The Effect of Online Quizzes on Student Achievement In High School Chemistry

by

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The Effect of Online Quizzes on Student Achievement
In High School Chemistry

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The idea of student engagement has come to the forefront of the United States educational system over the past decade. Student engagement requires learners to be actively involved in all stages of the learning process. This study focuses on the use of online quizzes in the chemistry classroom as a means to help students become more engaged in their learning outside of the classroom. Students were given three different types of online quizzes over the course of a chemistry chapter. Student scores on end of the chapter examinations was used to determine whether there was a significant difference in the amount of learning that occurred when a student took each of the three types of online quizzes.

Students in a private parochial high school chemistry class completed online quizzes over the course of a semester. The quizzes were taken after completing assigned readings from the chemistry text. After each reading, a third of the students took online multiple-choice quizzes, a third took a paragraph quiz, and a third took no quiz. Scores received from end of chapter tests were evaluated to determine if the impact each of the quiz types had on the learning.

All statistical analysis was done using SPSS using two-way split plot ANOVA with condition (paragraph, multiple-choice, nothing) as the within subject factor and group (A, B, C) as between subject factor. The data indicates that there was no significance within the condition $F(1.877, 90.087) = .996$, $p > .05$. or the interaction results. $F(3.754, 90.087) = .509$, $p > .05$. The data indicated that the effect of group was not significant either. $F(2, 48) = .981$, $p > .05$.

Interviews undertaken to explain this outcome discovered that students did not become engaged with the content until the night before each test. When they did so, they used a teacher-provided study guide as their primary learning tool.

TABLE OF CONTENTS

LIST OF TABLES

Chapter 1

Introduction

Context

The idea of student engagement has come to the forefront of the United States educational system over the past decade. Student engagement requires learners to be actively involved in all stages of the learning process. The learner takes responsibility for his or her learning rather than remaining passive and waiting for the teacher to pour knowledge into his or her brain.

This type of learning creates a new role for the teacher. Instead of lecturer the instructor becomes the coach. Teachers that are driven by the need to engage their students become less content driven and more focused on teaching students how to gather information that assists in the ability to solve problems (Phillips, 2005). Quality engagement also leads to an increased ability to analyze, synthesize, and evaluate new material (Austin & Mescia, 2004).

In contrast to active learning techniques that engage students, the traditional lecture format involves passive learning. Passive learning occurs when teachers do the majority of the work. Learners may or may not be motivated to become engaged in what is being taught. Passive learning is seen when students watch videos or DVD's without direction, or when students are simply told to read a text and receive no further guidance in text analysis. In passive learning, higher level thinking skills are less developed which results in students learning the material at a lower level of learning (Phillips, 2005).

At the same time new student engagement strategies were coming into practice, technology integration was becoming an important factor in the United States. Parents and students no longer believe technology is an optional tool for teachers to use. Instead, technology use has become an expectation of both parents and students. Web-based courses began appearing in high schools and colleges around the country and text book companies offer online assessments as part of their textbook packages. Teachers began developing their own web sites and posting their own project and assignment information.

Purpose of the Study

As teachers continue to look for new ways to increase student learning and student engagement, one continual buzzword is the use of technology. Parents ask teachers how they will use technology to prepare their children. As noted earlier, textbook sales persons emphasize the integration of technology and more specifically the use of online assessment in their textbook packages. This study focuses on the use of online quizzes in the chemistry classroom as a means to help students become more engaged in their learning outside of the classroom. Students were given three different types of online quizzes over the course of a chemistry chapter. Student achievement on end of the chapter examinations was used to determine whether there was a significant difference in the amount of learning that occurred when a student took each of the three types of online quizzes.

Research Questions

In this study the following questions were considered:

R1. Do students who take online multiple-choice quizzes during the course of the unit score higher on end of chapter exams than students who do not take these quizzes?

R2. Do students who take paragraph quizzes during the course of the unit score higher on end of chapter exams than students who did not take these quizzes?

R3. Do students who take paragraph quizzes during the course of the unit score higher on end of chapter exams than students who take multiple-choice quizzes?

Significance

Many chemistry teachers are faced with the growing demand to incorporate new technologies in their instructional repertoires. Some teachers are adept at the newest probe ware technologies while others cling to the more traditional forms of data gathering. In a similar vein, many teachers look at online assessments simply as time saving measures while others continue to assess in the same format that they were assessed. This study considered quizzes as a means to increase student engagement. It examined the effectiveness of the quizzes by measuring the increased overall learning of the chemistry concepts. In order for the online quizzes to increase learning, the students needed to become actively involved with the material.

If the use of the quizzes is seen to increase learning, then teachers should view the quizzes as a method of instruction that should be added to their teacher toolkit. If there is no difference between students who do use the quizzes and those who do not, then the quizzes can be seen as an optional tool that teachers may include in their toolbox. This

would indicate that the online quizzes neither hurt nor help the students to learn new chemistry material. If students who take online quizzes learn less than those who do not take the quizzes, then the use of the quizzes can be seen as a marketing ploy meant simply to make life easier for instructors while decreasing the content mastery of students. Learning less when taking online quizzes would indicate a negative correlation between concept mastery and the online assessment quizzes. Purchasing the rights to the quizzes from the textbook company should not be considered a good practice. The integration of new formative assessment techniques needs to be considered, since student achievement is a key factor for successful teaching and learning.

In the following literature review, the researcher identified the fact that the use of online quizzes does not significantly improve student achievement at the collegiate level. This being the case, one may ask why another online study should be completed. There are several areas of significance for this study.

It is important to note that nearly all of the studies reviewed occurred in the collegiate setting. No high school chemistry studies that examined high school online quizzes were found. In fact, there has been limited research published about the use of online quizzes outside of the college environment. College faculty have the advantage of software programs like WEB CT, which make using online quizzes more feasible. This fact alone explains why most studies of online quizzes are completed in college classes. However, one study of elementary math students demonstrated a significant difference when online methods are used. The difference in age and setting is one significant reason why this study was completed.

The difference in learning environment is another reason this study was undertaken. Typically, students attend college classes 3 each week with the expectation that the student is responsible for a great deal of reading outside of class. Content is also covered at a much quicker pace in college chemistry. Quizzes in college classrooms occur less frequently as well.

This study deals with high school students who meet daily with the instructor. Outside reading is much less and content is covered at a slower pace. At least one quiz was taken each week. The varied setting and pace differs dramatically so it was possible that the quizzes could have a different impact.

This study also includes follow up interviews that question the students about their study habits and use of the online quizzes. Many of the collegiate online quiz studies contain survey information about student attitude towards the quizzes. They also ask students to give their opinion of how the quizzes helped them learn. In this study, students are not asked about their feelings. Instead, they are asked about their study habits and how the online quizzes helped them prepare for the tests. In other words, they are asked to explain how engaged they were when they took the quizzes. They are also asked why they felt the quizzes were not effective. These are questions which typically have not been considered in past studies.

Another difference between collegiate and high school settings exists in terms of textbook adoption. Adoption of textbooks at the high school level occurs school district wide. Teachers are not allowed to choose their own text as college professors are. Districts that are influenced by outside pressures to include new technologies in their curriculum may be quick to purchase science texts that include online quizzes.

Researching the impact the quizzes have on learning would shed more light on the importance of an online quiz component in the text adoption process.

Chapter 2

Review of Literature

Introduction

There are several important concepts to consider as the idea of online assessment is discussed. This first section of this review will look at the relationship between student engagement and active learning. These two concepts are crucial to the learning process. Building an understanding of these concepts should allow the readers to identify whether or not the online quiz environment agrees with these ideas. The second section of the literature review focuses on self-generation of answers on quizzes. When students self-generate answers, they are actively engaged with the material.

Methods of feedback are considered in the third section of the literature review. Results of online studies without feedback are compared to studies where immediate feedback was provided. Age differences are also considered in the feedback section. Studies are reviewed from the elementary, middle level, and collegiate level with most coming from the collegiate setting.

The final section of the literature review examines the online quiz environment. Methods for using online quizzes vary drastically. Some instructors award credit for completing the online quizzes, while others do not. Some quizzes are taken to demonstrate content mastery and others are taken simply as review of the major course ideas.

Student Engagement and Active Learning

Increasing student engagement with the class concepts has become increasingly important in all forms of instruction. Lockyer, Patterson, and Harper (2001) believed,

"Whatever the method of delivery, student engagement with the material is of paramount importance" (Laurillard in Lockyer et al., 2001).

According to Bowen (2005), student engagement can be considered a four stage concept. He thought that initially, educators must get students actively involved with the learning process. Once students became active, they must be guided into directly experiencing something new. Bowen's third stage of student engagement required students to become involved in the learning experience so that the students see the importance of what they are learning. In the final stage, Bowen felt that the student connects what he or she has learned with their life.

Bowen (2005) continued by noting that teachers must use learning strategies like cooperative learning, continuous feedback, and writing across the curriculum to more actively engage their students. He felt teachers must also encourage students to examine, analyze, and evaluate what they are learning. In the field of science, this can occur in the laboratory setting as students consider the lab process and the data gathered. Finally, students begin to see the connections across the curricular areas. In science, this occurs as students balance ethical issues with scientific fact.

Breslow (1999) defined active learning as guided activity. He said that active learning required students to do something significant in class. Instead of sitting and listening, students should be doing. Breslow believed that if students were doing something their brains were more engaged and more substantial learning occurred.

Fink (2006) provided one model for active learning. His model assumed that, as the learner completed any learning activity, the student was involved in active conversations with self or with others. Fink speculated that this self dialogue occurred as

students reflected on their learning. The reflection included thinking about what they were learning, how they were learning, and how their learning connected to their lives. Fink concluded that students reviewed what they had heard and asked themselves if what they were hearing made sense. The dialogue students had with others included listening to teachers, reading a text, and small group discussions (Fink, 2006).

Fink's model also emphasized that the two main activities students completed in the learning process were observing and doing. In the science classroom, students observed the instruction provided by their teachers and peers. Science students also became involved with lab work and other instructional activities that involved them in actually doing science (Fink, 2006).

Fink's (2006) model also had applications for the online learning environment. He held that online learning's strengths were in promoting self dialogue. As students reviewed online reading or quiz materials, they questioned what they were reading and tried to apply learning strategies to the new concepts. The model also assumed that online learning's weaknesses were in the ability of students to do or observe experiences. Although lab simulations were available online, actual lab work was not present in this form.

Michael (2001) believed that the most common form of instruction is teacher lecturing. He believed that more emphasis should be placed on active learning where students were "talking the subject." This meant the students were explaining and justifying their answers to each other as well as explaining ideas to the instructor. Increased activity was seen as students interacted with one another. In many classrooms teachers shared information with students through the lecture technique. This type of

information sharing was referred to as passive learning. Students did little while the teacher did the majority of the work. Michael's research project looked at varied forms of active learning which reversed the roles of passivity and placed the responsibility of learning on the shoulders of the student.

According to Brooks, Schraw, and Crippen (2005), a learner who had limited learning engagement would sit in a lecture and take notes. A more actively engaged student discussed what the lecturer was saying with a peer. A third form of active learning occurred when a listener self questioned what he or she was hearing from the lecturer. In terms of a reading assignment, similar types of active learning can be defined. Some students simply read the text and placed most of their emphasis on bolded terms. A more engaged reader discussed their reading with peers, while another reader analyzed the text alone and questioned what was written.

In Brooks et al's. (2005) research study, it was assumed that completing the quizzes encouraged some level of active learning as students completed the reading assignments and answered online quiz questions. Throughout the course of the study, students took one of three types of quiz: They took multiple-choice quizzes that provided instant feedback; they completed paragraph quizzes; or they took no quiz at all. As students completed the quizzes, they were asked to self-generate their responses based on outside of class readings.

Schraw and Brooks (n.d.) referred to self regulation as the students' ability to understand and control their learning. They believed that students learned to self-generate using motivational and learning strategies. However, students must understand that their strengths were limited by their ability to use their metacognitive skills to selectively

identify which learning strategy was best in a given situation. Teaching strategies that enhanced self regulation were seen as a way to increase student learning (Schraw & Brooks, n.d.). The researcher hoped that studying the varied forms of quizzes would identify strategies that would enhance self-regulation and learning.

Self-generated Answers

In order to create a better system of learning, Metcalfe and Kornell (2007) researched using online quiz questions that required a student to self-generate their own answers. These researchers considered whether the use of the self generation of answers to questions helped students learn more. Initial findings from their study with both elementary and college students found that generating answers had no impact on learning. This was found to be in conflict with the findings of several other researchers (Slamenka & Graf, 1978; deWinstanley & Bork, 2004). After further examination of their results, they concluded that their control group was self-generating answers during the wait time they were allowed in the initial experiment. Further experimentation identified self generation as having a positive impact on student learning.

Feedback

Brooks et al. (2005) stated that if instruction was to be successful it generally included performance related feedback. Learners who were best at creating their own knowledge received some type of feedback based on their performance. Quite often this feedback came from an instructor. In the case of the present study, different levels of computer-based performance-related feedback occurred.

Hwang and Arbaugh (2006) proposed that one of the keys to improving learning was to provide students feedback on their learning. They found that there were at least

three types of feedback avenues available to students. The traditional method of students asking questions in class was referred to as InAsk. They concluded that many students were intimidated in class and failed to ask questions to advance their learning. In terms of learning, these students remained passive. A second form of feedback identified was OutAsk. This feedback occurred when students sought instructor help outside of the regular class period. This form of feedback was similar to tutoring and was much more active than InAsk. The third form of feedback cited was OutCheck. OutCheck occurred when students informally discussed instructional topics among themselves without the instructor present. This occurred in informal study sessions as students worked together to review course material (Hwang & Arbaugh, 2006).

In Reimer and Moyer's study (2005), third grade student achievement in math was examined. In their study, 19 third-grade students completed a two week unit on fractions using computer manipulatives as a guide. Results showed a significant improvement on post-test concept knowledge scores when compared to pre-test scores. The researchers attributed this improvement to immediate and specific feedback. This feedback was provided online and focused on correcting student errors. The computer feedback highlighted student errors and showed corrections to their mistakes. The corrections were identified and examples were shown which students could then model for future problems. The researchers also noted that the feedback helped teach the math concepts by using new math vocabulary in the context of the corrections.

Nguyen, Hsieh, and Allen*'s* (2006) study of middle level mathematics found that drill and practice on the computer with immediate feedback caused students to gain interest in math. Their study of 78 seventh graders compared a three week web-based unit

with a traditional paper and pencil unit. Although no significant difference in achievement was seen, these middle level math students felt that they became better problem solvers as a result of the drill and practice. In Nguyen's study, males tended to gain more confidence in math while females had stronger beliefs that the instant feedback helped them improve their problem solving.

Zerr (2007) understood that teachers were working in changing times. He identified that the days of teachers lecturing while students listened were being replaced with a setting where teachers and students interacted together. He cited the need for a change from the traditional math teacher format where the teacher worked numerous examples on the board until the end of class. Zerr's new method involved a brief time when the instructor provided an example followed by a time when students worked on problems in class. The student work time was followed by the teacher providing timely feedback on student work. This cycle continued with students generating work toward a correct solution. In this format, students attempted to solve a problem, received error instruction on where they went wrong and then were asked to complete similar problems again.

A similar cycle was seen in Zerr's study of the online environment. Online quiz programs asked students to complete a problem. If the student failed to answer correctly, immediate feedback was provided. This in turn was followed by another problem of the same type to complete. Zerr's (2007) study used the above process for online homework in his college calculus students. The goal of the online homework system was to create a learning environment where the learners were actively engaged outside the classroom.

The unique elements of this system were the instantaneous feedback students received and the ability to complete similar problems after reviewing this feedback.

Zerr's system was contrasted to similar homework studies where answers were provided, but no further feedback occurred (Hauk & Segalla, 2005; Hirsch & Weibel, 2003). In situations where no feedback was provided, limited or no significance was seen between the scores of students who completed online assignments and those who completed in class homework. In Zerr's work, students who were most engaged in the online trial-feedback-trial method were the most successful in the calculus class.

In agreement with other researchers, Mavrikis & Maciocia (2003) identified immediate feedback as the strongest asset to computer based learning. They concluded that, although students could receive this type of feedback in the classroom, this was not possible once they left class. They stated that human tutors had limitations and would not always identify every student's misconceptions about a concept. They also noted that receiving homework feedback days after it was completed was not as motivating as the nearly instantaneous feedback provided by a computer. A student's focus on hand graded homework tended to be more on the grade and less on being actively engaged with their errors.

Jacobs (2005) believed that the use of online assessments was an important aspect of learning new material. Jacobs stated that, when online multiple-choice quizzes were designed to provide immediate feedback, students were able to recognize and correct the errors made. Jacobs also said that getting answers correct increased student confidence in their content knowledge. When a format is used where students are asked to repeat missed items until mastery is achieved, students were encouraged to find the correct

answer and also reflected on why the answers they chose were wrong. A weakness Jacobs identified with online quizzes was the opportunity for students to simply guess the right answer. He found that a poor student with little motivation would simply guess at the right answer to complete the online quizzes rapidly.

Online Quizzes

Research results for the effectiveness of online quizzes vary greatly. Numerous factors can play a role in learning. As factors change in the online quiz environment, results change. In the 1980's, several studies on the effect of note taking were studied. In one instance, Norton (1981) noted that there was a relationship between note taking and examination scores. With further research, Norton and Hartley (1986) discovered that better student performance on exams occurred when students took notes in class and enhanced them with notes taken from handouts and specific readings.

With the growth and use of educational technology, many studies were conducted to compare technology's effect on learning compared to the traditional methods of classroom instruction (Lockyer, Patterson, and Harper, 2001). In a recent literature review conducted by Chumley-Jones, Dobbie, and Alford (2002), 206 studies of medical web-based learning were considered. Although web-based learning rated positively among health care students, a significant increase in academic performance was not evident. Twenty of the 206 studies measured the learning gains of students when they were involved in web-based learning strategies. Although several studies showed knowledge gains, in studies where an experimental and a control group received identical content there was no significant difference in the gains made by those students involved with web-based learning compared to their counterparts who did not receive the web

learning. Web-based learning improved post test scores, but did not significantly outperform other traditional teaching methods.

As a corollary to Metcalfe's question about student self-generation of answers cited earlier in this review, Metcalfe et al. (2007) considered whether self-generating a wrong answer had a negative impact on the learning of the materials. The researchers were concerned that generating incorrect answers could negatively impact learning. Based on their research, they concluded that there was not a negative effect when a wrong answer was generated as long as correction and feedback was provided to the student.

A third portion of the Metcalfe et al. (2007) study focused on feedback. In all cases, student learning was better when feedback was provided. As stated earlier, self-generating correct or incorrect answers both improved learning when feedback was provided.

Online quiz methods can be considered active learning if students were asked to self-generate answers to quiz questions. Daniel and Broida (2004) considered the use of web-based quizzing as a means to improve summative examination performance in the university setting. They thought that instructors who gave numerous shorter quizzes in class improved student's overall scores on their college exams. However, this practice was seldom followed since multiple in-class quizzes greatly reduced the in class time that the instructor could use on instruction. With this in mind, the researchers began using short online quizzes that students took outside of class. Their initial research found that there was no significant difference on exam scores between the online quiz group and the group who did not take the short quizzes. With further investigation, they discovered that

the online quiz groups were “cheating” while taking the online quizzes. Daniel and Broida stated that cheating strategies included students sharing answers with one another, students looking up answers while taking the quiz, and students working in groups on the quizzes. The students were giving up the active learning piece. Few were thinking about what they were learning. Instead, they were taking the easy way out and completing the tests without thinking for themselves.

In a follow up study, Daniel and Broida (2004) were able to reduce the cheating by assigning different questions randomly to the online participants. Results showed that, when the cheating was reduced, online quizzes significantly improved student performance on exams.

In her research, Sporer (2001) reported that frequent quizzing encouraged students to become more engaged with the course material. Sporer developed a NO-Fault quiz system that was meant to improve the overall scores of her students. Students were asked to complete short quizzes in class that were based on the week’s learning. Correct answers on the quizzes were awarded extra credit points on the exams. Students who missed class or scored poorly on the quizzes were not punished. They simply did not receive bonus points. Sporer found that the students reviewed the week’s material prior to the quizzes and made sure they were in class on the day of the quiz. Preparation for the quizzes was considered active learning since students were quizzing themselves in preparation.

In contrast to Sporer’s success with frequent testing, Haberyan (2003) found no significant difference between students who took quizzes and those who did not. He administered quizzes to two sections of his General Biology class while two other

sections did not complete the quizzes. The quiz group felt the quizzes helped them study and believed they were helpful in preparing them for the examinations. However, this was not evident when class exams were evaluated.

Huon, Spehar, Adam, and Rifkin (2007) compared the extent a student used course resources provided by the instructor to their overall performance in a college psychology course. They also considered the impact several different resources had on student learning. They asked the students to self-report how often they used the course text and course text supplements. They were also asked how often they used the course website which contained lecture notes, tutorials, practice quizzes, discussion forums, and simulations. Results of this questionnaire indicated that only 31% of the students used the text weekly while 35% of the students accessed the course website weekly. Also of interest was the fact that only 11% of the students used the practice quizzes on a weekly basis.

The researchers considered whether the use of certain resources had an impact on a student's overall performance in the class. In terms of text use, there was a significant positive relationship between text use and course grades. The more frequently the text was used, the higher the overall student grade. The reverse was true for the website use. The more often a student consulted the class website, the lower the student's grade. Huon et al. (2007) assumed that students appeared to be drawn less to resources designed to help them learn and more to those items which seemed to help them receive a good grade. Students appeared to focus on short term learning of what was going to be on the test rather than on long range concept building. The researchers also believed that the text was viewed by students as a reference or support item for the class.

In a study comparing the use of online quizzes by developmental students versus non developmental students, Brothen and Wambach (2006) found that online quizzes were beneficial to all students even though the developmental students were found to use the quizzes less effectively. The term developmental in their research referred to students who needed extra assistance in becoming successful in the college environment. They needed to be taught learning strategies that made them successful learners throughout the college experience.

Brothen and Wambach (2006) cited the following as benefits of online quizzes for developmental students: "First, students learn the information better and come to appreciate the value of feedback and review. Second, they get feedback about the effectiveness of their learning strategies and how to improve them."

Inappropriate use of the online quizzes was also identified by these two researchers. They noted that some students took the quizzes before reading the text or simply skimmed the text in order to find the correct answers. Since the online quizzes were not timed, students took as long as needed to scan the reading and find the right answer to the quiz. To counteract this poor learning strategy, they began limiting the time students had to complete each test item on the quizzes. As a result, more students read the text prior to completing the quizzes (Brothen and Wambach, 2007).

In a follow up study of student performance in a hybridized college psychology class, Brothen and Wambach (2007) required students in a developmental college psychology class to complete course practice quizzes online. The term hybridized referred to a class that included both face-to-face and online components. Brothen and Wambach questioned how students viewed the use of the required practice quizzes,

questioning whether students considered them to be an advantage for learning or just another class requirement.

Brothen and Wambach (2007) identified the fact that there had been limited research on the learning that took place in courses that contained both face-to-face and online components. Their course contained both. Students were required to attend a Monday session for review and a Wednesday session for developmental writing. The remainder of the class was taught using a modified Keller Plan model that required students to complete self-paced lessons online. In their study, students were required to complete ten fill-in-the-blank and ten multiple-choice quiz items each week. Students practiced these quizzes during additional in class time if their grade was below a C- or outside of class if their grade was higher. As a result of these requirements, half of the students were allowed to work on the online quizzes outside of class.

Results of Brothen and Wambach's (2007) study showed that a third of the students never reached a high enough grade to be allowed to take the quizzes outside of class time. The motivation to work at home or outside of class was not great enough to encourage the students to earn a successful grade in class. Of the two thirds that did have permission to complete the quizzes at home, only a third actually did so. Half of the successful students chose to continue to complete the quizzes on campus during the additional study sessions. Those students who did complete work online outside of class performed better on exams. However, it is important to note that their scores were not significantly better.

The implications of this study indicated that instructors who designed hybrid courses should provide varied opportunities for student learning. Students tended to be

motivated by different factors in the class. Some students were very much concerned with their ability to complete work outside of class while others were not concerned by this at all.

Grimstad & Grabe (2004) questioned the findings of Brothen and Wambach (2007). In the Grimstad and Grabe study, 179 psychology students completed three 50-item in-class exams during a semester long psychology class. 61 students completed 50 or more online quiz items to prepare for the exams for the first quiz, while 73 and 60 students completed 50 or more items to prepare for the second and third in class exams. Their findings showed that those students who completed 50 or more online quiz items prior to the exams scored significantly higher on the exams. Students who participated in at least 50 online quiz items performed better on the class exams than those who did not.

Grimstad and Grabe (2004) felt that Brothen and Wambach awarded course points for quiz completion while they did not. They felt that Brothen and Wambach's teaching choice led to different methods of completing the quizzes than their methodology. They felt that, when the motivation was to earn points contributing to the course grade, high achieving students quickly met this goal. Lower achievers repeated the same items over and over. They went on to say that students who knew less used their text as a way to get quick class points rather than as a way to learn. Grimstad and Grabe felt Brothen and Wambach's design led to a negative correlation between items completed and test score success. They felt that, when the items were not computed as part of the class score, student had more motivation to practice more questions for a longer period of time. Voluntary quiz completion took the emphasis off of the quick fix and onto learning and concept mastery.

Shimazu (2005) explored the effectiveness of a 5-unit college-level Japanese class taught with and without online supplements. The instructor used a traditional text book in all classes. Students received five 50-minute class sessions per week in Japanese. The experimental online group also completed online quiz assignments outside of class. All students were asked to complete the same course quizzes, midterm exam, and final exam. Surveys indicated that online experimental students spent 3.5 hours per week outside of class using the online format for review. The control students spent 3.7 hours per week reviewing their Japanese language skills by studying their notes and the textbook.

Results of independent *t* tests showed that there was no significant difference between the two groups on 9 of the 10 class quizzes or on the final. Differences were seen on one of the quizzes and on the midterm exam. On these two items, students who used the traditional review format scored better than those who used the online format. Shimazu concluded that the dropout rate for online users was 12% compared to a dropout rate of 31% for traditional students. Shimazu indicated that those who remained in the traditional group were more of the high achievers while more students of all levels remained in the online format.

Harter and Harter (2004) considered the use of online quizzes for students in their college economics students. Students were provided voluntary access to the course website which contained multiple-choice quiz items. After completing an item, students received a computer-generated response. If the student choice was correct, they received a response stating why they were correct. Questions answered incorrectly were followed by an in depth explanation of why their choice was not correct. After reading the explanation, students were given the opportunity to answer the question again. In this

study, student scores on the quizzes were not awarded course points. Positives of this format were round the clock access to course materials and explanations for why incorrect answers were incorrect. Statistical analysis showed that the use of the quizzes did not increase student performance on in-class economic exams or on the class final.

In a study similar to this researcher's, a large first year biology course at the University of Sydney was created using both on ground and online teaching methods. The on ground teaching methods were typical of most large introductory biology courses with instructors using lectures and lab work to convey class materials. Students were asked to complete weekly online multiple-choice quizzes that asked questions about the week's lab work and course content. Biology students preferred the online quiz format to the in class quiz format. They cited the immediate feedback, question format, and speed of completion as positives. Negatives included the questions level of difficulty and the ambiguity of the questions. They also felt taking the quizzes improved their performance in the class (Peat & Franklin, 2002).

This literature review has focused on student engagement, feedback, and online quizzes. Based on the review, it appears that immediate feedback on online quizzes will create the most engaging environment for the learner.

Chapter III

Methods

Introduction

This chapter will provide the methodology of the study. Demographic information about the participants and the school setting will be delineated. An explanation of the dependent variables will be followed by a detailed explanation of the design and procedures taken to complete the study. Data analysis procedures will also be included.

Participants

The sample population for this study is all sophomores and juniors enrolled in a first year high school chemistry class. The study took place during the fall semester of the 2007-2008 school year. The sample was limited to the students in the researcher's chemistry classes who received parental consent. 53 students were enrolled in the instructor's chemistry class. One student chose not to participate in the study. One other student was removed from the study due to a long illness and absence from school.

Sophomores were 16 years old when class began in the fall or were nearing their sixteenth birthday by the end of first semester. The juniors were either 16 or 17 years of age. The sample contained 22 males, five were juniors and 17 were sophomores. There were 29 females with 4 being juniors and 25 sophomores. All students were Caucasian, with most living in homes from the middle or upper class.

Parent permission to access student GPA was not specifically requested, but the following chemistry requirements demonstrate the academic standing of the students in the study. Chemistry is a required course at this Midwestern school. Students take

chemistry in their sophomore or junior year. Sophomores who receive a grade of A or B in biology as a freshman are automatically registered for chemistry as a sophomore. Students receiving a C in biology must petition the instructor for permission to enroll in chemistry as a sophomore. There were two sophomores in the study who had C's and were granted permission to take the chemistry class. The rest of the sophomores had a grade of B or better in biology the prior year.

The juniors enrolled in the chemistry class were students who had earned a grade of a C or lower in biology as freshman. They took physical science their sophomore year and were then enrolled in chemistry as juniors.

Permission to use the student data was obtained through informed consent from both parents and students. All students enrolled in the course were new to the world of chemistry. None had prior experience in a chemistry class.

Setting

The study was conducted in a private, parochial high school in the Midwest. The Midwestern school had an overall enrollment of 200 students in grades 9-12. The parochial school was located in a suburban section of a Midwestern city of 250,000 people.

Dependent Variables

Several treatment conditions occurred in this study. Before the study began, students were randomly assigned to one of three groups. (A, B, or C) The students provided an email address which was recorded on the UNL website. As the email addresses were entered, the computer randomly placed the students in Group A, Group B, or Group C.

The computer assigned students in such a way that groups A, B, and C had nearly equivalent numbers.

Throughout the entire semester, students were assigned chapter sections to be read outside of class. All students were assigned the same reading material. After reading a section from the text, students were instructed to log onto the UNL website.

On the first screen of the website, students were asked to complete a brief online verification that he or she had read the assigned reading. Students who stated that they had not read the material were not given access to their online quiz. Instead, they were directed to read the section and return to complete their quiz.

After the students verified that they had read the material, they were asked to rate how hard the reading was for them. They were also asked how well they felt they understood the material.

After rating the reading, one third of the students were "done" with their assessment for the reading section. A second third of the students were asked to complete an online multiple-choice quiz over the assigned chemistry reading. Students who took the multiple-choice quizzes received immediate computer-generated feedback on their quiz scores. The remaining third of the students were asked to complete an online paragraph quiz over the assigned chemistry text reading. Students taking the paragraph quizzes did not receive immediate feedback on their answers.

Both the paragraph quiz answers and the multiple-choice quiz answers were read later by the instructor. In terms of homework grades for the quizzes, all students received five point completion grades for each quiz they completed online. If the quizzes were completed on time, they received the points for taking the quiz.

At the end of a chapter, student learning was measured using end of chapter examinations. Mastery of the first semester chemistry content was measured by examining student answers to individual chemistry test items. Students who scored well on the end of chapter tests were considered to have mastered the material.

To compare the effect of the online quizzes to content mastery, individual test items were used that coincided with each section of the chapter readings. These test items were selected from textbook written assessments.

In order to collect data on the effect of the different quizzes on the end of chapter tests, the number of items correct on each section of the test was calculated. If a student took a multiple choice quiz over section one and got three of six questions correct, he or she had a number correct score of 3/6 for section one multiple choice. The same method was followed for those students who took the paragraph quiz or no quiz. This procedure was repeated for each test and section of reading.

At the end of the semester, a final percent score for each student was calculated for each treatment; multiple-choice quiz, short answer paragraph quiz, and no quiz. Every student in every group had three different end of semester percent scores.

The study considered the relationship between the percentage of items correct and the type of quiz a student completed. The relationship between the number correct on the sections where a multiple-choice quiz was taken was compared to the sections where no quiz was taken. The relationship between the number correct on the sections where a multiple-choice quiz was taken was compared to the sections where the paragraph quiz was taken. The relationship between the number correct on the sections where a paragraph quiz was taken was compared to the sections where no quiz was taken.

Procedures

Prior to the start of the study, several forms of permission were needed. Permission to conduct the study was received from the high school principal and executive director of the parochial school. Permission was also requested and received from Glencoe/McGraw-Hill to use their online quizzes in this research. (See Appendix C.) IRB forms were completed and IRB approval was obtained. (See Appendix D, E.)

Approximately a month before school began, parents were notified that their child was invited to take part in a research study conducted by their child's chemistry teacher. This information was provided to the parents at registration day in a packet of material distributed by staff other than the chemistry teacher. They were informed that at no time would their child's test data be identifiable. They were also informed that refusal to participate would have no impact on their child's chemistry grade. (See Appendix A) All but one of the enrolled chemistry students agreed to take part in the study.

Prior to the start of school, the online website was created with the help of Dr. David Brooks and tested by Dr. Brooks and the chemistry instructor. Both Dr. Brooks and the instructor created log in names and passwords in the same way as the chemistry students. They also logged in and took a paragraph and multiple choice quiz. No log in errors were detected, but a few errors involving the paragraph quiz construction were identified and corrected.

During the first week of class, the chemistry teacher explained the use of the online quizzes. The instructor told the students that the online quizzes would be treated as homework. As such, completion of the quizzes contributed to the overall homework

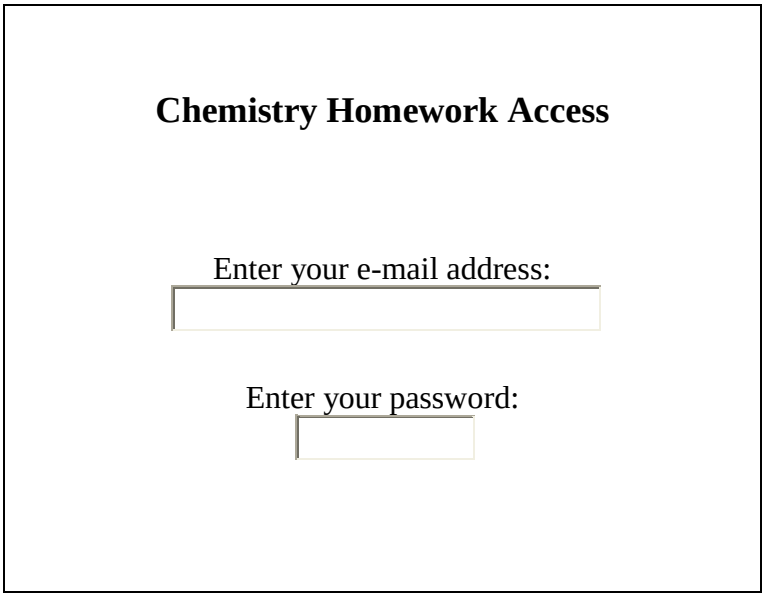
portion of the student's grade. The student who chose not to participate was provided an alternate written copy of the online quizzes.

Next, the instructor verbally explained how to use the online quiz website. He explained how to log in, create a password, and proceed to the first screen that asked the students to verify they had read section one.

Due to a lack of computer lab availability, students completed their first log in individually. This was done with the instructor or at home. Students who completed the log in process at home reported any problems to the instructor the following day.

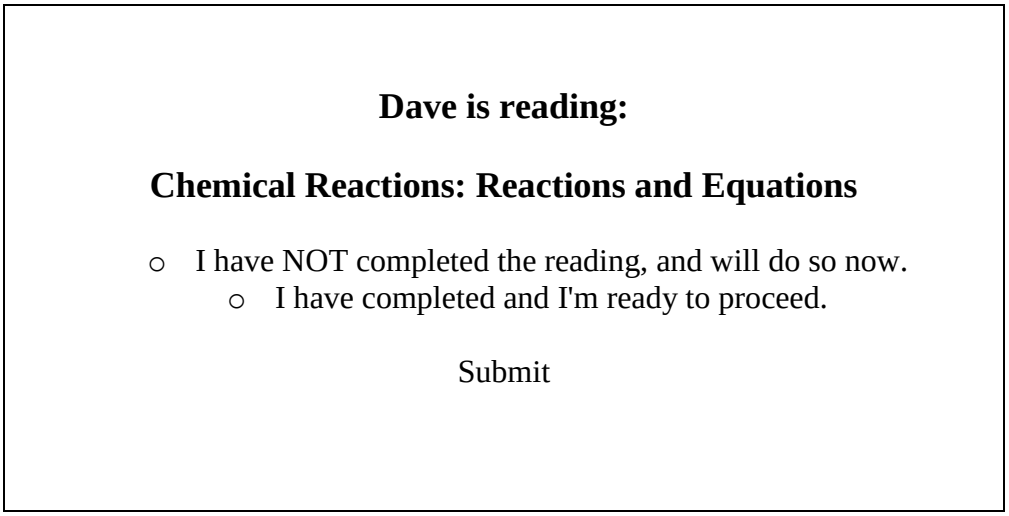
The first time the students logged in to the website, they used their email address as their password. As they logged in the first time, the computer randomly placed them into Group A, Group B, or Group C. Once they successfully reached the verification page, students were instructed to write down their log in name and password. After logging in, the student's identifying password was converted to an unidentifiable number to preserve anonymity. (See Figure 1 below.)

Figure1 Student Log In Page



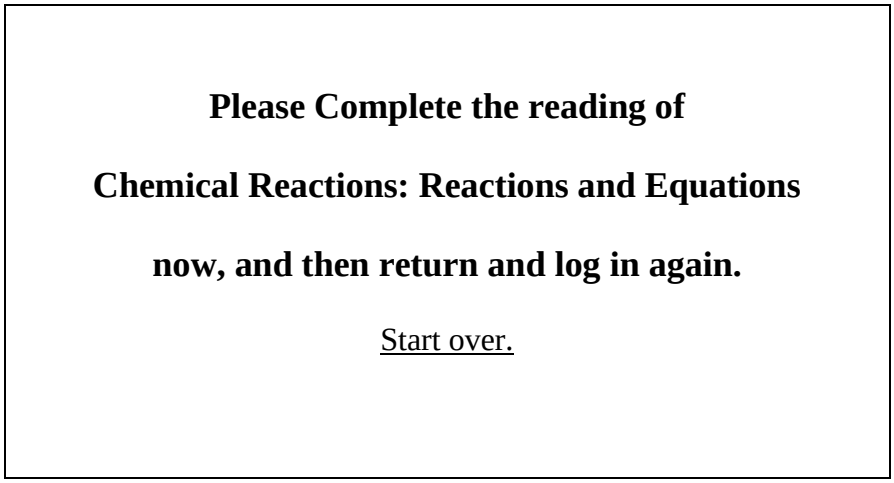
Following the orientation, students were asked to read the first section of reading on their own. After they read the first section from the text, all students were directed to return to the first page of the UNL website. Once they were logged on to the website, they verified that they had read section one. (See Figure 2 below.)

Figure 2 Student Reading Verification Page



Students who noted they had not read were denied further entry. They were instructed to complete the reading and then return to the website. (See Figure 3)

Figure 3 Student Redirection Page



Those who acknowledged that they had read the material were asked to rate how difficult the reading was and how well they understood the reading. (See Figure 4)

Figure 4 Student Rating Page

Dave: Please Rate the Reading
Chemical Reactions: Reactions and Equations

Please rate how hard (how difficult) the material is to understand:

- Not Rated Yet
- Trivial
- VERY easy
- Easy
- Average
- Hard
- VERY hard
- TOO HARD to understand

On a scale from 1 to 99, rank how confident you are that you understand this material AND can use it. 99 = VERY confident; 1 = not at all confident.

Submit

Once the students completed the rating process, two of the groups proceeded to their next task. The third group which was designated the no quiz group. This group was "done" with their online assessment.

As noted, students taking the multiple choice or paragraph quiz were directed by the UNL computer program to their assigned quiz. A sample multiple choice quiz can be seen in Appendix G. A sample paragraph quiz can be seen in Figure 5 below.

Figure 5 Sample Paragraph Quiz

Chemical Reactions: Reactions and Equations

Write a Summary Paragraph or Two

Describe the steps used to balance chemical equations.

Throughout the semester, all students were assigned the same periodic readings in their chemistry text. At times, the instructor skipped a section of reading in a chapter. There were also two occasions where two chapters of the text were tested at the same time. All other parts of the chemistry course were identical for the sample. They completed the same lab activities and attended the same classroom lectures and discussions.

Over the course of the semester, every attempt was made to ensure that each group took the same number of quizzes. For instance, every effort was made to ensure that Group A took 5 multiple-choice quizzes, 5 paragraph quizzes, and have 5 instances when no quiz is given. This was not possible since the number of sections of reading was not divisible by three. This meant that the number of quizzes varied by one. Group A took 12 multiple-choice quizzes, 12 paragraph quizzes, and have 11 instances when no quiz is given.

At the end of each chapter, students completed a test based on the material in the chapter. The individual results for each of the test items were saved for later analysis. Answers to the test items were grouped based on the type of quiz taken. For instance, if students took a multiple-choice quiz over section 4.2, the test questions for section 4.2 were grouped with all other sections where multiple-choice quizzes were completed. At the end of the study, a percentage correct score for each student and each type of quiz was computed. For example, student A had a percent score for multiple-choice quiz, paragraph quiz, and no quiz. The overall group results were analyzed using a split plot analysis.

Since no significance between the test scores was seen, IRB approval was sought and received to conduct follow up interviews. (See Appendix F.) Parents were informed that follow up interviews would be conducted at the end of the semester. (See Appendix B.) Twenty parents agreed to allow their child to be interviewed. These follow up interviews were conducted with students at the end of the semester.

Design

At the end of each section of reading, students took reading quizzes. They rotated through the quizzes so that they took at least one multiple-choice quiz, one paragraph quiz, and no quiz in each chapter. At the end of the chapter, students completed a chapter test based on the reading material, class discussions, and lab activities. Items on the test were written so that they were similar in nature to those seen on the online quizzes. The items were coded so that it was possible to determine which online section they correlated with. A student's number of correct responses was recorded for each test section. Student A had a number correct score for the multiple choice quiz, the paragraph

quiz, and the no quiz section of each test. The scores for each type of quiz were combined and summed. These raw score were then converted to percentages.

At the end of the semester, the researcher developed a set of interview questions which were then piloted by an independent interviewer. This interviewer met with five chemistry students. After the five were interviewed, the questions were refined and ten more students were interviewed. The answers of these ten students were similar and thematic. This being the case, the final five students who had agreed to be interviewed were not interviewed.

Chemistry Chapters Covered

The following chapters from the chemistry text provided the chemistry concepts for the study.

Chapter 1: Introduction to Chemistry

Chapter 2: Data Analysis

Chapter 3: Matter - Properties and Changes

Chapter 4: The Structure of the Atom

Chapter 5: Electrons in Atoms

Chapter 6: The Periodic Table and Periodic Law

Chapter 7: The Elements

Chapter 8: Ionic Compounds

Chapter 9: Covalent Bonding

Chapter 10: Chemical Reactions

Data Analysis Procedures

This study initially used a two-way split plot design to evaluate the effect of taking different types of reading section quizzes on student scores on end of chapter chemistry examinations. The within-subject factors were multiple-choice quizzes, paragraph quizzes, and no quiz taken. The between subject factors were the group assignments for each student. The dependent variable measured was the student percent score for each section of the chapter examination.

A minimum of three sections of reading were assigned before each test. At times a chapter contained four sections. During the completion of a given chapter, each group completed at least one multiple-choice quiz, one paragraph quiz, and one no quiz. By the end of the study, each student had been through 35 cycles of assessment. Students in group A had taken 12 multiple-choice quizzes, 12 paragraph quizzes, and 11 no quiz sessions. Students in group B had taken 12 multiple-choice quizzes, 11 paragraph quizzes, and 12 no quiz sessions. Students in group C had taken 11 multiple-choice quizzes, 12 paragraph quizzes, and 12 no quiz sessions. Items on the end of chapter book exams came from all sections of reading. These items were coded by section. For instance, items whose content was covered in section 4.1 were coded 4.1 on the test.

The tests were graded and the number correct scores for each section of reading were then calculated. At the end of the study, each student's average percent score was calculated by treatment group. The descriptive statistics for each group and each treatment were calculated. Each student received a score for multiple-choice quizzes, paragraph quizzes, and no quiz. Group averages by treatment are reported in Table 4.2 on the next page.

In the table below Para are scores on paragraph quizzes, Noth are scores on no quizzes, and MC are scores on multiple choice quizzes.

Table 4.2 Descriptive Statistics

	Group	Mean	SD	N
Para	A	.75246	.143074	17
	B	.78738	.133345	17
	C	.77823	.116886	17
	Total	.77269	.129751	51
Noth	A	.73929	.109194	17
	B	.80112	.102588	17
	C	.77038	.162040	17
	Total	.77026	.127419	51
MC	A	.71205	.165705	17
	B	.76475	.101745	17
	C	.77888	.109285	17
	Total	.75189	.129481	51

All statistical analysis was done using SPSS using two-way split plot ANOVA with Condition (paragraph, multiple-choice, nothing) as the within subject factor and Group (A, B, C) as between subject factor. The independent variable was the percentage score on each part of the end of chapter examination.

Chapter IV

Results

Introduction

This study investigated the relationship between online chemistry quizzes and high school chemistry student's scores on end of chapter book exams. The study looked at the impact of online multiple-choice quizzes, online paragraph quizzes, and taking no online quiz. Data collected examined the differences each treatment had on student performance on the end of chapter tests.

Results

Levine's Test of Equality of Error Variances was run on the data prior to the two way split plot ANOVA. Levine's Test indicated that, for multiple-choice, the homogeneity of variance was not tenable. $F(2, 48) = 3.573$, $p < 0.05$. However, the sample sizes were equal and the F statistic is robust to violation so the split plot was completed. Mauchly's Test of Sphericity indicated that the Greenhouse-Geisser Test of Within-Subject Effects should be used. The Greenhouse-Geisser results are displayed in Table 4.3.

Table 4.3 Test of Within-Subjects Effect

Source	df	Mean Squares	F	Sig
Condition	1.877	.007	.996	.369
Condition/ Group Interaction	3.754	.004	.509	.718

Error	90.087	.007		

There was no significance within the condition F (1.877, 90.087) =.996, p> 0.05. or the interaction results. F (3.754, 90.087) =.509, p> 0.05. Tests of Between-Subjects Effects were also completed. Results can be seen below in Table 4.4

Table 4.4 Test of Between-Subjects Effect

Source	df	Mean Squares	F	Sig
Group	2	.036	.981	.382
Error	48	.037		

The effect of group is not significant. F (2, 48) =.981, p> 0.05.

Results of Research Questions

Research Question 1. Do students who take online multiple-choice quizzes during the course of the unit score higher on end of chapter exams than students who do not take these quizzes?

Participants took 11 or 12 multiple-choice quizzes and 11 or 12 no quiz experiences during the course of the study. The type of quiz rotated throughout the duration of the study. Each participant took at least one type of quiz in every chapter. There was no significant difference on the test scores for multiple-choice quizzes when compared to no quiz. The multiple-choice quizzes did not improve student learning. On the other hand, they did not hurt student achievement either.

Research Question 2. Do students who take paragraph quizzes during the course of the unit score higher on end of chapter exams than students who did not take these quizzes?

Participants took 11 or 12 paragraph quizzes and 11 or 12 no quiz experiences during the course of the study. The type of quiz rotated throughout the duration of the study. Each participant took at least one type of quiz in every chapter. There was no significant difference on the test scores for paragraph quizzes when compared to no quiz. The paragraph quizzes did not improve student learning. On the other hand, they did not hurt student achievement either.

Research Question 2. Do students who take paragraph quizzes during the course of the unit score higher on end of chapter exams than students who take multiple-choice quizzes?

Participants took 11 or 12 paragraph quizzes and 11 or 12 no multiple-choice quizzes during the course of the study. The type of quiz rotated throughout the duration of the study. Each participant took at least one type of quiz in every chapter. There was no significant difference on the test scores for paragraph quizzes when compared to multiple-choice quizzes.

Interview Questions

Since no significant difference was identified between the three groups, initial follow up interviews were conducted with five students. The interview questions were refined and 10 randomly selected students completed full interviews. These interviews were completed to get student input on the use of the online quizzes. Students shared their answers to the following questions:

1. Tell me how you prepared to take the chemistry tests that Mr. Ddddd gave in class.
2. Tell me about the chemistry book for your course?

3. After you were assigned reading, you always answered two questions about how hard the material was and how confident you were. After that, sometimes you did nothing else, sometimes you wrote a paragraph, and sometimes you were asked some multiple-choice questions. We didn't find any difference between how you prepared and how you did on the chemistry exams that Mr. Ddddd gave in class. That is, when you were doing one thing (like writing a paragraph), other students were doing something else. It didn't seem to matter what you did. Can you explain why it didn't matter?
4. When did you get down to really studying for Mr. Ddddd's tests?
5. When you were preparing for a test, say during the last 24 hours before the test, what were the materials you used most?
6. What about a review sheet? A work sheet? Questions at the end of the book chapter? Re-reading the book?
7. If you were a teacher using the online quizzes, how would you use them differently
8. Is there anything else that you would like to tell me about chemistry?

Interview Results

Student answers were placed into categories and tabulated. It is important to note that some students responded with more than one answer so not all tabulations sum to ten. The questions and their responses can be found in Table 4.5-4.10

Table 4.5

How did you prepare to take the end of chapter exams?

Reviewed Class notes	6
Ask teacher questions	1
Reviewed assignments	1
Used review guides	8
Did not review	3
Used online quiz	1
Asked Parents	1
Reviewed from book	1

Comments on this question included:

I reviewed my notes and homework assignments and if I had a question I asked Mr. Ddddd or looked in the book.

I used the study guides, my notes and worksheets and I asked my Dad. If it was hard, I checked the book.

I know the material so I don't study, but I do look at the review guide.

Table 4.6

Describe your chemistry textbook

Non descriptive, needs more explanation	1
I don't really read the text fully	1
I learn more from the teacher and review guides. The book does not make sense. Too hard to understand on my own.	10
Mostly a good understandable book	2
A resource for labs and data	6

Comments on this question included:

The book is sometimes non-descriptive and needs an explanation.

I read the book sometimes for definitions and experiments. I never really read it like fully.

I didn't use the book much in class. I learned everything from Mr. Ddddd.

The book is hard to learn on your own. Chemistry can't be self-taught. Some chapters needed handout and lectures.

Good book. Lots of stuff that could be explained in one paragraph instead of three pages.

It is easier from Mr. Ddddd. I like the chapter reviews. It's easier reading them than the whole chapter when necessary.

Table 4.7

Why do you think that the online quizzes did not help you do better on the tests?

No idea	2
Questions are worded differently	1
Computer questions were not as hard as test questions. They were mostly recall	3
I need the teacher to understand it	1
Quizzes were not taken seriously	7

Comments on this question included:

Before the quizzes I didn't study. I just used them as help to study. I just read the review guide before the online quiz. The questions were not hard, but the computer questions were not as hard as tests.

That's because students are not motivated so they go from their general knowledge. You have to pay attention to do good.

Students need to ask questions which a lot of people are "scared" to do. Asking questions makes you sound weak.

People didn't take it seriously.

Table 4.8

When did you begin studying for the end of chapter tests?

1 day before	9
Period before	1
I learn it in class	1
2 days before	2

Comments on this question included:

The day before or when the review guide was assigned.

In class, then night before, but not in advance.

The night before. If not, I'd cram the period before.

The day before; maybe 2 days before.

I pay attention so it doesn't affect me that much

Two days or night before.

Table 4.9

When you were preparing for a test, say during the last 24 hours before the test, what were the materials you used most? What about a review sheet? A work sheet? Questions at the end of the book chapter? Re-reading the book?

Book	3
Notes	10
Old assignments and review guides	7
Labs	2

Comments on this question included:

Book and notes

Worksheets, assignments, and the text book some, but not as much.

Review guides.

The stuff I wrote down; not book the books very much.

Table 4.10

How would you use the online quizzes differently?

I would not use them.	3
Prevent the use of text when they are taking quizzes	5
Prevent going back	1
Have teacher created material	1

Comments on this question included:

Wouldn't use them. [Why not?] Kids would just use books or work together on them.

Kids know how to beat the system "more than you think."

Make the quizzes so students couldn't go back. Students can just change the answers.

Watch students take it to make sure they are not using the book.

Closing comments from the students indicated that most prefer getting the information from the teacher rather than the book. Three comments seem to drive this idea home:

He should explain more concepts rather than just asking us to do them on our own. He's better at explaining [than the book] I understand it better when he explains it.

He needs to lecture more. I need some things need to be covered more with further explanation.

I like it when he makes you think -- makes it challenging. I learn a lot by experiment.

Rather learn through lecture than reading book.

Chapter V

Discussion

Introduction

The purpose of this study was to determine the impact online chemistry quizzes had on the learning of chemistry concepts. The study looked for a connection between the use of the quizzes and the mastery of the material. If a relationship existed, the scores on the various end of chapter tests would have been significantly different. If the scores on the end of chapter exams did not vary, it would suggest that the online quizzes did not impact learning.

Grade Level

This study did not find a significant difference when students took online multiple-choice quizzes, online paragraph quizzes, or no quiz. This result was similar to the findings of several other researchers who had implemented online quizzes at the collegiate level. Chumley-Jones (2002) noted in their review of 206 studies of web-based learning that using the web improved post test scores, but these improvements were not significant. The Shimazu (2005) and Harter and Harter (2004) studies both indicated that there was no significance in the online versus groups who did not work online. Student scores were compared within each group and between each group. No significance was seen in t-test comparisons or one way ANOVA comparisons. The results can be contrasted with the results found at the elementary level. Reimer and Moyer (2005) found a significant improvement in third grade math achievement when online methods were used to teach fractions.

In the significance portion of this dissertation it was noted that the use of online quizzes at the high school level had not been studied in depth. The results of the study indicate that the high school chemistry students exhibited learning patterns that were more closely aligned with the college studies reviewed in the literature review.

Immediate Feedback

In the literature review section of this paper, Brooks et al. (2005) stated that immediate feedback was seen as a sign of successful instruction. This feedback allowed students to become more actively involved online.

In the current high school chemistry study the quizzes that received immediate feedback were the multiple-choice quizzes. The paragraph quizzes and the no quiz groups did not receive immediate feedback on their answers. Even though the multiple-choice quiz participants received immediate feedback, their scores were not significantly better. Providing immediate feedback on the online quizzes did not have an impact on the results on the chapter exams. This shows that the students in this study were not actively involved in the multiple choice process at a higher level than when they completed the paragraph quiz or took no quiz at all.

Hwang and Arbaugh (2006) and Reimer and Moyer (2005) found that immediate feedback was one of the major assets of online learning. All noted that it was important to provide "immediate and specific feedback that students could use to solve future problems." In terms of this study, the online quiz feedback does not seem to align with the quoted feedback requirements. One high school student noted, "I can't explain why it (taking the quizzes) didn't matter. The test questions were phrased differently." Another student noted that, "the computer questions were not as hard as the test questions." A

third student said, “The computer questions were too easy or just recall.” Difficulty seems to be an influence on the students’ scores. They were not able to make much transfer from the recall quiz questions to the more in-depth test questions. The use of quiz items as models for future problems does not seem to exist for these students.

Mavrikis and Maciocia (2003) identified the fact that immediate feedback outside of class was a benefit of taking quizzes outside of class. Having the ability to take quizzes outside of class and receive feedback on the quizzes was seen as a benefit. This benefit was not important to interviewed students. Based on interviews the students did not take the quizzes to learn, but to get the completion points awarded. Students noted, “People did not take the tests seriously. They guessed and wrote the answers down. I didn’t really read. It was easier to guess online.”

Learning

Zerr’s (2007) description of teaching as a brief explanation followed by student work and then more teacher feedback may shed some light on how students in the class learned the chemistry material. According to the interviews, students placed a high priority on the review guides. The review guides were always completed in class. Students would work on them and then asked the teacher to check their work to see if it was correct. If it was not correct, the instructor would model the correct answer and then have the students continue to do the review guide.

Jacobs (2005) agreed with the importance of immediate feedback in the online environment. He suggested that the format of repeating a type of questions until mastery was reached; students became more engaged with the material. In terms of the textbook format for the chemistry text, students were not able to answer an unlimited number of

questions until mastery was reached. This is another possible explanation for why the online quizzes were not significant. Students were not required to complete questions until a mastery level was reached.

Cheating

This study seems to most closely resemble the study completed by Daniel and Broida (2004). They discussed the idea of "cheating" on online quizzes. This involved students sharing answers with one another, doing the quizzes together, and looking up answers while taking the quiz. Evidence from interviews indicated that similar activities were occurring with the high school chemistry students. Students said, "Kids just use the books or work together on the quizzes." Another student noted, "I can just change the answers on the quiz."

Interview Discussion

After piloting and revising questions based upon interviews with five randomly selected students, interviews were completed by selecting ten participants at random. The researchers felt that conducting the interviews would shed some light on the lack of significance that was seen between the treatment groups. When asked how they prepared for the exams, the student responses to this question indicated that the online quizzes were not seen as a way to actively prepare for the tests. Only one of the ten students interviewed identified the online quiz portion of the course as a method of test preparation. Although three noted they did not review, the remainder said they placed value in studying their notes and review guides as their main form of test preparation.

When asked their opinion of the chemistry text, student opinion seemed to indicate that they viewed the text more as a resource than as something they could

become actively engaged with. Quoting one student, “I never really read it…like fully.” One student noted that chemistry was not something she would study individually stating, “Chemistry is not something you learn on your own.”

Although the textbook company prepared both the tests and the online multiple-choice quizzes, many students believed that the test questions were more challenging. Many students identified the fact that they did not take the quizzes seriously as the reason for the quizzes not helping them read the text better or perform better on the exams.

When asked about the lack of significance in the data, students shared some valuable insights. A majority of those interviewed believed the quizzes were not taken seriously by the class. One student shared, “Students are not motivated to do well on the quizzes so they just go from their general knowledge.”Several students shared that rather than read the text fully; they just guessed the right answer.

The way students prepared for these end of chapter tests was also a topic of discussion in the interviews. All, but one student interviewed delayed preparation for the test until the night before the test. It is interesting to note that none stated that the online quizzes were a form of test preparation. This seems to follow the pattern of not taking the reading assignments and quizzes seriously. One student did note that simply by listening in class they were able to be prepared for the exams. If and when the students did begin studying, they placed major emphasis on the text written review guides. Nearly all of the students found that the reviews guides played a major role in their test preparation. Since the review guides and the end of chapter exams were both prepared by the textbook company, the students identified the correlation between understanding the review guides and doing well on the exams.

When asked how they would change the use of the online quizzes, several noted that they would eliminate them from the class. One student's thoughts are very telling, "Kids know how to beat the system." Several of those interviewed noted that, instead of reading the text, they completed the quizzes by looking back in the text. Others noted that they completed them together rather than individually. Students felt that if the quizzes were to be used successfully, they needed to be held more accountable "They should not be able to scroll back and retake the quizzes." They also felt the questions should more closely mirror the instructor's style. These statements indicated that the high school chemistry students were focused more on earning a high score on the exam than on actually learning the concepts.

Recommendations

After reviewing this research, several recommendations come to mind. Creating student accountability was a key suggestion identified from the student interviews. To improve accountability on the multiple-choice quizzes, a student should be prevented from retaking the same quiz. A large number of quiz bank questions should exist so that students would receive different questions each time a quiz was taken. A time limit for answering a given quiz item should also be implemented. The time limit would prevent students from reading a question and then searching the text for the correct answer.

Several teacher actions might improve the effectiveness of the online quizzes. Teachers who implement the online quizzes should make a conscious effort to emphasize the connection between the quizzes and the exams. Questions from the online or paragraph quizzes could be discussed in class or even used on the chapter exams.

Awarding a percentage score rather than a completion grade for each quiz taken would also add emphasis to the quizzes.

Students should not be awarded points for completion of the quiz. Instead, percentage scores for the multiple-choice quizzes should be recorded. Students taking paragraph quizzes should receive more immediate feedback on their responses and these responses should also be graded.

At least one student action is also worth consideration. The fact that students were more concerned with earning a good score than learning the material should be studied. Interviews noted that scoring well on the quizzes using any method possible was the norm. Good grades seemed to be more of a motivating factor than learning. Methods for creating better connections between good grades and learning could provide a better means for improving learning in the chemistry classroom.

Limitations

Several limitations need to be identified for this study. Since the students selected for the study all came from one high school, a larger sample or a sample of students from several high schools would provide more complete information on the impact of online quizzes at the high school level.

This student body tends to have students whose overall academic achievement is high. 40 of the students in this study received a B or higher in their prior science class with none of the students having identified special needs. Using the online quizzes with a more even grade distribution would provide evidence of the impact of the online environment for all students.

The sample population was also limited by the students' race and socio economic background. All students were Caucasian and most were from middle class or upper class families. Here again, including a more diverse population would broaden the findings of the study.

Another limitation involves the researcher. The researcher was the only chemistry instructor involved in the study. Other teachers may plan and teach differently which could lead to differing results.

Student behaviors also limited the findings of the study. Based on the interviews, it became apparent that many students chose not to read the material and yet took the online quiz. These students impacted the data by not reading the material prior to taking the quiz. This in turn could have affected their percentage correct scores.

A final limitation involved the technology used. A few students had computer access difficulties. At times, their internet was down which prevented ready access to the online quizzes. This forced them to take the quizzes without the necessary preparation time.

Future Research

One major area of future research lies in the way the online quizzes were used. Students suggested changing the online quiz format. One possible study would involve preventing the students from taking the quiz more than once. This would prevent the students from recording phony answers on the multiple-choice quizzes, getting the correct answers, and then retaking the quiz.

Providing immediate feedback on the paragraph quizzes is another factor to consider. If students were awarded grades for what they wrote the day after the quiz was taken,

more influence on the types of writing that was allowed would occur. This in turn would improve student engagement with their reading.

A third follow up study might involve more control of the online environment. Quizzes could be taken in the computer lab rather than at home. This would eliminate the convenience of the online quizzes, but the level of cheating on the quizzes would be greatly limited. Another control would involve limiting the time allowed for each question. This would prevent searching for answers in the text rather than reading the text in advance.

Implications

The findings of this study provide several implications for the high school chemistry teacher. Since there was no significant difference on online multiple-choice scores and the scores of students who took no quiz, teachers should not be persuaded to adopt texts that have this option. The results did not indicate the online quizzes hurt learning, but neither did they show any improvements in student achievement.

The majority of students interviewed stated that the teacher and the review guides were their main source of information. The book was seen as a good resource for lab work and charts, but they felt their learning occurred in class and while completing the review guides. Referring back to the literature review, the ways students said they were actively engaged with the material occurred when the teacher followed Hwang and Arbaugh's (2006) InAsk and Outcheck methods of learning.

Student interviews indicated that the quizzes were not seen as a way to actively learn with the textbook. The textbook was seen as a good reference, but it was not viewed as an integral part of the course. Many students felt the text was too challenging to read on

their own. They preferred the guidance of the instructor over independent learning with the text. The active learning of the content occurred in class through discussion and small group work.

Conclusions

The purpose of this study was to examine the impact online quizzes had on the mastery of chemistry concepts as measured by end of chapter exams. The researcher felt that completing the online quizzes might create a higher level of student engagement which would result in a more active learning environment for the student.

The results of this study indicate that the type of quiz taken after reading a section of chemistry had no impact on the student's learning. The results also indicated that, in this study, student's who took no quiz after reading did not score significantly better or worse than they did on the sections where a quiz was taken.

Follow up interviews with students indicated that students did not make a connection between the online quizzes and preparation for the tests. They simply did not take the quizzes seriously. Most students identified notes and review guides as their primary mode of test preparation. Teacher lectures and listening in class were also seen as a method of for test preparation.

The online quizzes could have been negatively influenced by several factors. Those interviewed identified several factors that diminished the importance of the online quizzes. Students noted that since they had the ability to take the multiple-choice quizzes repeatedly, they did not read the text prior to completing the quizzes. Instead, they went off of general knowledge or just guessed. When they got an answer wrong, students read the correct answers and corrected the answer the next time they took the quiz. Other

students noted that they worked together on the quizzes sharing answers. Students wanted to score well on the quizzes, but they did not see a connection between doing well on the quizzes and earning a good grade on the examination.

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Appendix A

University of Nebraska Lincoln

IRB # 2007-08-458 EX

Dear Parents,

This fall I will be conducting some science education research with my chemistry students. I will be looking at the best way to assess chemistry textbook readings. The attached consent form explains in detail what data I will be doing. I want to assure you that the project I am completing will not harm your child. I would appreciate it if you would read the assigned consent form and return it today.

Thanks for your help,

Chris Deeter

Appendix B

University of Nebraska Lincoln

Dear Parents,

IRB # 2007-08-458 EX

As many of you know, I am in the process of completing my PHD program through the University of Nebraska-Lincoln. The final part of this program involves the completion of a research project. Your child has the opportunity to take part in this research project because he or she is a student in one of my chemistry classes. It is important to note that student grades will not be impacted by participation or non participation in the study. Care will be taken to ensure the instructor will not know who has opted in or out of the study until after grades for the semester have been submitted.

Attached to this letter is an informed consent form. Please read it and return it to Mrs. Heislen as soon as possible.

If you have questions, please feel free to contact me.

Chris Deeter

Appendix C

GLENCOE/MCGRAW-HILL P.01/01

Glencoe

Glencoe/McGraw-Hill
School Solutions Group

21600 Oxnard Street
Suite 500
Woodland Hills, CA 91367-7809
818 615 2600 Tel
818 615 2699 Fax

July 30, 2007

Chris Deeter
Lincoln Lutheran Middle/High School
1100 N 56th St
Lincoln, NE 68504
FAX: 402-467-5405

Dear Chris:

You have our permission to post the self-check quizzes from *Chemistry: Matter and Change* on a secure server at the University of Nebraska, as part of an experiment to determine whether participation in and feedback from self-check quizzes enhances student performance, provided that you agree:

1) To post the material as published, without alteration or deletion.
2) To post the material only on a password protected site, accessible solely to Nebraska students participating in your experiment.
3) That this permission will expire on February 4, 2008, at which time the material will be removed from the University of Nebraska server. Future use will require a renewal of this license, which will not be unreasonably withheld.
4) That this permission does not pertain to any material that is the property of one of more copyright owners as so specified in our text.
5) That this permission is non-exclusive, not transferable, and pertains solely to the particular term, medium, usage and distribution specified above.

Please feel free to contact me if you have any questions.

Sincerely,

Mark Schaefer
Permissions Coordinator

Appendix D

Online Assessment in the Chemistry Classroom

Statement of Informed Consent

IRB # 2007-08-458 EX

Purpose of the Research
We are interested in studying how online assessment impacts the understanding of first semester chemistry topics.

Procedures
When students log on for the first time, they will be given an identifying password known only to them. After logging on, they will be asked to complete an assessment based on the assigned reading for the day. At times students will be asked to complete multiple choice quizzes over the readings or short answer paragraphs based on the readings. At other times students will be asked only how well they understood what they read.

Risks and/or Discomforts
There are no known risks to users from using this type of web site assessment.

Benefits
The students will review material as they complete the assessments. This has the potential to increase their knowledge of chemistry.

Alternatives
Students without web access will be provided paper and pencil copies of these materials.

Confidentiality
The privacy of the participants in the research will be maintained throughout the study. The information obtained in this study may be published in scientific journals or presented at scientific meetings but the data will be reported as aggregated data.

Compensation
There is no compensation for participating in this research.

Opportunity to Ask Questions
Persons interested in discussing the research can contact the senior researcher, Larry Walter. Mail to: jwalter@unlserve.unl.edu

Freedom to Withdraw
You are free to decide not to participate in this study or to withdraw at any time without adversely affecting your relationship with the investigators, the University of Nebraska,

or the participating agent. Your decision will not result in any loss of benefits to which you are otherwise entitled.

Consent, Right to Receive a Copy
You are voluntarily making decision whether or not to participate in this research study. Selecting 'agree' certifies that you have decided to participate having read and understood the information presented. We encourage you to print a copy of this form for your records.

Investigators
Larry Walter, mail to: jwalter@unlserve.unl.org
Chris Deeter, mailto:cDdddd@lincolnlutheran.org

If you have any questions about your rights as a research subject that have not been answered here or by the investigator, you may contact the University of Nebraska-Lincoln Institutional Review Board, telephone (402)-472-6965.

_____Signature of Parent _____Date

_____Signature of Student _____Date

Appendix E

University of Nebraska Lincoln

HUMAN RESEARCH PROTECTION
Institutional Review Boar

October 10, 2007

Dr. Larry Walter
TLTE
238 Mabel Lee
(0234)

IRB# 2007-08-458 EX

TITLE OF PROJECT: **Online Assessment in the Chemistry Classroom**

Dear Dr. Walter:

This letter is to officially notify you of the approval of your project by the Institutional Review Board (IRB) for the Protection of Human Subjects. This project has been approved by the Unit Review Committee from your college and sent to the IRB. It is the Board's opinion that you have provided adequate safeguards for the rights and welfare of the participants in this study. Your proposal seems to be in compliance with this institution's Federal Wide Assurance 00002258 and the DHHS Regulations for the Protection of Human Subjects (45 CFR 46) and has been classified as exempt.

Date of EX Review: **10/10/07**

You are authorized to implement this study as of the Date of Final Approval: **10/10/07**. This approval is Valid Until: 10/09/08

1. Attached on NUgrant is the IRB approved informed consent forms for this project. Please use these forms when making copies to distribute to your participants. If it is necessary to create a new informed consent cover letter, please send us your original so that we may approve and stamp it before it is distributed to participants.

We wish to remind you that the principal investigator is responsible for reporting to this Board any of the following events within 48 hours of the event:

- Any serious event (including on-site and off-site adverse events, injuries, side effects, deaths, or other problems) which in the opinion of the local investigator was unanticipated, involved risk to subjects or others, and was possibly related to the research procedures;
- Any serious accidental or unintentional change to the IRB-approved protocol that involves risk or has the potential to recur;
- Any publication in the literature, safety monitoring report, interim result or other finding that indicates an unexpected change to the risk/benefit ratio of the research;
- Any breach in confidentiality or compromise in data privacy related to the subject or others; or
- Any complaint of a subject that indicates an unanticipated risk or that cannot be resolved by the research staff.

This project should be conducted in full accordance with all applicable sections of the IRB Guidelines and you should notify the IRB immediately of any proposed changes that may affect the exempt status of your research project. You should report any unanticipated problems involving risks to the participants or others to the Board. For projects which continue beyond one year from the starting date, the IRB will request continuing review and update of the research project. Your study will be due for continuing review as indicated above. The investigator must also advise the Board when this study is finished or discontinued by completing the enclosed Protocol Final Report form and returning it to the Institutional Review Board.

If you have any questions, please contact Shirley Horstman, IRB Administrator, at 472-9417 or email at shorstman1@unl.edu.

Sincerely,

Dan R. Hoyt, Chair
for the IRB

Shirley Horstman
IRB Administrator

Appendix F

University of Nebraska Lincoln

HUMAN RESEARCH PROTECTIO
Institutional Review Bo

January 2, 2007

Dr. Larry Walter
TLTE
238 Mabel Lee
(0234)

IRB# 2007-08-458 EX

TITLE OF PROJECT: , **Online Assessment in the Chemistry Classroom**

Dear Dr. Walter:

The Institutional Review Board for the Protection of Human Subjects has completed its review of the Request for Change in Protocol submitted to the IRB.

1. It has been approved to complete a random sample and interview 20 students.

We wish to remind you that the principal investigator is responsible for reporting to this Board any of the following events within 48 hours of the event:

- Any serious event (including on-site and off-site adverse events, injuries, side effects, deaths, or other problems) which in the opinion of the local investigator was unanticipated, involved risk to subjects or others, and was possibly related to the research procedures;
- Any serious accidental or unintentional change to the IRB-approved protocol that involves risk or has the potential to recur;
- Any publication in the literature, safety monitoring report, interim result or other finding that indicates an unexpected change to the risk/benefit ratio of the research;
- Any breach in confidentiality or compromise in data privacy related to the subject or others; or
- Any complaint of a subject that indicates an unanticipated risk or that cannot be resolved by the research staff.

This letter constitutes official notification of the approval of the protocol change. You are therefore authorized to implement this change accordingly.

If you have any questions, please contact Shirley Horstman, IRB Administrator, at 472-9417 or email shorstman1@unl.edu.

Sincerely,

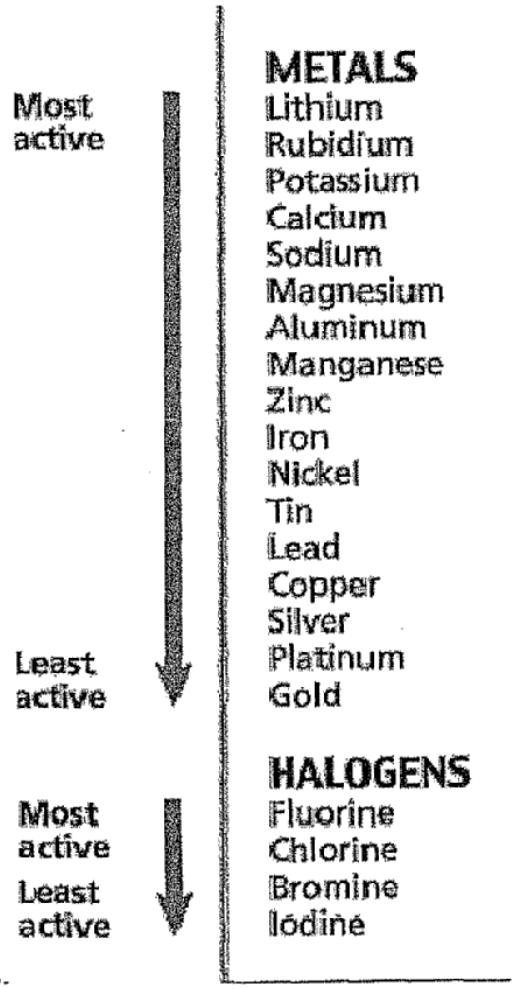
Dan R. Hoyt, Chair
for the IRB

Appendix G

Chemical Reactions: Classifying Chemical Reactions

1. Will the double displacement reaction $NaOH + CaBr_2$ occur? If so, what is the product of the reaction?

- ☒ x. No response
- ☐ a. No
- ☐ b. Yes, $Br(OH)_2$
- ☐ c. Yes, $CaNa$
- ☐ d. Yes, $Ca(OH)_2$



2.

Which of the following single-replacement reactions will occur?

- x. No response
- a. $Br_2(g) + HF(aq) \rightarrow$
- b. $Cl_2(g) + HBr(aq) \rightarrow$
- c. $Au(s) + Cu(NO_3)_2\ (aq) \rightarrow$
- d. $Cu(s) + ZnCl_2(aq) \rightarrow$

3. What type of reaction occurs when potassium and chlorine gas produce potassium chloride?

Predicting Products of Chemical Reactions

Class of reaction	Reactants	Probable products
Synthesis	Two or more substances	One compound
Combustion	A metal and oxygen	The oxide of the metal
	A nonmetal and oxygen	The oxide of the nonmetal
	A compound and oxygen	Two or more oxides
Decomposition	One compound	Two or more elements and/or compounds
Single-replacement	A metal and a compound	new compound and the replaced metal
	A nonmetal and acompound	A new compound and the replaced nonmetal
Double-replacement	Two compounds	Two different compounds, one of which is often a solid, water, or a gas

- x. No response
- a. combustion
- b. decomposition
- c. replacement
- d. synthesis

4. What are the products of the reaction between barium hydroxide and hydrochloric acid?

- x. No response
- a. barium chloride and water
- b. barium hydroxide and water
- c. barium chloride and barium hydride
- d. chloric acid and barium

5. The following chemical equation is classified as a _____.
$CaCO_3 \rightarrow CaO + CO_2$

- x. No response
- a. synthesis reaction
- b. decomposition reaction
- c. single-replacement reaction
- d. double-replacement reaction

6. In the combustion reaction of propane, C_3H_8, what are the products?

- x. No response
- a. C_3H_8 and O_2
- b. C_3H_8 and CO_2
- c. O_2 and H_2O
- d. H_2O and CO_2

7. The major physical indicator of a combustion reaction is _____.

- x. No response
- a. heat
- b. a color change in solution
- c. the formation of a precipitate
- d. cold

8. The chemical equation $2H_2 + O_2 \rightarrow 2H_2O$ represents a _____.

- x. No response
- a. synthesis reaction
- b. decomposition reaction
- c. single-replacement reaction
- d. double-replacement reaction

9. The chemical equation $Zn + 2HCl \rightarrow H_2 + ZnCl_2$ represents a _____.

- x. No response
- a. synthesis reaction
- b. decomposition reaction

c. single-replacement reaction

d. double-replacement reaction

Submit

In recent years, textbook companies have created additional online perks to attract school districts faced with pressure to include technology in their curriculum. Many textbook companies have included online reading quizzes. The textbook salesmen have encouraged the idea that instructors who required the reading quizzes were providing motivation for their students to do the text readings. The quizzes were also identified as a method students could use to identify the main ideas in a section of reading. Teachers were told that those who completed the online assessments would be more aware of the crucial portions of the text. In this study, the following questions were considered.