

THE EFFECT OF DAILY QUIZZES ON STUDENT LEARNING IN THE
ADVANCED PLACEMENT CHEMISTRY CLASSROOM

by

Jolene A. Kayser

A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2015

©COPYRIGHT

by

Jolene A Kayser

2015

All Rights Reserved

ACKNOWLEDGEMENT

I would like to acknowledge all those who supported me during my action research. To my colleagues and friends who helped edit, provided feedback, and listened as I trudged through the research writing process, thank you. Your guidance has helped me develop into a more efficient teacher. To the staff at Montana State University, thank you for designing and facilitating a wonderful program. Through the Masters of Science in Science Education program, I have been able to expand both the depth and breadth of my science education knowledge. Finally, I would like to thank my husband, Bryan, who helped take care of the many small tasks, so that I could read, reflect and write.

TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND	1
2. CONCEPTUAL FRAMEWORK	3
3. METHODOLOGY	7
4. DATA AND ANALYSIS	9
5. INTERPRETATION AND CONCLUSION	19
6. VALUE	22
REFERENCES CITED	25
APPENDICES	27
APPENDIX A: Institutional Review Board Approval	28
APPENDIX B: Student Survey Questions	30
APPENDIX C: Interview Questions	33
APPENDIX D: Quiz Examples	35

LIST OF TABLES

1. Data Triangulation Matrix9

LIST OF FIGURES

1. Effectiveness of Quizzes as Self-assessment.....	11
2. Effect of Daily Quizzes on Study Time.....	12
3. Average Score Over Time Graph	13
4. Distribution of Quiz Scores	14
5. Comparison of Treatment and Control Content.....	16

ABSTRACT

Students taking advanced courses at Sturgis Brown High School struggle to manage time and homework along with other activities. In addition to learning how to better manage their time, students also need to develop study skills in order to be successful at the college level. Throughout a semester-long, Advance Placement (AP) Chemistry Course, students were given daily quizzes in lieu of homework. The purpose of this treatment was to identify if frequent assessments increased student learning over time. In addition, the study looked at changes in students' study skills and students' self-assessment. The study concluded that daily quizzes had a positive impact upon student retention and mastery of material.

INTRODUCTION AND BACKGROUND

Project Background

Teaching and Classroom Environment

As I approached the beginning of my second year of teaching at Sturgis Brown High School, I observed that students' time was spread thin between homework, jobs and a multitude of extracurricular activities. Students taking advanced classes were often faced with a lack of time to devote to all of their responsibilities. Academic assignments become just another task to be accomplished instead of an opportunity to learn and develop skills. As a result, it is difficult to use homework as a formative assessment to guide instruction because of the various possible reasons for low scores, such as lack of time to complete the assignment, working with a peer, copying a friend's assignment, or lack of understanding of the content. In order to reconnect homework with its intended purpose, practicing skills needed for mastery, I used daily quizzes in lieu of homework. Practice problems and answers were still provided. The intent was to assist the students in self-assessment of their understanding of the material, so they could modify their study habits in order to master chemistry content.

School Demographics

Sturgis Brown High School is a relatively large high school in South Dakota with approximately 700 students. The student population is 88.63% Caucasian, 3.24% Hispanic, 3.24% Native American and 2.45% multi-racial. Thirty three percent of the high school students have applied and qualified for free/reduced lunch (Meade School District, 2014). The school offers a wide variety of programs to enrich students' education such as welding, geometry in construction, internships and advanced placement

(AP) classes. The high school utilizes a modified four-by-four schedule, and as a result, the AP chemistry class meets everyday for 90 minutes for the first semester only. During the 2014-2015 school year, the high school implemented a one-to-one technology program, which provided each student with a school-issued MacBook Air for the academic year.

Class Demographics

I currently instruct two sections of AP chemistry with a total of 32 students. The majority of the students come from middle class parents, and a small portion of the students was raised in upper class households. Regardless of the socio-economic status of each student, he or she is very busy with work and/or extracurricular activities. Since the socio-economic status and schedule for the class is fairly homogeneous, I will instead focus on the prior academic experiences of the students. The sample group is composed of 17 juniors who are taking advanced placement classes for the first time. On the other hand, the sample group is also composed of 15 seniors, 13 of whom have taken a previous AP science class.

From both personal observation and discussions with other AP teachers at Sturgis Brown High School, I was aware that many students struggle with the transitions to a more rigorous course work. This is due to the fact that, for many of the students, this is the first year they are taking an advanced science course. Prior to this point, these individuals were typically the top 10% grade-wise in a class. The majority of the students are confident in their study skills, which have been very successful in the past. AP chemistry may be the first class that the students have struggled with, and for some of them, it is the first instance of failure on a small scale. In addition, to exploring the

chemistry content, the intent of AP courses at Sturgis Brown High School is to help develop the skills necessary to be successful in college, such as time management and self-assessment.

The above situation can be summarized in the following problem statement and question.

- Problem Statement: Students transitioning into advanced courses struggle with adapting their previously successful study skills.
- Question: How can I help improve students' study skills in preparation for college courses?

My primary research question is “What is the impact of daily quizzes in an Advanced Placement classroom.” In order to answer my primary question, I must first answer the following sub-questions:

- How do daily quizzes affect student retention /mastery of material?
- How do daily quizzes affect students' study skills?
- How does daily quizzes affect instructor planning?

CONCEPTUAL FRAMEWORK

Frequent Assessments

The effect of frequent or daily quizzes has been studied in multiple classrooms over the last decade. For example, in one study conducted in a middle school science class, quizzes were given over certain target topics and then the scores on these topics were compared to non-quiz scores (McDaniel, M. A., Agarwal, P. K., Huelser, B. J., McDermott, K. B., & Roediger, H. L., 2011). The results showed a significant difference

between quizzed and non-quizzed items. McDaniel and his colleagues stated that the quizzes caused the students to practice their retrieval systems in a low stake environment.

In other studies, the United State Department of Education found “that having students take a test is almost always a more potent learning device than having students spend additional time studying the target material” (Department of Education, 2012, p 2).

In addition to research at the middle school level, there have been multiple studies at the introductory college level. For example, Frank Leeming of the University of Memphis utilized an exam-a-day strategy in his four sections of under-graduate level psychology courses (n=192). Students were given two short essay questions each day, and then afterward, the class discussed and reviewed the correct answers (Lemming, 2002). Comparing the final semester grades, Leeming found that students exposed to a quiz-a-day had on average of an eight percent higher grade.

An article in the *Journal of Instructional Pedagogies*, “Formative assessment: the one-minute paper vs. the daily quiz,” the author compares the effectiveness of one-minute papers and daily quizzes. It was found that even though the one-minute paper required less preparation, the one-minute paper and short quiz took approximately the same amount of time to administer, especially if immediate feedback was given. Since quizzes tended to be more focused, post-quiz discussion typically took less time. In addition, it was found that the short quizzes were more effective because the student tended to be more motivated to complete them correctly. Students in the study were less focused and sometimes found the formative assessments as gimmicks. Finally, the author found that it sometimes took “a red-marked correction on their quiz” in order to finally be motivated to master the topic (Kwan, 2011, p 5). As result of the learning potential from a low

score on a quiz, I wanted to maintain that the quizzes were graded. This increased the level of concern for the students and provided an increased amount of focus when we reviewed.

Self-Assessment and Growth Mind Set

According to Carol Dweck, there exist two different types of mindsets that affect how people respond to challenges: growth and fixed mindsets (Dweck, C., 2008). A growth mindset views intelligence and believes abilities can be developed. On the other hand, a fixed mindset views intelligence as a fixed trait that cannot be improved. Each academic mindset is not tied to previous achievement. For instance, Dweck states “students who have a fixed mindset but who are well prepared and do not encounter difficulty can do just fine. However, when they encounter challenges or obstacles they may then be at a disadvantage” (Dweck, p.4).

For many of my students, AP Chemistry was the first class where they encountered difficulty. Before having students attempt to assess their understanding of chemistry concepts, I first wanted to discuss both growth and fixed mindsets and how we can enhance our growth mindset. Students were not surveyed in order to determine their primary mindset but instead attributes and strategies were discussed. Additionally, I strived to create a low stake environment by dropping the lowest quiz score for each student each week. This was done in order to provide an environment where it was “okay” to make mistakes because mistakes are part of the learning process.

Immediate Feedback

In the classroom, assessments are used in order to provide feedback on mastery of material and to guide instruction. A study at Rider University combined mastery with

immediate feedback by creating the Immediate Feedback Assessment Technique (IT AT). Students were given feedback on their answer choices by using a scratch ticket form of an answer sheet. Psychology students were either given a scantron answer sheet or an IT AT form. The IT AT form allowed students to scrape off their initial answers, and if a star was present, then their answers were correct. If students did not initially get the correct answers, then they could choose another answer (Epstein, M. L., Lazarus, A. D., Calvano, T. B., Matthews, K. A., Hendel, R. A., Epstein, B. B., & Brosvic, G. M. 2010). The study found that using the answer until correct method was effective in correcting misconceptions resulting in better score the next day and the following week.

In addition, the study was duplicated using a paper form and a computer program that also allowed for the answer-until-correct method. During this trial, students taking the computer assessment did not show the same improvements over time as the paper ITAF form even though they also received immediate feedback. The authors go on to hypothesize that a slight delay in feedback may be more effective because it forces the students to make deliberate choices.

Even though Epstein, et al., found that computerized assessment did not increase retention, I hypothesize that this may be a result of the types of questions asked. For example, the psychology questions may have been of a conceptual manner while a typical question in my study was quantitative required calculations. As a result, my students would need to recalculate, which would cause a delay in their next choice selections.

For my action research project, I wanted the students to learn from the daily assessments in order to gain mastery of the material. Therefore, it was important to provide feedback in a timely manner. In my research, students received immediate

feedback regarding their scores but a longer delay in going over the results. Students were encouraged to meet with me to discuss their individual scores and often we discussed the quiz results as a class.

METHODOLOGY

The treatment in this study was the implementation of daily quizzes for my AP chemistry classes. The Montana State University's Institutional Review Board approved an exemption for the methodology used in this project and the project maintained compliance for working with human subjects (Appendix A). Quizzes were teacher-generated, but modeled after released advanced placement exams and homework practice problems. The majority of the quizzes were given using the "Schoology" learning management system, which is an internet-based system. Approximately 95% of the quizzes were given on a computer with 5% being print quizzes. The unit tests were two-part, with 50% on the computer and 50% on paper. The treatment period started during the second week of the semester and lasted 16 weeks. Each day in AP Chemistry, the students took a short quiz about topics that had been covered since the beginning of the school year. The material covered within the previous two school days was not eligible for the quiz in order to provide students time to practice and make up in the event if they were absent. Ungraded homework was strongly recommended, but was not collected. Instead, students had access to the solutions for the assigned problems. Students were informed that quizzes were modeled after the homework assignments.

Daily quizzes typically took five to ten minutes. Immediately after each quiz, students received immediate feedback about their scores. In addition, I received near real-time data about the average score for each question and what percentage of students

selected each choice. Once all students had taken a daily quiz, it was then unlocked, so learners could see both their responses and the correct answers. Each week, 15 weeks the lowest quiz grade for each student was eliminated in order to emphasize that quizzes are part of the learning process and we should grow from our struggles. In addition, dropping low quizzes helped reduce some of the stress for the students in order to provide an encouraging learning environment.

Instrumentation

In order to determine the effect of daily quizzes, the following data collection devices were used: teacher journal, teacher observations, student surveys (Appendix B), student interviews (Appendix C), quiz/test set results.

Throughout the process, I maintained a reflection journal that captured both observations and my reflections on the process. Included in the journal were quotes from students, ideas for modification, notes on struggling topics and possible trends.

Additionally, I surveyed and interviewed the students to determine how the daily quizzes changed learners' study skills. The surveys utilized free response questions, numerical reporting of study time/habits and Likert scale questions. The purpose of the free response portion of the survey was to gather information about students' feelings regarding the quizzes and later student interviews expanded upon those responses. Students were asked to track their study time and to report their study habits during the survey. Finally, the surveys asked the students to evaluate how the quizzes affected their mastery of material using a Likert scale. After the surveys, I interviewed two to four students from each class to clarify and expand upon the survey results. The students who were interviewed volunteered based on their schedule availability.

In order to gain a better understanding about how quizzes affect student retention, I created sets of similar quizzes over key topics. I administered the quiz sets to every student in AP chemistry as part of students' normal daily quizzes. Each set of quizzes consisted of at least three formative assessments covering the same standards but may vary based on numbers for calculations or chemical reactions. In addition, three sets of quizzes were administered over the following topics: stoichiometry, Lewis structures and reduction/oxidation reactions. Example quizzes are located in Appendix C.

Table 1 *Data Triangulation*

Research Questions	DATA SOURCE		
	1	2	3
Sub-question 1 How do daily quizzes affect student retention /mastery of material?	Pre, During, Post and Follow-up Quizzes	Unit Tests	Teacher Observation/ Journal
Sub-question 2 How do daily quizzes affect student study skill?	Interviews	Student Surveys	Student Study Time Tracking Sheets
Sub-question 3 How do daily quizzes affect instructor planning?	Teacher Journal	Teacher Observations	NA

The data collection techniques were reviewed by my support committee, which was composed of colleagues. These colleagues had experience with both research and the students involved, and this helped to insure validity in my study. In addition, teacher observation, pre/post-quizzes, and student surveys were utilized in previous research on frequent assessments

DATA AND ANALYSIS

As part of my data collection, I utilized student surveys, student interviews and multiple quizzes over numerous weeks. The purpose of collecting this data was to answer the following sub questions:

- How do daily quizzes affect student study skills?
- How do daily quizzes affect student retention /mastery of material?

Students completed multiple study skills surveys throughout the course of AP Chemistry. In addition, at the end of the course, a random sample of students was interviewed in order to clarify and expand upon survey results. A copy of the survey and interview questions are provided in Appendix A and B respectively. Multiple trends were found in both the interviews and survey results.

One of the most prominent trends was the transformation of students' perspective on missing a problem on the quizzes. Of the 32 students, 31 stated that they consistently checked their scores immediately after completing the quizzes. Initially about 50% viewed missing a problem or earning a low score with frustration and made comments, such as "It makes me angry when I miss problems," or "I feel stupid when I miss questions." On later surveys, many of the students that initially responded with frustration started to make comments that "missing a problem shows them what they need to study more." Conversely, if they did well on quiz then they felt they had a good understanding of the material. This shows transformation in the thinking of many of the students as they begin to use the quizzes as a learning opportunity and a chance to assess their own learning. Additional evidence of this change is that throughout the semester, students reported reviewing old quizzes more often and requesting access to quizzes that had not been unlocked yet. The increase in reviewing of older quizzes can be attributed to the use of an online learning management system that organized the access to previous quizzes. The students began to use the older quizzes to study for both upcoming tests and the

final. Finally, during the end of semester survey, students were asked if the quizzes helped them self-assess. The results are found in figure 1 below.

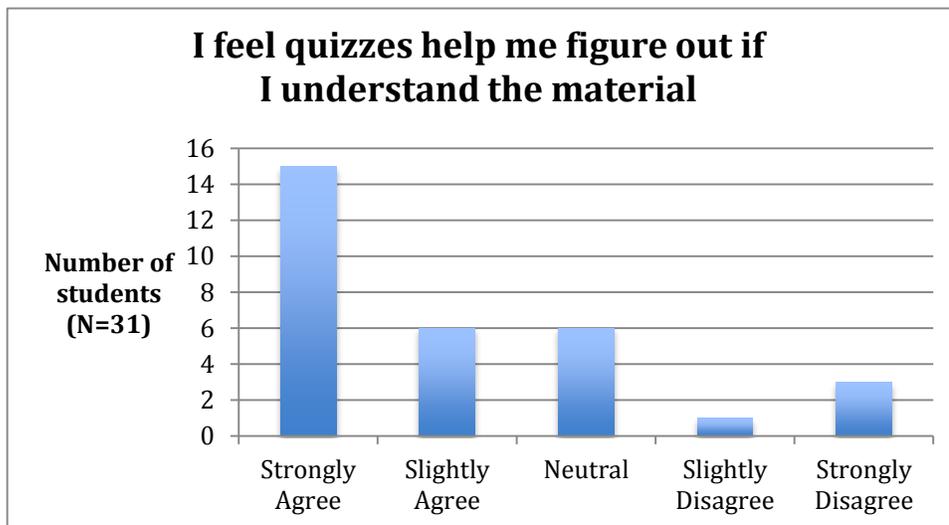


Figure 1: Effectiveness of quizzes as self-assessment.

A majority of the students agreed that the quizzes were beneficial in determining if they could successfully accomplish a certain objective. Four students felt that the quizzes did not help them assess their understanding of the material. Based on observations and discussions with the students, a low score resulting from different problems could become overwhelming for them. There appeared to be a threshold of concepts that needed to be corrected before the feedback was effective. For example, if a student missed one or two problems out of twelve then he or she could focus on the concept or calculation he or she did not understand. On the other hand if a student missed a significant amount of points on a quiz, then it was hard for the student to focus on particular areas where they needed to improve. Based on teacher observation, this trend was stronger when the quiz was over a broad range of topics. For example, if a quiz included questions about reduction/oxidation reactions, thermochemistry, and

stoichiometry, and a student missed three problems out of nine, it became harder for the student to process that information.

In addition, throughout the semester, there was a student who interpreted any mistakes as a fault of the course. This mindset was detrimental to the student's success in the course. Even when the student was shown the improvement over time, more focus was still given to the mistakes.

Furthermore, students were asked how the daily quizzes affected their study time.

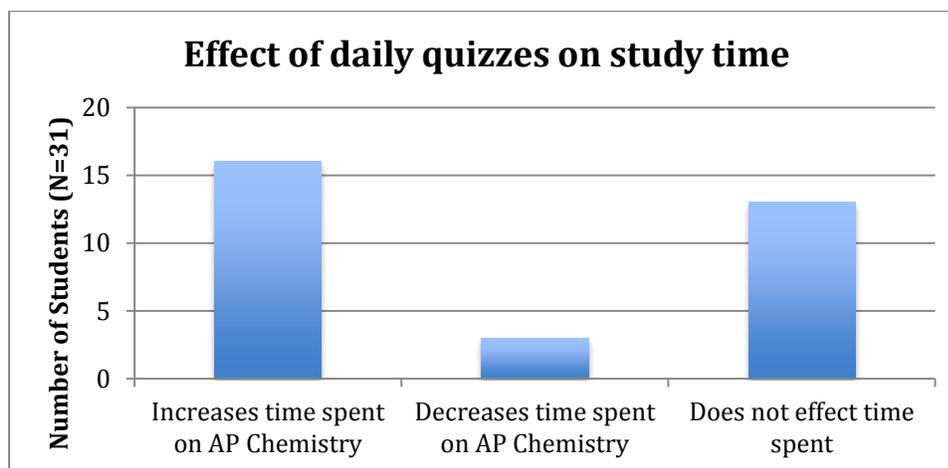


Figure 2: Effect of daily quizzes on study-time.

Initially it appeared that for 50% of the students, daily quizzes had no effect on study time or decreased the study time, which was not the desired result. Yet, when they were interviewed, the students explained that the quizzes reduced the amount of study time required because they had a better idea about what to study. Furthermore, the students stated that the major hindrance to using the quizzes to identify strengths and weaknesses was the time-delay in having access to see their individual results.

In addition to interviews and surveys, pre/during/post and follow-up quizzes were utilized and the average score was tracked over multiple weeks. Each quiz topic had a set

of quizzes that are very similar in difficulty and question type but unique in the actual answers. The pre-quiz was given before the topic was covered during class and the during-quiz was given within a week of the topic being covered. Additionally the post-quiz was given either during the unit test or shortly after. Finally the follow-up quizzes occur every three-four weeks until two follow up quizzes are complete. Example quizzes are located in Appendix C. In Figure 3, the class average is plotted for three different topics and five different timeframes. There is an additional gain of points to reach the peak of the summative post-quiz. The average score drops during the first follow-up-quiz but then rises slightly during the second follow up quiz. The initial drop in score was between five and ten percent for the class average.

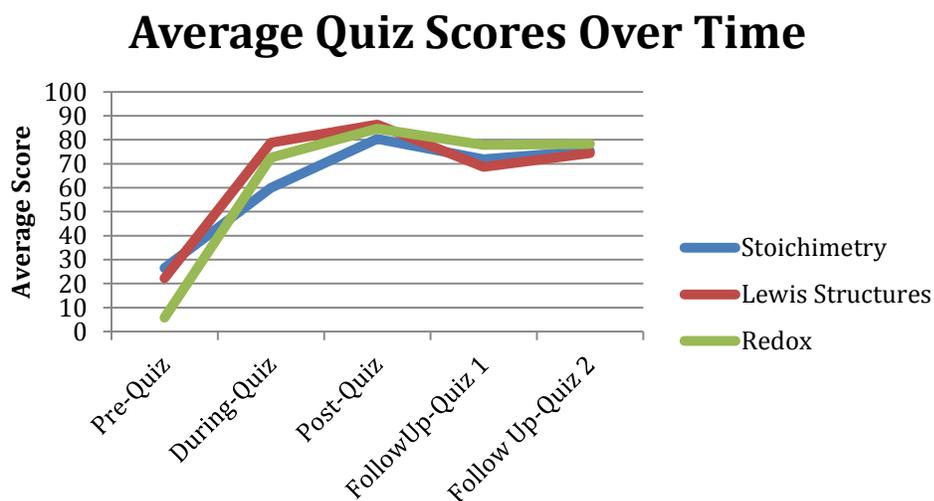


Figure 3: Average score over time graph, ($N=32$).

When students were asked about their confidence levels after the follow-up quizzes, the consensus was that they remembered most of the information but forgot some of the finer details. For example, one student stated “it seems like we move so fast... it has been a long time since we talked about it and I couldn't remember some

parts.” Even though, the post quiz and the initial follow-up quiz were only two or three weeks apart, we had covered a vast amount of information during that time. I hypothesis that the drop in retention was due to the natural forgetting of information especially as new skill are being assimilated. The secondary rise of the score can be attributed to the review of previous quizzes including the follow-up quiz.

Additionally, the individual scores of the quizzes were tracked and plotted in figure 3. As mentioned earlier, with the follow-up quizzes there is “slippage” of the average score. For example, average score for the during-quiz was 84% and the follow-up scores were distributed around 80% for the reduction-oxidation reaction (REDOX) topic. Based on interviews with the student and review of the missed problems, a majority of the students understood the content but made computational mistakes or tried erroneously to apply newer concepts to the older material of the follow-up quizzes.

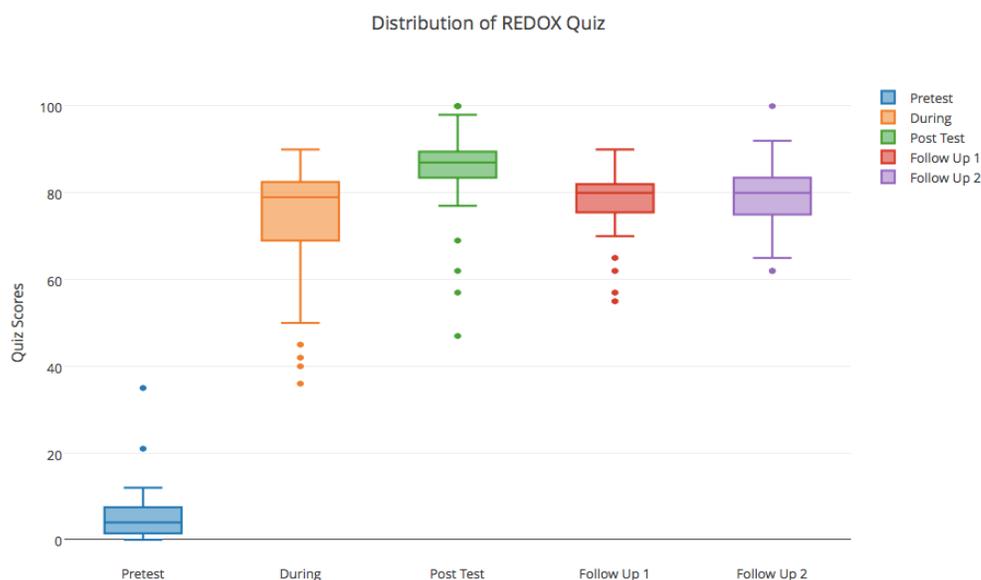


Figure 4: Distribution of REDOX quiz results, ($N=32$).

In addition, to analyzing the average score, Figure 4 also shows the distribution of scores. As students were re-exposed to a certain topic multiple times, the number of outliers decreased. I observed that most struggling students sought help once they realized that the topic was not going away. There were a few students who struggled but would come not seek extra help and they remained as either a lower outlier or at the lower range of the scores. In general, the same students continued to be the lowest scores but two students made significant progress in their average scores throughout the semester. Initially, their average scores for week three were 53% and 57% and then at the end of the semester (week 16) their average quiz scores were 82% and 81%. This increase in scores can be attributed to constant review and that the student sought extensive small group instruction.

The value of small group instruction either from a peer or from myself was crucial in closing the gap between the outlier and the majority of the class. The students that were able to increase their score the most, were successful because they sought help and then reattempted problems until they were confident. Through working with students during these small group sessions, I was able to coach the student through the analysis of the problem. When reviewing previous quizzes with students, some would ask questions like “How do I know to use Hess’s Law?” or “Where do I even start on this type of problem?” We would then discuss indicators that a particular problem required a certain technique in order to solve.

It appeared that the students struggled with determining what strategy to use because they had a plethora of tools at their disposal but no all were necessary for a particular problem. I believe that this challenge is encountered when quizzes or exams are

cumulative because students are asked to decipher problems and then apply the correct tactic to complete the problem. Since all quizzes and exams were cumulative during this course, I do not have any data on the effect of frequent quizzes on the ability to choose the correct strategy.

To gain a better understanding of how daily quizzes affected retention of material, I graphed the class average score on treatment problems and a control topic of empirical formulas. For each of the topics assessed, the average score decreased from the unit test to the final. This decrease can be attributed to the rigor of the cumulative timed final. Compared to the treatment topics, the control topic (empirical formula) scores decreased significantly as shown in Figure 5.

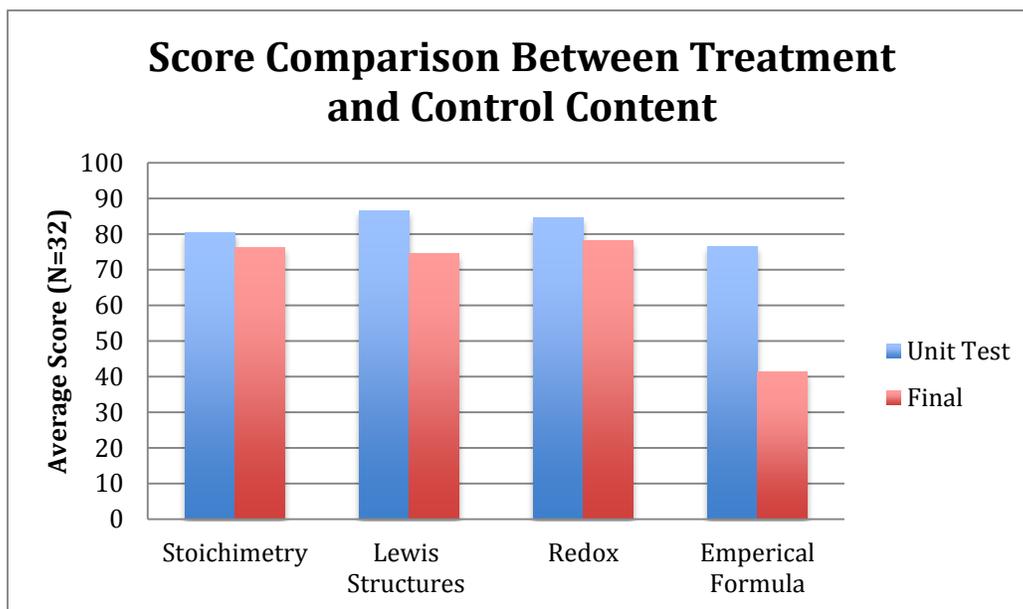


Figure 5: Comparison of treatment and control content, ($N=32$).

This drop in retention was a result of students being confident in their abilities, based on previous success, without actively reviewing the topic. For example, after the final, one student asked, “when did we cover empirical formulas?” In addition, since the topic was

not repeatedly reviewed on quizzes, then students interpreted it was a less important topic of the course. Since the premise of the frequent quizzes was to have repeated exposure to key topics, a bias of important topics was introduced.

In the reflection journal I kept as the instructor, there was the common theme of being overwhelmed by quiz creation. The additional responsibility of creating unique quizzes would not be sustainable for multiple courses. An instance of this can be seen from the following comment in my reflection journal “This week we are covering solubility rules, K_{sp} , ionic and covalent bonding. I don’t know what to focus on. There are a lot of different topics that could be quizzed.” During this quote, I was as overwhelmed as the student at the vastness of material needing to be taught. I lacked depth of knowledge of the AP curriculum to be able to prioritize the essential topics that need to be reviewed. Equally important is that as I gain experience in distinguishing the crucial topics, the burden of creating quizzes will also be less since many were created this year. In future years, questions will need to be refined or revised but majority of creating has been accomplished. In fact, towards the end of the course as I was preparing online reviews, I commented, “It is nice to have a stock-pile of questions.”

In addition, another common theme was the value of near real-time data and repeated exposure. I observed that the students thrived when they received immediate scores and that they wanted to see immediately what they got wrong. It was difficult as an instructor to balance the desire to unlock the quizzes for the students to see their individual results and the need to keep the quizzes locked in order to maintain the quizzes validity. For instance, students would see their scores and would like to know, what particular problems they missed. I felt that this was an important study strategy and I

want to foster it but at the same time I needed to main the validity of the quiz for those who had not taken the quiz yet.

Furthermore, the concept and application of time management was a strong theme in my reflections. It was difficult to judge how much time to allocate for each quiz. I felt it was important to provide enough question on each quiz that missing one or two problems would not result in failing the quiz. Additionally, when we had time to go over the quiz results as a class, the discussion could easily take longer than expected. For instance, I noted in my reflection journal multiple times, “discussed two questions but took way too long- some students were really interested but other were disengaged.” Throughout the discussions, I tried to stress the need to seek individual help if they were not achieving the scores they wanted. Yet, many students preferred to use class-time and thus it was a classroom management concern. My students and I noted that the quizzes and post-quiz discussions were rushed. As the semester progressed, my ability to judge the amount of time increased and time management became less of a concern. Yet, the amount of time used for both the actual quiz and the discussion afterwards needs to be a factor in future studies.

Finally, it was noted that students were not as confident with topics that were not quizzed repeatedly. It appears they did not retain as much of the content as was seen in Figure 5. I also observed during class discussions that students were more confident with topics that they were recently quizzed about. For that reason, as the semester evolved, I re-introduced previous topics using the daily quizzes if future problems built upon older concepts.

INTERPRETATION AND CONCLUSION

The data was analyzed to answer the question posed, “what is the effect of daily quizzes in the AP chemistry classroom?” To effectively conclude the effect, one must connect the data analysis to the focus questions.

How do daily quizzes effect student retention/mastery of material?

Through daily quizzes, students were repeatedly exposed to the material, which prevented the typical drop in retention. In figure 3, it is observed that the peak scores were on the unit test and then there was a slight drop in average scores. Comparatively, there was a much more significant drop in retention of material if the topic was not included in the quizzes. Based on observations in my reflection journal, there is a significantly larger drop in retention when a topic was not repeatedly quizzed. It is inconclusive whether the results of drops in retention are consistent among all topics covered but not quizzed. Additional studies will need to be done to determine if retention of material is based on repeated exposure, frequent inclusion in quizzes, or inherent to the topic. For example, names of elements were not frequently quizzed nor deliberately reviewed in class. Yet, the retention and mastery of the topic increased throughout the semester based on frequent usage.

In addition, as a topic was quizzed multiple times, the number of outliers and the gap between the majority of students and the outliers decreased. This is evidence that the quizzes helped close the gap for struggling students. Repeated exposure to the topic provided students multiple attempts to master the material throughout the course. Additionally, once students were quizzed multiple times on a topic, they understood that

the topic was not going to go away. As result, many students came in for small group instruction in order to master the material.

How do daily quizzes effect student study skill?

It can be concluded that daily quizzes assist student success when determining study focus. Survey data shows, 21 of 31 students stated that frequent quizzes help them determine what they understand and what they need to review.

Based on the data, it is impossible to determine if frequent quizzes made a positive effect on study time because the amount of study required by students is inherently unique for each student. Yet, based on interview results, students' feelings about the quizzes transformed from reluctant acceptance to slight approval. Initially, students did not like the idea of very frequent quizzes. However, by the end of the semester, students had found that the quizzes helped them review the material.

The frequent quizzes helped the students distinguish which topics were crucial to the course and their mastery of the material. Based on their self-assessments, the students were then able to better manage their study time. In addition, students were able to see their progress over the semester. When covering particularly difficult concepts, we discussed how they had improved on other topics since the beginning of the course. This discussion promoted a growth mindset. Additional study needs to be done in order to determine how frequent quizzes affect the mindset of students.

I did have students who were adamant that the quizzes did not help them review and learn. Some individuals were overwhelmed by all of the available information. They could not make a connection between difficulty on the quiz and learning from that difficulty what they needed to study to prepare for the test. I question the maturity levels

of these students and wonder if they would have been better served by waiting another year to take the class. Some of the students who disliked the quizzes and who felt they were not helpful showed no meaningful insight to prove that the formative assessments did not help them. Even though these students did not feel that the quizzes help them retain the information, their quiz scores increased over time and their overall grade in the class was above average.

How do daily quizzes affect instructor planning?

Incorporating daily quizzes into instructor planning time resulted in both positive and negative effects. Initially, the time required to create the quizzes was overwhelming and cumbersome. Additionally, it took time and organization to manage the unlocking of quizzes once all students had completed each quiz. Without the opportunities and capabilities a one-to-one school provides, the workload required could easily result in burnout.

Also, when I implemented the treatment plan – the daily quizzes, I told students I would not quiz them over anything covered in the previous two days. This decision handicapped my ability to assess whether the students had the prerequisite skills for future topics within the same week.

On the other hand, the daily quizzes provided me as the instructor a rich view of student understanding. I could see what topic the students needed to review and then incorporate the review in the schedule. Therefore, a couple of days after the review, the students could be re-quizzed over the same topic and the process could begin again.

The purpose of my action research was to aid AP chemistry students in developing study skills along with increasing students' retention. The data shows that

frequent quizzes are useful in increasing student retention, but they can be overwhelming for both the teacher and the students. The immediate feedback, however, was the greatest advantage of daily quizzes because it increased student ownership of the material.

In order to determine the effectiveness of daily quizzes, more studies need to be accomplished. For example, this study brought focus to student's problem solving abilities on cumulative assessments. Further study should be done to determine if daily quizzes on a wide variety of concepts improve student skills in identifying the strategy necessary. Additionally, daily quizzes were helpful because they provided the student and the teacher with frequent and timely feedback. Yet, results are inconclusive about the optimal delay in feedback for students. Future studies should determine the effect of waiting until the next class day to provide student feedback and discuss the quiz results.

VALUE

This capstone project has colored how I implemented one-to-one technology in my classroom. Utilizing daily quizzes would be almost impossible without the use of technology. Daily quizzes could be accomplished with pen and pencil but the effectiveness would decrease based on the delay in feedback for the students. Furthermore, using electronic quizzes helped organize the student's study material. Instead of students losing track of old test or quizzes before the final, the students could instead review the material online.

Based on my experience with daily quizzes during this capstone, I have incorporated weekly quizzes in my regular chemistry courses. In these quizzes, I included review problems in additions to a typical weekly quiz. In addition, I modified the policy regarding my earlier decision to not include any material covered in the previous two

school days. Instead, the question is worth zero points; although the lack of points does not help nor hurt the students' grades, it does provide the instructor more information in order to plan future lessons.

The next time I teach advanced or AP Chemistry, I plan to again use frequent quizzes, but I will modify the implementation. For example, I will utilize an asynchronous mastery-based curriculum. I plan to make the quizzes mastery-based where students will have multiple attempts to demonstrate understanding. In order to effectively implement mastery-based program I will have to incorporate lessons learned from this study and begin to compile a multitude of questions. Even though the students may not take a quiz everyday, there will still be frequent quizzes, which will include material previously covered. The inclusion of review material will help the students develop the question decoding skills as they have to decipher which strategy to use in order to solve a particular problem.

Additionally, based on student comments, I will include review quizzes as part of any class I instruct to improve the retention of key concepts. As a result it is imperative to determine the essential skills that must be mastered as part of the course and then assess that skill often. For example, in our regular chemistry course, our science department is determining the essential skills that must be mastered in order to be successful in chemistry. Based on the results of this study and the score comparisons found in Figure 5, these objectives will be incorporated in quizzes throughout the course. The frequent recall of review topics assist in maintaining proficiency.

Results were inconclusive on how frequent quizzes affected student study skills and more research is needed. I plan to use the frequent mastery quizzes in order to help

the students develop additional study skills. Through the use of numerous mastery-quizzes, I can work with student's to develop the skills necessary to decipher the correct strategy.

REFERENCES CITED

- Dweck, C. (2008). Mindsets and math/science achievement. Retrieved on April 5, 2015 from http://www.growthmindsetmaths.com/uploads/2/3/7/7/23776169/mindset_and_math_science_achievement_-_nov_2013.pdf
- Epstein, M. L., Lazarus, A. D., Calvano, T. B., Matthews, K. A., Hendel, R. A., Epstein, B. B., & Brosvic, G. M. (2010). Immediate feedback assessment technique promotes learning and corrects inaccurate first responses. *The Psychological Record*, 52(2), 5.
- Kwan, F. (2011). Formative assessment: the one-minute paper vs. the daily quiz. *Journal of Instructional Pedagogies*, 5, 1-8.
- Leeming, F.(202).The Exam-A-Day Procedure improves performance in psychology. *Teaching of Psychology*, 29 (3), 212
- McDaniel, et all (2011) Test-enhanced learning in a middle school science classroom: the effects of quiz frequency and placement. *Journal of Education Psychology* 103: 399-414
- Meade School District 46-1. (2014). Annual Report 2013-2014. Retrieved May 8, 2015 from http://www.meade.k12.sd.us/offices/pdf_files/2013-14%20District%20Annual%20Report.pdf
- United States Department of Education. (2012). Teaching Community, Quizzing Works, the Evidence Says, Retrieved November 22, 2014 from <http://teaching.monster.com/benefits/articles/5051-quizzing-works-the-evidence-says>

APPENDICES

APPENDIX A
INSTITUTIONAL REVIEW BOARD APPROVAL



INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 0000165

940 Technology Bldg, Room 127
c/o Immunology & Infectious Diseases
Montana State University
Bozeman, MT 59718
Telephone: 406-994-6783
FAX: 406-994-4503
Email: cheryl@montana.edu

Chair: Mark Quinn
406-994-5721
mquinn@montana.edu
Administrative:
Cheryl Johnson
406-994-6783
cherylj@montana.edu

MEMORANDUM

TO: Jolene Ann Kayser and Walt Woolbaugh
FROM: Mark Quinn, Chair *Mark Quinn Chy*
DATE: December 3, 2014
RE: "The Effects of Daily Quizzes on Learning in the AP Chemistry Classroom" [JK120314-EX]

The above research, described in your submission of December 3, 2014, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.
- (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
- (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX B
STUDENT SURVEYS

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way

Please complete the survey.

- What is your estimated amount of time you spend on AP chemistry outside of class each day?
- Do daily quizzes increase the amount of time spent on AP Chemistry, decrease the amount of time spent on AP chemistry or have no effect on the amount of time?
- Out of 5 quizzes, how many times do you check your score online?
- Out of 5 quizzes, how many times do you review the right and wrong answers once the quiz has been unlocked?
- Are you part of a study group for AP Chemistry?
- After you miss a problem or do not do well on a quiz, what are your thoughts?

Study Habits

Over the last two weeks, how many minutes have you spent on AP chemistry each night?

- 0-10 min
 10-20 min
 20-30 min
 30-40 min
 40-50 min
 50-60 min
 Longer than a hour each night

Study Habits

Out of the last five quizzes, how many times did you reopen the quiz to check which question(s) you got wrong.

- 1
 2
 3
 4
 5

Study Habits

What strategy do you use to improve your quiz scores? (choose all that apply)

- Review old quizzes
 Complete the suggested homework
 Attend study sessions
 Complet homework with friends
 Ask questions before or after school
 Re-watch videos
 Other:

Mastery

I feel that the quizzes help prepare me for the unit test.

1 2 3 4 5

Strongly Agree Strongly Disagree

Mastery

I feel the quizzes help me figure out if I understand the material.

1 2 3 4 5

Strongly Agree Strongly Disagree

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way

APPENDIX C
INTERVIEW QUESTIONS

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way

- Do daily quizzes increase the amount of time spent on AP Chemistry, decrease the amount of time spent on AP chemistry or have no effect on the amount of time? Why did you put the answer you did?
- How do you think you could improve in the quizzes?
- What was the best part of the daily quizzes?
- What was the worst part of the daily quizzes?
- What advice would you give to a future AP chemistry student?

APPENDIX D
QUIZ EXAMPLES

1. Balance the equation (Remember to still include 1 on the blank if 1 is the coefficient)



2. Which of the following is the name of $\text{Al}_2(\text{SO}_4)_3$?

- A. Dialuminum Trisulfate
- B. Dialuminum Sulfate
- C. Dialuminum Sulfite
- D. Aluminum Sulfate
- E. Aluminum Sulfite

Answer: (just put the letter)

3. To the nearest whole number, what is the formula weight of copper sulfate? amu

4. How many grams of $\text{Al}_2(\text{SO}_4)_3$ will be formed if you start with 74.44 grams of copper sulfate and you have an excess of Aluminum metal?

 grams of $\text{Al}_2(\text{SO}_4)_3$ (Round to the tenth place- 1 decimal)

5. In 1 molecule of $\text{Al}_2(\text{SO}_4)_3$ how many atoms are there? atoms

1. Balance the equation (Remember to still include 1 on the blank if 1 is the coefficient)



2. Which of the following is the name of Na_2SO_4 ?

- A. Disodium Monosulfur Tetra Oxide
- B. Disodium Sulfate
- C. Disodium Sulfite
- D. Sodium Sulfate
- E. Sodium Sulfite

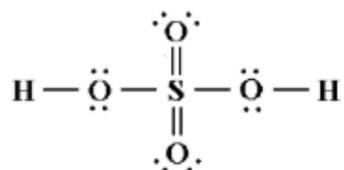
Answer: (just put the letter)

3. To the nearest whole number, what is the formula weight of sodium hydroxide? amu

4. How many grams of Na_2SO_4 will be formed if you start with 200.0 grams of sodium hydroxide and you have an excess of sulfuric acid?

 grams of Na_2SO_4 (Round to the tenth place- 1 decimal)

5. In 1 molecule of Na_2SO_4 how many atoms are there? atoms



Refer to the lewis structure of sulfuric acid to answer the following question.

What is the hybridization for the left oxygen atom? _____

What is the hybridization for the sulfur atom? _____

What is the effective bond order for the Sulfur atom? _____ (round to 2 decimal places #.##)

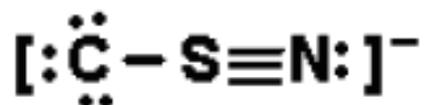
In the entire structure, how many sigma bonds are there? _____

In the entire structure, how many pi bonds are there? _____

What is the formal charge on the sulfur atom? _____

What is the formal charge on the top-most oxygen atom? _____

What is the formal charge for the over all molecule? _____



Refer to the lewis structure to answer the following questions.

What is the hybridization for the sulfur atom? _____

Sulfur has _____ unmorphed p orbitals.

In the entire structure, how many sigma bonds are there? _____

In the entire structure, how many pi bonds are there? _____

What is the formal charge on the nitrogen atom? _____

What is the formal charge on the carbon atom? _____

What is the formal charge on the sulfur atom? _____

(Yes or No) Is this lewis structure likely to exist? _____