

THE EFFECTS OF DAILY QUIZZES ON STUDENT ACHIEVEMENT  
IN A CHEMISTRY CLASS

by

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## ABSTRACT

Students often struggle for their first time in high school when taking chemistry. The complex nature of the course along with the high level of problem solving makes the course challenging for a lot of students. In order to do well in chemistry, students need to learn a new language, love math, think often, and spend time at home practicing each day's lessons. Students therefore need to develop good study habits to ensure success in a high school chemistry course. During an 4-week window students were divided into two treatment groups. Treatment group A were given ten to fifteen minute quizzes every other day. These quizzes were valued at less than 5% of their overall grade, and their grades could be improved upon by demonstrating mastery on the unit test. The control group, B were not given access to the quizzes. The study compared the results and concluded that students who took quizzes frequently earned higher scores on the unit test and earned higher grades for the subsequent marking term.

## INTRODUCTION

I teach at a school in Essex, Vermont with approximately 1200 students. I currently instruct 2 sections of chemistry 200 with a total of 40 students. The class is considered a 200 level, meaning it is more advanced than a 100 level, and moves at a faster rate.

Currently, students use their lab reports, classwork, and homework grades to boost their overall grade in the class. Since my school is moving towards separating formative assessments out of the student's actual grade, I want to make sure my students develop better study skills to enable them to achieve greater knowledge and be able to show it on the summative assessments. It is my belief students struggle on the summative assessments because they have a hard time with cumulative aspect of these high stakes tests and do not know how to prepare properly. I also believe these same problems cause many of our college students to struggle. The above situation can be summarized in the following problem statement and question:

- Problem Statement: Students struggle with the challenging nature of chemistry.
- Question: How can I help improve my students' study habits and develop the confidence needed to learn the material and improve their summative assessment scores?

My primary research question is, "will frequent formative assessments (quizzes) positively impact student learning in a chemistry classroom?" In order to answer my question, I must first answer the following sub-questions:

- What is the impact of increased quizzing and credit recovery on student achievement?
- How do students perceive the value of increased quizzing and credit recovery?
- What is the impact of increased quizzing on the curriculum pacing?
- What types of post quiz enrichment activities can be used to help struggling students?

### CONCEPTUAL FRAMEWORK

There are a large number of studies on the benefits of using formative assessments in the classroom. These assessments can be given to the students in many ways. Formative assessments can be given daily or weekly and can be used for extra credit, for self-reflection only, or as parts of the students' grades. The literature reviewed will address the best practices in using formative assessments to improve self-regulation thus improving student achievement as measured by their summative assessment test scores.

Black and Wiliam (1998) defined formative assessment as “all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged” (pp. 7-8). Summative assessments according to Garrison and Ehringhaus (2007) “are given periodically to determine at a particular point in time what students know and do not know” (p.3). They happen too late in the process to provide information to the teacher. At this point teachers are unable to make instructional adjustments and interventions during the learning process. Formative assessments need to be used to make these adjustments



and interventions. In this sense, “formative assessment informs both teachers and students about student understanding at a point when timely adjustments can be made” (p.3-4).

Most importantly, through the use of formative assessments students can develop the skills needed to self-assess. Nicol and Macfarlane-Dick, D. (2006) stated “if students are to be prepared for learning throughout life, they must be provided with opportunities to develop the capacity to regulate their own learning as they progress through higher education” (p.215) Students will then be able to ask meaningful questions of their teachers and prepare for the rigors of exams.

There are many examples of teachers from all subject areas using formative daily or weekly quizzes to increase self-reflection and learning. Palmen, Vorstenbosch, Tanck, and Kooloos (2015), focused in Anatomy & Physiology, and found more frequent participation in formative quizzes correlated to higher scores in the summative exam. Shirvani (2009), a math professor, found the use of daily quizzes increased achievement. Zhang and Henderson (2015), attempted to use formative quizzes prior to each unit test in a Physical Examination class for students who were pursuing becoming chiropractors. They concluded, that the two sections of students who were given the formative quizzes prior to the exams had significantly higher scores on their summative exams (p. 16). Yalaki and Bayram (2015), however, concluded that the formative quizzes used in a chemistry course, for non-majors, didn’t have a positive effect in every case. They stated that “students need to be educated about the use of formative assessments ahead of time to help them take advantage of the opportunities” (p.151).

Formative assessments can be used in a variety of ways. Teachers can choose to grade the students' work, offer extra-credit only, or make the assessments optional. Assessments could also be computer taken or hand completed. In all cases immediate feedback followed the assessments. Johnson (2006), offered his students 28 optional, unscored quizzes. Not surprisingly, only 10% of the students decided to take the quizzes. "It appears that the majority of students were unmotivated to use the online quizzes" (p.69). Muchovej (2009), also found students unmotivated to use optional on-line quizzes. Less than 50% of the students decided to use the practice quizzes to prepare for exams in a biology course for non-science majors.

Teachers choosing to give points for the quizzes had more students' success and greater participation. Kibble (2007) administered online multiple choice quizzes. He found, like Johnson (2006), that in the absence of course credit, students did not participate in the quizzes. When offered credit, quiz participation increased as did their exam scores. James and Williams (2014), also found success with giving points for completed online computer assessments. The four online quizzes accounted for 20% of the students' final grade. Students could access the quizzes anytime and spend as much time as they liked working on the quizzes. All of the students during the study completed the quizzes. There was found to be a positive correlation between the time spent on the quizzes and the total quiz score, however, this did not translate into unilateral success on the exams. Unfortunately, the computer-aided assessments (CAA) didn't seem to help the weak students catch up with their stronger classmates, even when they "have practiced to the point of getting full marks for their CAA quizzes" (p.279). Dobson (2008), also used

online quizzes to enhance class preparation. These quizzes, however, were given before the material was covered, forcing students to read ahead and prepare for the lectures and discussions. Each quiz was worth one percent of the final grade and were required. The quizzes were considered “non-threatening” with such a low point value. Students’ scored significantly better on the exams as a result of “more effective class preparation” (p.301). Poljičanin, Vilović, Marinović, Aljinović, and Grković (2009) offered students extra credit for completing daily mini-quizzes. A reward system was established for students answering eight out of ten questions correctly. Students could earn a maximum of 17 points on each exam. As a result of the quizzes, 60 % of the students passed the Anatomy & Physiology course during their first attempt, compared to only 40% prior to the quizzes. The authors concluded that the use of min-quizzes was a great way to encourage and monitor students. By administering formative assessments, teachers can track student progress and encourage students to study daily, rather than cramming right before an exam, thus increasing their chances of success in the class.

Formative assessments in the form of quizzes can be given daily, a few times a week, or weekly. Palmen, et al. (2015), examined the differences between giving daily or weekly quizzes. Students were given the option of taking daily or weekly quizzes. When surveyed students much preferred the weekly quizzes over the daily quizzes, although no differences were found in the test results between the two groups. Student participation was also found to be much higher in the weekly quizzes.

An analysis of the research indicates that the use of formative assessments increased student achievement on summative exams. The findings are not surprising as

students who completed the formative assessment, in the form of quizzes, were more prepared for class and exams. The research also identified the importance of offering a reward system for completing the quizzes. When quizzes were optional, students didn't take advantage of them, while conversely, students who were offered points (even as little as 2%), took the quizzes and did statistically better on the exams. Lastly the research shows that there was no difference between the frequency of the quizzes, either daily or weekly, and performance.

### METHODOLOGY

The treatment in this study was the implementation of quizzes for my honors chemistry classes. The quizzes were given every other day and were generated using "Mastering Chemistry", a collection of online homework, tutorial, and assessment products created by Pearson. The treatment period started on the first day of the second semester and lasted a total of four weeks. The period started with a teacher led discussion about the use and importance of formative assessments as a tool for self-reflection and success. Every other day, the students took a short quiz about topics that had been covered prior. The quizzes didn't contain any questions from the previous day in order to provide students time to practice and make up the material if they were absent. The students were assigned homework each night for practice on the classwork of that day. Students were informed that the quizzes were modeled after the homework assignments.

### Participants

I teach at a school in Essex, Vermont with approximately 1200 students. I currently instruct 2 sections of chemistry with a total of 40 students. The majority of the students come from middle class parents. There is an equal split of girls and boys with 98% of them being Caucasian. The class is considered a 200 level, meaning it is more advanced than a 100 level, and moves at a faster rate. Students choose the 200 level based not only their readiness for the upper level, but their career interests as well. Students in the 200 level must all be enrolled or have taken Algebra II. When polled, 75% of the students said they would be pursuing some type of science major in college.

### Implementation of the use of quizzes

The students were broken down into two groups. Treatment Group A were given low stakes quizzes, valued at less than 5% of their overall grade, while the comparison group, B, were not given access to the quizzes. Both groups were given identical homework and classwork. Group A had the ability to raise their scores on their quizzes by demonstrating mastery on the unit test. Each section of the test matched a quiz with equal points. The day after the test, the students were given a credit recovery paper to complete (Appendix A).

Daily quizzes took a maximum of ten minutes, and the students received immediate feedback about their scores upon completion. In addition, I also received the students' scores, and the answers selected. Once all the students had taken the quiz, the students had access to both their responses and the correct answers in the event they made a mistake. A total of 16 quizzes were given during the eight weeks. During the

treatment period, the students were consistently told the benefits of formative assessments, and how to use the results to increase their achievement on the summative exam at the end of the unit.

#### Data collection tools

In order to determine the effect of every other day quizzes, I compared scores on the summative exam for the unit, evaluated a Likert Survey (Appendix B), and conducted student interviews (Appendix C). In addition, I used a journal; recording daily observations, reflections, student quotes, and noticeable patterns.

The students were surveyed each week using both Likert Scale questions and open ended questions. Students were asked to report the amount of studying they completed each week, their comfort level with the material, what their weaknesses were, and what further steps were needed for success. Students were also randomly selected and scheduled during their Flex block (a 30-minute period every day where students can get extra help or make up work), using Enriching Students (a personalized learning and scheduling program), to expand upon the survey results. In order to remove bias from the students selected for interviews, I used the True Random Number Generator powered by random.org. Each week two numbers, which corresponded to the students' number in the grade book, were selected and then they were interviewed (Appendix C). This project was reviewed and approved by the Montana State University Institutional Review Board.

Table 1  
*Triangulation Matrix*

Focus Question: "Will daily formative assessments (quizzes) positively impact student learning in a chemistry classroom?"			
Subquestions	Data Source		
Subquestion 1: What is the impact of increased quizzing and credit recovery on student achievement	Student Surveys	Unit Tests	Teachers Gradebook and Journal
Subquestion 2: How do students perceive the value of increased quizzing and credit recovery?	Student Study Time Tracking Sheet	Interviews	Class Discussions
Subquestion 3: What types of post quiz enrichment activities can be used to help struggling students?	Interviews	Student Surveys	Discussions with Peers
Subquestion 4: What is the impact of increased quizzing on the curriculum pacing?	Previous Teacher Calendars	Teacher Observations	NA

## DATA AND ANALYSIS

As part of my data collection, I used multiple quizzes and an exam during one unit of study. The purpose of collecting this data was to determine if giving frequent quizzes benefitted student learning.

In addition, at the end of the unit all students were surveyed and a random sample of students were interviewed to determine the perceived values of the increased number of quizzes. Lastly, pacing was compared between the control and treatment group.

Test scores went up for the treatment group by four percentage points. Students in the treatment group averaged 89% on the unit test, while the control group averaged 85% with a standard deviation of 7.28 and 7.90 respectively. In an unpaired T test, the P value was found to be .0156 showing a statistically significant difference in the test scores. In addition, students, responded favorably to the frequent quizzes and wanted all units to be

assessed using the same methodology (although this didn't happen instantly). Students originally didn't like the idea of frequent quizzes and also didn't like taking the quizzes on the computer. However, after receiving instant feedback and realizing the quiz scores could be raised by their performance on the test, a good portion of the students enjoyed the quizzes. The results are found in Figures 1 and 2 below.

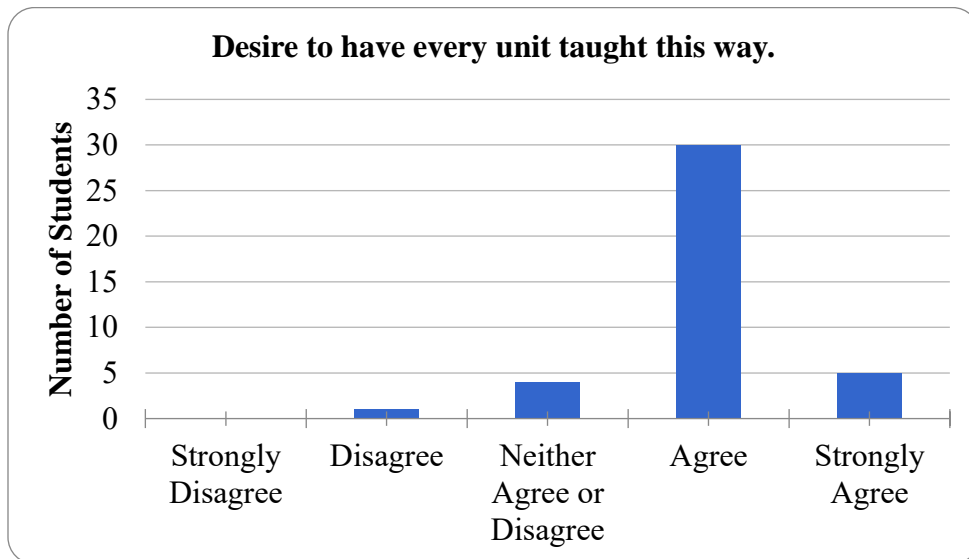


Figure 1: Student perceptions of the quizzes.

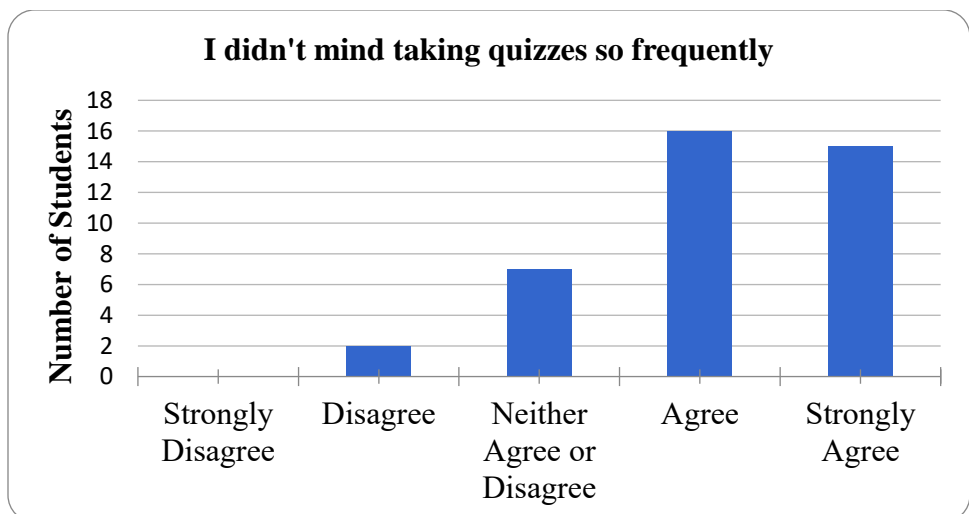
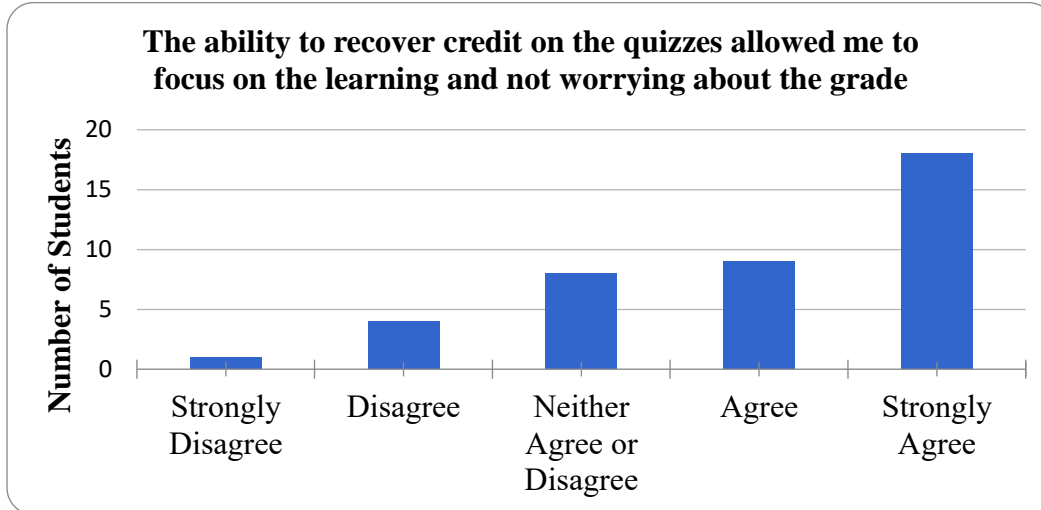


Figure 2: Students willingness to take frequent quizzes.



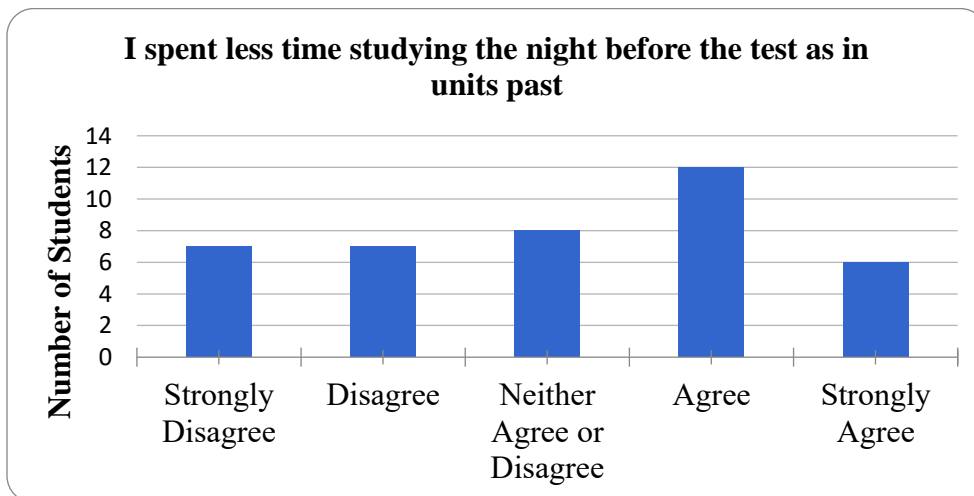
Based on observations throughout the treatment period, it became noticeable that students were starting to focus less on the grade on the quizzes and more on the material. During the first few quizzes, students made comments such as, “Does this have to go on my grade?” or “I did terrible on the quiz, how can I improve the grade.” Students who did well on the quizzes were very excited and quick to share with their friends. From the interviews, getting good scores on the quizzes, gave the students a confidence boost going into the unit test. A typical response was, “I did great on all of the quizzes, so I knew I was going to do great on the test.”

Students who were unsuccessful on the quizzes started coming in for more help as well. Using the software, Enriching Students, I was able to track the number of student visits during the treatment period. Students have 30 minutes every day to schedule a teacher to see for extra help which we call “Flex Block”. They also have the option of going to the library, the gym, or staying with their friends in their homerooms. During the study, there was a 30% increase in student visits during the treatment period. Students often came seeking help from a problem on the quiz, and weren’t as worried about their scores. Unfortunately, 13% of the students still worried about their scores on the quizzes even though they could recover the points by getting the matching section on the test correct. While talking to the students, it became clear for the students who were worried, it was more of a parent issue. One student saying, “My parents look at my grade every day on Power School and get very angry if I don’t have A’s on everything”. This made it difficult for the student to focus on the formative nature of the quiz. Figure 3 summarizes students’ ability to focus on the learning instead of the score.



*Figure 3: Focus on learning instead of score.*

Interestingly, it appeared that students spent the same amount of time studying as in the past (see Figure 4), as the survey results established no trends relating to differing studying times.



*Figure 4: Time spent studying compared to previous units.*

However, 83% of the students thought the quizzes helped them prepare for the test, and didn't mind the extra time studying. During the interview process it became

clear that the students who were spending the same or more amount of time studying were more focused on the information found on the quizzes, which helped them be more prepared for the test, resulting in better test scores. A student response, when asked about the extra-time said, “I rework all of the quizzes for practice before the tests, and that’s been very helpful. I don’t mind spending extra time studying if it will pay off. Figure 5 summarizes the effectiveness of the quizzes.

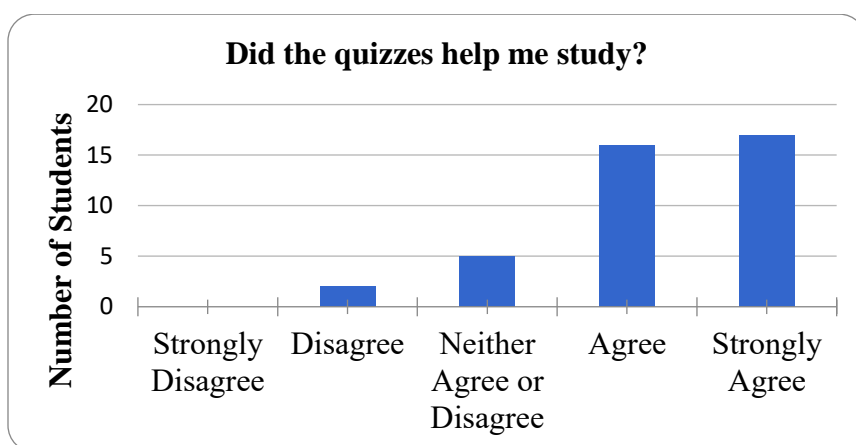


Figure 5: The quizzes effectiveness on study habits.

Since the quizzes were given using Mastering Chemistry, an online Pearson product, which has hundreds of problems to draw from (based on the e-text we use for class), students not only got instant feedback upon completion of the quiz, they also had the ability to complete the quiz problems for practice as many times as they liked. Many students took advantage of having unlimited access to the quizzes. One typical student response was, “I rework all of the quizzes for practice before the tests, and that’s been very helpful”. “I don’t mind spending extra time studying if it will pay off”. Another common theme among the students who didn’t do as well as they liked on the quizzes, found the problems much easier when preparing for their test.

The pacing and timing of the material was a topic of much discussion with my colleagues. The treatment group took three extra days to complete the unit. This doesn't seem like a lot of time, but if every unit was treated the same, the time differences would be substantial. As a school that uses common mid-terms and final exams, I wouldn't be able to get through all the necessary material to keep up with my peers. The amount of time used for the actual quiz needs to be considered in future studies.

#### INTERPRETATION AND CONCLUSION

The data was analyzed to answer the question, "Will frequent formative assessments (quizzes) positively impact student learning in a chemistry classroom?" In order to successfully conclude the effect, the following sub-questions must be answered.

##### What is the impact of increased quizzing and credit recovery on student achievement?

Increased quizzing and credit recovery increased student achievement as measured by the unit test. Students achieved higher scores in the treatment group. This study agrees with previous studies of Palmen, Vorstenbosch, Tanck, and Kooloos (2015), Kooloos (2015), Shirvani (2009), and Zhang and Henderson (2015) whom all concluded that frequent quizzes led to higher scores on summative assessments. Additional units would need to be compared the same way to establish more data points to positively correlate achievement with frequent quizzes.

##### How do students perceive the value of increased quizzing and credit recovery?

Teaching the students, the value of formative assessments was the best part of the study. Students originally were very reluctant about taking the quizzes and were worried about a number grade, more than about the material. Over the course of the unit, it was

refreshing to see a change in the mindset of the students. One of my proudest moments came while my class was being observed by someone from the Great School Partnership. The observer came on a quiz day and after the quiz was over asked a student some questions about learning targets and the quiz. I overheard the student say, “The quizzes inform me of what I know and don’t know and what I need to work on in the future”. The observer then asked the student how they figure out what they did wrong. The student said, “I try to figure it out at home, and if I can’t, I schedule myself for Flex Block the next day.” Nicol and Macfarlane-Dick, D. (2006) stated “if students are to be prepared for learning throughout life, they must be provided with opportunities to develop the capacity to regulate their own learning as they progress through higher education” (p. 215). As a result of the frequent questions, students were then able to ask meaningful questions and were better prepared for their test.

During the interview and survey process it became clear that students felt good about the quizzes, the grading, and the material. Students felt more relaxed when they knew they could earn any points lost on quiz back when they took the test. Future studies could be used to see if this model could work on unit tests and final exams.

#### What is the impact of increased quizzing on the curriculum pacing?

The unit took longer to complete as a result of the frequent quizzes. Quizzes could be made shorter, or time could be made up elsewhere. Originally, I had the quizzes taking ten minutes, but for many of the students the quizzes took fifteen to twenty minutes. Students were very methodical about checking their answers before entering into the computer, and as a result I extended the time limit to twenty minutes.

What types of post quiz enrichment activities can be used to help struggling students?

The ability for students to use Flex Block, to seek help was a huge bonus. As a result of the quizzes, more students came to see me, and as a result, there was an overall better understanding of the material. Students became more actively involved in their own learning and learned to use the formative assessments as a method for evaluating their own understanding of the material. The study will continue next year, when all students will be quizzed frequently during each unit.

VALUE

The purpose of this project was to use Action Research as a tool to improve teaching practices in my classroom. This project was very relevant to me because the focus of the project was chosen after much reflection about the struggles of students in my chemistry classes. As a result of the research, I became a more effective teacher, and have seen improvement in student's skills and confidence.

This capstone project has forced me to reflect on best practices in my classroom and has been a platform of discussion with the other members of my science department. As a teacher, I have been clearer on the learning targets and students have been more successful. The careful calibration between the quizzes and the tests has ensured that all learning targets and course proficiencies have been taught and assessed.

Great teachers constantly make changes in their curriculum and pedagogy to change student behaviors and increase student success. Going from a teacher who never gave quizzes to giving them frequently was a huge change in my teaching practices. This large time commitment was worthwhile as the students were taught how to self-assess

and self-advocate for their own learning. Students took more ownership of the material and were more likely to seek help from me or a peer. Watching the students interact and help one another was extremely rewarding and an unexpected benefit of the treatment period.

Based on the success in my class, the other chemistry teachers are also going to add frequent, short quizzes into their curriculum next year. This would be an unlikely scenario if it were not for the use of Mastering Chemistry, which simplified the creating and grading of the quizzes.

A large portion of the study was to determine if student's study skills were changed. I believe that more work still needs to alter student practices. Students are still concerned about the percentage, rather than the mastery of the material. I will continue to administer the frequent quizzes with the hope that students can create the skills to enable them success in the rest of their subjects and college.

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APPENDICES

APPENDIX A  
CREDIT RECOVERY SHEET

Chemistry 200  
Credit Recovery

Name \_\_\_\_\_ Block \_\_\_\_\_ Date \_\_\_\_\_

**Learning Target 1**

Quiz grade : \_\_\_\_\_ Test grade : \_\_\_\_\_

What did you do to increase your understanding of this topic? (at least 1 complete paragraph!)

**Learning Target 2**

Quiz grade : \_\_\_\_\_ Test grade : \_\_\_\_\_

What did you do to increase your understanding of this topic? (at least 1 complete paragraph!)

**Learning Target 3**

Quiz grade : \_\_\_\_\_ Test grade : \_\_\_\_\_

What did you do to increase your understanding of this topic? (at least 1 complete paragraph!)

**Learning Target 4**

Quiz grade : \_\_\_\_\_ Test grade : \_\_\_\_\_

What did you do to increase your understanding of this topic? (at least 1 complete paragraph!)

If any of your test grades were lower than your quiz grade, please explain what went wrong.

APPENDIX B  
STUDENT SURVEYS

Chemistry 200  
Survey Questions

Name \_\_\_\_\_ Block \_\_\_\_\_ Date \_\_\_\_\_

Circle the box that you most agree with.

Question 1 – The quizzes helped me prepare for the test.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree
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Question 2 – I would like every unit in the future to be modeled the same way.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree
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Question 3 – I didn't mind taking quizzes so frequently.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree
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Question 4 – I spent less time studying the night before the test as in units past.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree
------------------------	------------	------------------------	---------------	---------------------------

Question 5 – The quizzes help me figure out if I know the material.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree
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Question 6 – Taking the quizzes electronically was not a problem.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree
------------------------	------------	------------------------	---------------	---------------------------

Question 7 – The ability to recover credit on the quizzes allowed me to focus on the learning and not the worrying about the grade.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree
------------------------	------------	------------------------	---------------	---------------------------

Chemistry 200  
Survey Questions

Name \_\_\_\_\_ Block \_\_\_\_\_ Date \_\_\_\_\_

Please complete the following survey by picking the best answer.

1. Over the last week, how much time have you spent on chemistry per night?
    - a. 0-10 minutes
    - b. 11-20 minutes
    - c. 21-30 minutes
    - d. 31-40 minutes
    - e. 41-50 minutes
    - f. 51-60 minutes
    - g. Over an hour
  
  2. How much time did you spend the night before the test studying?
    - a. 0-10 minutes
    - b. 11-20 minutes
    - c. 21-30 minutes
    - d. 31-40 minutes
    - e. 41-50 minutes
    - f. 51-60 minutes
    - g. Over an hour
  
  3. What grade did you get on the test?
    - a. 90 -100 %
    - b. 80 -89 %
    - c. 70 – 79 %
    - d. 60 -69 %
    - e. Below a 60 %
  
  4. What strategies did you use to prepare for the test (choose as many that apply)?
    - a. Review old quizzes
    - b. Complete the suggested homework
    - c. Ask questions during Flex Block
    - d. Work in a study group
    - e. Look up information on the internet
    - f. Rework the lesson starters
    - g. Completed review problems
    - h. Other
-

APPENDIX C  
INTERVIEW QUESTIONS



Chemistry 200  
Interview Questions

1. How do you think you could have increased your scores on the quizzes? Test?
2. What is the best part about the frequent quizzes?
3. What was the worst part about the frequent quizzes?
4. What advice would you give to next year's chemistry students to be successful in the class?
5. If your score went down on any section of the test (compared to the quiz), what reasons caused this?
6. Have you changed any of your study habits as a result of the quizzes in chemistry or any other classes?
7. Do you feel better prepared to use formative assessments to prepare yourself for the summative assessments?