the name and draw the Lewis Dot structure.
   a. K₂O
c. Nitrogen trichloride
   b. C₅H₁₂
d. Beryllium oxide

3. Fill in the missing elements of the chart.

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Element Symbol</th>
<th>Protons</th>
<th>Neutrons</th>
<th>Electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-42</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron (III)</td>
<td></td>
<td>15</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>Lithium Ion</td>
<td></td>
<td>30</td>
<td></td>
<td>28</td>
</tr>
</tbody>
</table>

Chapter 18

1. Balance the following chemical reactions:
   a. _____ Na₃PO₄ + _____ KOH → _____ NaOH + _____ K₃PO₄
   b. _____ P₄ + _____ O₂ → _____ P₂O₃
   c. _____ AgNO₃ + _____ Cu → _____ Cu(NO₃)₂ + _____ Ag

2. How many moles are in 118.2 grams of Al₂O₃?

3. How many grams are in 9.84 moles of Ba(NO₃)₂?

4. Draw the Lewis Dot structure and determine if the molecule is polar or nonpolar:
   a. Methane
   b. HCN
APPENDIX C: IRB APPROVAL

ACTION ON EXEMPTION APPROVAL REQUEST

TO: Joseph Siebenaller
    Biological Sciences

FROM: Dennis Landin
    Chair, Institutional Review Board

DATE: June 12, 2014
RE: IRB# E8822
TITLE: Frequent Quizzing vs. Daily Anticipatory Set


Review Date: 6/12/2014
Approved X Disapproved

Approval Date: 6/12/2014 Approval Expiration Date: 6/11/2017

Exemption Category/Paragraph: 1

Signed Consent Waived?: No

Re-review frequency: (three years unless otherwise stated)

LSU Proposal Number (if applicable): 

Protocol Matches Scope of Work in Grant proposal: (if applicable) 

By: Dennis Landin, Chairman

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –
Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU’s Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects after that approval.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
8. SPECIAL NOTE:
   *All investigators and support staff have access to copies of the Belmont Report, LSU’s Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/irb*
APPENDIX D: STUDENT ASSENT FORM

Child Assent Form

I, ______________________________________________________, agree to be in a study that will help Mrs. Daigle find ways to help educate students at Brusly High School by using frequent quizzing and class reviews. I understand that I will have to work to the best of my abilities while in this study. I will devote my time towards this study by participating in all learning instruction, classroom and at home activities, and assessments while observing classroom rules at all times. I am fully aware that I can decide to stop being in the study at any time without getting in trouble or affecting my grading.

Student’s Signature:_________________________________________ Age:_____ Date:______________

Witness Signature:_________________________________________ Date:______________
APPENDIX E: PARENT CONSENT FORM

Parental Permission

PROJECT TITLE: Frequent Quizzing vs. Class Review

PERFORMANCE SITE: Brusly High School
West Baton Rouge School System
630 Frontage Road
Brusly, LA 70719

INVESTIGATORS: The following investigators are available for questions about this study,
Monday-Friday 9:00 am-3:00 pm
Dr. Joseph Siebenaller (225) 578-2601
Kayla Daigle (225) 749-2815

PURPOSE OF THE STUDY: The purpose of this study is to determine whether there is an increase in students’ test scores and retention rates in my Physical Science classroom when using frequent quizzing and class reviews.

INCLUSION CRITERIA: Students in 10th grade enrolled in Physical Science taught by Kayla Daigle.

DESCRIPTION OF STUDY: Over the course of the 2014-2015 school year, the investigator will implement two different strategies in the classroom. The investigator will provide a pretest to determine students’ content knowledge prior to instruction. The instructor will continue with either a daily quiz or class review sessions. The material on each quiz will be covered the class prior to the quiz, and each class review will include the same questions found on the quiz. Following the unit, the students will be given a posttest to determine the effectiveness of each strategy. I will also provide a student survey to determine students’ viewpoints on each strategy.

BENEFITS: It is anticipated that the techniques used will increase students’ test scores on tests as well as students’ ability to retain the content for a longer period of time. This study should also enhance the overall confidence of scientific knowledge by participating in this study.

RISKS: There are no known risks associated with participation in this study.

RIGHT TO REFUSE: While participation in this study is highly suggested and recommended, it is not mandatory that a student subject choose to participate. At any time, either the subject may withdraw from the study or the subject’s parents may withdraw the subject from the study. Non-participation in this study will leave no impact on student’s final grades or assessments throughout the duration of the school year.

PRIVACY: The records of participants in this study include, but are not limited to test scores and attendance, which may be reviewed by investigators. Also, results of the study may be published, but no names or other identifying information will be disclosed in publication. All subjects’ identity will remain confidential unless otherwise advised by law.
FINANCIAL INFORMATION: There is no cost for participation in this study, nor is there any compensation to the student subjects and/or their representatives for participation.

SIGNATURES: This study has been discussed with me and all questions have been answered. I may direct additional questions regarding study specifics to the primary and/or co investigators. I will allow my child to participate in the study described above and acknowledge the investigator’s obligation to provide me with a signed copy of this consent form.

Parent Signature: ___________________________________________ Date: _____________
VITA

Kayla Brittany Daigle was born in 1990 on a United States Air Force base in Landstuhl, Germany. She attended primary and secondary school in Mississippi, where she graduated from Harrison Central High School in 2008. She attended Louisiana State University and earned her degree in Biological Sciences in August 2012. She entered the Graduate School at Louisiana State University Agricultural and Mechanical College through the Louisiana Math and Science Teacher Institute (LaMSTI) in May 2013. She was a high school science teacher at Brusly High School for three years.