

INCREASING THE EFFECTIVENESS OF CLASSROOM  
CHEMISTRY DEMONSTRATIONS

by

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of

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July 2012

## DEDICATION

I would like to dedicate this research to my husband, my best friend. He is the most amazing, caring and thoughtful person I know. I couldn't agree more with Ralph Waldo Emerson's statement that, "Life is a journey, not a destination." And I couldn't imagine the journey with anyone except my wonderful husband.

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## ABSTRACT

William Butler Yeats once wrote “Education is not the filling of a pail but the lighting of a fire.” I believe that a safe, well-structure, inquiry-based demonstration provides an opportunity to do both in a classroom; light a fire and fill a pail. And more specifically, a science demonstration draws on a student’s natural wonder about the world around them. In only for a brief moment, a science demonstration causes the student to ask “How did that happened?” or “Why did that just do that?” At that moment and the moments that follow, a teacher has an extraordinary opportunity to simultaneously “light a fire” and to “fill a pail.”

This study aims to discover the best practice methods for improving the depth of learning and understanding that surrounds a well-structured, inquiry-based demonstration. Specifically, the study seeks to determine how the effectiveness of a demonstration can be increased when students are required to record observations and make connections between the demo and real-world applications. As well, the study aims to determine if peer collaboration and discussion is a critical element for student understanding and to make connections between textbook concepts and practical examples. Lastly, the study will evaluate the value of demonstrations presented in-person versus in video format.

The study will involve two sections of Chemistry C, which is an elective upper-level course. Approximately 45 students will be included in the study. The study will be conducted during the unit Chemical Reactions and Types because the unit naturally includes several demonstrations within the curriculum.

Qualitative and quantitative data collection methods will be utilized during the course of this study. These methods include a summative assessment for the Chemical Reactions and Types Unit, a student survey, a student questionnaire, several student interviews and several other data collection sources.

## INTRODUCTION AND BACKGROUND

### Project Background

William Butler Yeats once wrote “Education is not the filling of a pail but the lighting of a fire.” I believe that a safe, well-structure, inquiry-based demonstration provides an opportunity to do both in a classroom; light a fire and fill a pail. And more specifically, a science demonstration draws on a student’s natural wonder about the world around them. In only for a brief moment, a science demonstration causes the student to ask “How did that happened?” or “Why did that just do that?” At that moment and the moments that follow, a teacher has an extraordinary opportunity to simultaneously “light a fire” and to “fill a pail.”

Science supply companies and publishers of educational materials have safe and wonderful ideas and procedures for chemistry demonstrations. However, demonstration kits and specifically designated demo supplies provide little if any support for amplifying student engagement. Key techniques, class discussion prompts, inquiry ideas or other methods for maximizing student learning are often not included. As a result, I believe many teachers achieve the rewarding “ohhhs and ahhs” from their students but are wasting key moments of engagement to truly discuss and connect their students with chemistry.

Specifically, this study seeks to address ways to replace these wasted moments with techniques that enhance learning and increase chemistry content retention. This study aims to determine how the effectiveness of a demonstration can be increased when

students are required to record observations and make connections between the demo and real-world applications. As well, this study will determine how important peer collaboration and discussion is for student understanding and providing students a chance to make a connection between textbook concepts and practical examples. Lastly, this study will evaluate the value of demonstrations presented in-person versus in video format.

### Teaching and Classroom Environment

I have spent my entire eight year teaching career at Hesperia High School. I have a DX certification in secondary science, which allows teachers in Michigan to teach any science grades 6 – 12. I also have DC certification which is a specifically designated chemistry certification. I have taught primarily high school chemistry courses at Hesperia. My main teaching responsibilities are Chemistry B and C, which are typically junior-level courses.

This action research study was conducted in my two sections of Chemistry C, which is an elective class. The majority of students in Chemistry C are college bound. The Chemistry C curriculum consists of units ranging from the mole to stoichiometry to the gas laws. The present school calendar and daily schedule is presented to students in a two-semester format with daily schedule of 6, 55-minute class periods. The school year calendar consists of 2 semesters, each composed of 18-week long classes.

### School Demographics

My high school is located in Hesperia, Michigan. The community has been transformed in the last few decades from primarily a farming community to a community that people live and commute elsewhere for employment. According to the 2010 Census data, the mean travel time to work for workers age 16+ was 28.9 minutes.

The school is located on the border between Oceana County and Newaygo County on the west side of Michigan's Lower Peninsula. According the US Census Bureau in 2009, Oceana and Newaygo Counties had median household incomes of \$37,655 and \$39,059, respectively. Additional US Census data from 2010 indicates the average percentage of people graduating from high school is 84.6%. The average graduation rate in 2000 for Michigan as a whole was slightly higher at 87.4%. The percentage of people that have a Bachelor's degree or higher is approximately 13.5% (2010 US Census) for the two counties.

The vast majority of the residents in both Newaygo County and Oceana County are white; approximately 95% of the student body is white. The second highest race is Hispanic. The community data is representative of the student population at Hesperia High School.

The demographics of my classroom are fairly comparable to the community demographics as a whole. More specifically, the students in my Chemistry C classes come from middle-class families. These students are mostly 11<sup>th</sup> graders. In past years, students in Chemistry C were high-achieving, college-bound students. Contrary to the student dynamics in past years, the students in this year's Chemistry C classes represent a wider variety of ability levels. The students this year do not have an elevated grade point average compared to the peers in their graduating class as seen in previous years. This

can be attributed to an increased student interest in the course and few elective classes offered as a result of a reduction in the district budget. There are 40 Chemistry C students divided between two sections.

### Focus Question

Concern about how to get the most out of a classroom science demonstration led me to my primary focus questions: How can the effectiveness of a demonstration be increased if students are required to record observations, answer questions and generate new questions in a written format [Student Demo Sheet] about how the demonstrations connects chemistry content to a real-world application? Additionally, can student participation in the demonstration itself increase student focus and as a result of witnessing peer involvement increase the quality of observations? Lastly, if a demonstration is presented as a video, is the educational value of the demonstration sacrificed? My project questions all focus on determining the critical components of a highly effective demonstration.

## CONCEPTUAL FRAMEWORK

### Introduction

All high school speech teachers emphasize the importance of a thoughtful and engaging “attention-getter” to their students. In science classes the attention getter is often a demonstration. The science demonstration can serve as the glitz and glam of a science lesson to grab a student’s attention. But the science demonstration also needs to do more for science education than just verify science concepts presented in the textbook.

More importantly, a science demonstration can engage learners and serve as the starting block for processing, generating and understanding scientific information. A science demonstration can also help build a sense of community as teacher and learners embark on a quest to explain the wonderment generated during the demonstration.

A review of the literature on the topic of “effective demonstrations” generated several connections and links to science inquiry articles and studies. Moreover, Majerich and Schmuckler (2007) report that the literature available to substantiate “identifiable merits” associated with the teaching and learning of science using demonstrations was very limited. Majerich and Schmuckler present their research that compares a traditional lecture demonstration method and a modified demonstration lecture method. The literature review is broken into several key sections, 1) The role of demonstrations in the science classrooms 2) the link between science demonstrations and the science inquiry process and 3) methods for improving student motivation and increasing learning.

### The Role of Demonstrations in the Science Classroom

Science demonstrations have long been a key component in many science lessons. As scientists seek to explain the world through research and discovery, science teachers aim to bring this knowledge into the lives of their students, make connections to the real world and explore the amazing realm of science. Demonstrations allow science teachers to explain and illustrate these scientific theories and ideas in an engaging and enjoyable way. “Demonstrations provide students with opportunities to develop crucial higher level thinking skills such as analysis, characterization, evaluation, and synthesis. Observing an unexpected event prompts students to wonder, to ask questions, to investigate, and to

draw conclusions that explain what was observed” (Meyer et al., 2003, p. 432). Meyer et al. (2003) further explain that demonstrations can create a positive learning environment and a sense of “community.”

When a student’s question is choked off with an immediate answer, the learning process ends and the student retains the knowledge for a short amount of time. A deeper understanding is formed when students are given the opportunity to discuss, not just what happened, but why an event happened. Meyer et al. (2003) reports that “teacher and students draw closer together as learners, and discussion based upon personal interpretation so shared experiences is more likely to lead to positive and productive ends” from the teacher but rather allow for conversation to ensue (p. 433). University professor, Thomas O’Brien (1991) reports that “demonstrations can guide students to construct accurate conceptualizations and become competent, science ‘S<sub>2</sub>EE<sub>2</sub>R’s’ if they are Safe, Simple, Economical, Enjoyable, Effective and Relevant for the particular student audience” (p. 934). Ten researched, positive merits associated with the use of science demonstrations that have been identified and summarized (Majerich & Schmuckler, 2007) in Table 1.

Table 1  
*Positive Merits of Science Demonstrations*

1. act as a motivational device, arouse curiosity or gain students’ attention (Roadruck 1993),
2. convey the instructor’s attitude toward the discipline (Shakhashiri 1992),
3. stimulate the thought processes of students (Chiappetta and Koballa 2002; Roadruck 1993),
4. challenge students’ knowledge of claims, naïve conceptions, and alternate

conceptions (Chiappetta and Koballa 2002),
5. help students to focus and increase their attention (Chiappetta and Koballa 2002),
6. help students negotiate theory and experiment (Chiappetta and Koballa 2002),
7. help students see abstract science ideas in concrete examples (Ogborn et al. 1996; Shakhashiri 1992),
8. enhance students' learning of science concepts (Chiappetta and Koballa 2002; Shakhashiri 1992),
9. serve as a substitute for laboratory exercises, experiments that are too costly or dangerous to students (Alyea and Dutton 1965), and
10. develop creativity in students and promote cooperation among students and teacher (Miller 1993)

### The Link Between Demonstrations and the Science Inquiry Process

The wheels of learning are unquestionably turning, when a teacher initiates wonderment in their students and cause them to think about possible reasons that caused the changes they have seen. Everett and Moyer (2007) describe a simple outline or method for turning a traditional science lesson into an educationally engaging experience. A traditional lesson might include a teacher performing a demonstration then explaining the demonstration, followed by the students writing about how the demonstration connects what they have read about in their textbook. On the other hand, an “inquirized” lesson, would still involve a demonstration but afterwards the students become actively involved in discovering answers to their “Why?” or “How?” questions that were generated through observations of the demonstration. The students get an opportunity to answer or investigate their questions.

The National Science Education Standards (National Research Council, 1996) provide key elements for “inquirizing” a lesson. The Standards report that fundamental

elements of inquiry include: asking a question, conducting an investigation, making observation and collecting data, using the data to develop an explanation, and communicating the results. Everett and Moyer reference these standards in the five phase learning cycle required to “inquirize” a lesson. The five phases, which were originally developed in conjunction with the Biological Science Curriculum Study (BSCS), include “an *engage* that focuses students on a question, an *explore* where that question is investigated, an *explain* where the data from the investigation are analyzed and interpreted, an *extend and apply* where concepts are connected to other concepts as well as to the real world, and finally, an *evaluate* where the understandings are assessed” (p. 54).

#### Methods for Improving Student Motivation and Increasing Learning

Majerich and Schmuckler (2007) report that the format of telling students what they are about to see, showing them the demonstrations and telling them what they just saw is a traditional method in large lecture-based classrooms. Students might see a soda can imploding, a fountain of colored bubbles erupting from a tall beaker or a balloon “blown up” into the inside of a flask. And in many instances, the teacher would have already told students to watch for this to happen. The demonstration is then performed and following the demonstration the teacher explains to students what they just witnessed. Majerich and Schmuckler (2007) conducted research to substantiate the 10 merits of demonstrations presented in Table 1 and to “establish a research-based, student-centered instructional method using science demonstrations, improving students’ mastery of content, for adaptation by all science teachers” (p. 60). The study compared

examination results and student survey results between several sections of an introductory college chemistry course designed for students not majoring in science. One section was taught in a traditional lecture demonstration format and the other section was taught using a modified science lecture demonstration format. In contrast to the traditional method of incorporating demonstrations using the “tell ‘em, show ‘em, retell ‘em” format, the modified science class made several changes to make the course more student-centered. The modified science class involved students in the demonstrations and engaged students more actively in discussions involving the demonstration in order to promote student to student interaction and teacher to student interaction. In addition, the increased level and amount of discussion in the modified science class focused, at least partially, on connecting the current demonstration to previous performed demonstrations. Majerich and Schmuckler (2007) “felt that this would afford students more than one opportunity to revisit their current understandings of each demonstration and to make the course content coherent for those students who could not do so independently” (p. 63). At the conclusion of the semester a student survey was administered in order to determine students’ perception of the 10 merits reported in Table 1. The Likert-type survey indicated that students in the modified lecture demonstration course “perceived more [than the traditional demonstration lecture course] often that the demonstrations stimulated their thought processes, encouraged creativity, promoted cooperation within the lecture hall, challenged their existing knowledge of science and helped them to see abstract concepts with the demonstration materials” (p. 65).

Table 2 (Majerich & Schmuckler, 2007) compares the results for 3 examinations between the 2 courses and reports the statistical analysis for the 3 exams. The modified

demonstration lecture course scored at least 18% higher on each of the 3 exams compared to the traditional demonstration lecture course. Furthermore, a comparison of percentages clearly illustrates the higher achievement on all 3 exams by the modified demonstration lecture course. On exam 1, the modified course had an average percentage of 82% while the traditional course had an average percentage of 60%. On exam 2, the modified course had an average percentage of 80% while the traditional course had an average percentage of 56%. On exam 3, the modified course had an average percentage of 80% while the traditional course had an average percentage of 62%.

Table 2  
*Examination Results for a Traditional College Chemistry Course versus a Modified, Student-Centered, Chemistry Course (Adapted from Majerich and Schmuckler, 2007).*

<i>Exam</i>	<i>Traditional Course ± SD</i>	<i>Modified Course ± SD</i>	<i>Difference between Means</i>
1	(N = 191)	(N = 181)	Modified Course Mean 22% greater than Traditional Course Mean
	39.42 out of 66 points ± 11.64	53.94 out of 66 points ± 10.20	
	(Mean = 60%)	(Mean = 82%)	
2	(N = 166)	(N = 171)	Modified Course Mean 24% greater than Traditional Course Mean
	32.69 out of 58 points ± 7.33	46.18 out of 58 points ± 6.48	
	(Mean = 56%)	(Mean = 80%)	
3	(N = 140)	(N = 166)	Modified Course Mean 18% greater than Traditional Course Mean
	52.08 out of 84 points ± 11.83	67.21 out of 84 points ± 9.32	
	(Mean = 62%)	(Mean = 80%)	

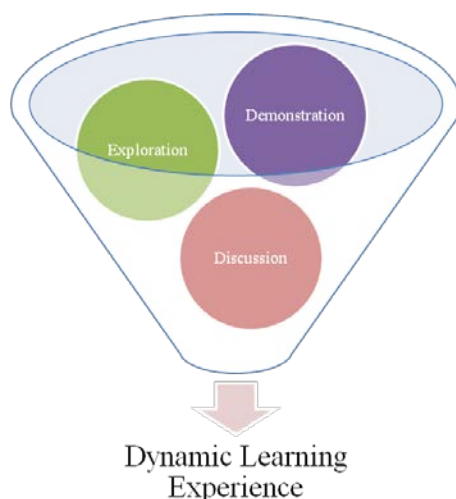
Overall, students in the modified demonstration lecture course felt that they learned more course content than the traditional demonstration lecture course, which was substantiated with comparison of student performance on the examinations. The methods used in the modified course provided students with more opportunity to engage in their own learning and utilize strategies to connect key concepts presented throughout the semester.

In addition to increasing student involvement during a demonstration and providing methods for making connection to previously taught concepts, the National Science Education Standards (National Research Council, 1996) highlights the importance of student questioning as a key component in the process of inquiry. The National Science Education Standards (1996) further state that “inquiry into authentic questions generated from student experiences is the central strategy for teaching science” (p. 31). van Zee, Iwasyk, Kurose, Simpson and Wild’s (2001) made several assertions about effective student and teacher communication methods in a science classroom. The first assertion from the study stated that “students asked questions when we [the teacher researchers] invited them to do so” (p. 182). The second assertion reported that “students asked perceptive questions during conversations about familiar contexts in which they had made many observations over a long period of time” (p. 183). In other words, students in the study formed the best questions if they had prior knowledge. The third assertion acknowledged the emotional and physical environment of the classroom and atmosphere surrounding the discussion or conversation. van Zee et al. proclaimed that “students asked questions when we [the teacher researchers] created comfortable discourse environments within which they could try to understand on another’s thinking”

(p. 183). The final assertion made by van Zee et al, 2001, involved observations and recordings made during student conversation and peer collaboration. van Zee (2001) states, “Students used ways of speaking with one another that we [the teacher researchers] had modeled in whole group discussions, such as asking questions that moved the thinking forward while mentoring a classmate” (p. 183).

Undoubtedly, demonstrations generate student questions through observation. Student learning should then extrapolate from their speculation and wonderment. Minstrell and van Zee (2003) report that in many science classrooms a common discourse of teacher posing a question, student answering and teacher evaluating occurs. Minstrell and van Zee further report that questioning and conversation can be a powerful tool to move past a memorization of facts to a deeper understanding of science concepts and theory. Furthermore, Minstrell & van Zee state (2003) “knowing *how* we know is at least as important as knowing *what* we know” (p. 61).

Miller (1993) has also conducted research on the implementation of demonstration, exploration and discussion. Miller reported that when his instruction was focused on learning material, learning was “static.” Miller’s demonstration – exploration – discussion method is illustrated in Figure 1.



*Figure 1.* Demonstration, Exploration, Discussion Method Model (Adapted from Miller, 1993).

The method is not necessarily performed in a linear sequence which provides students with a richer understanding of science concepts and learning becomes more “dynamic.” Miller states (1993, p. 188) that “during the process students have an opportunity to practice being scientists: they observe, they discover, they formulate hypotheses, they test their hypotheses, they create, and they expand their knowledge.”

The literature highlights effective, engaging but perplexing science demonstrations as wonderful ways to initiate learning. The literature review of science demonstrations and inquiry illustrate reoccurring themes revolving around student participation in teacher-facilitated, whole-class discussion or peer discussion and making connections to previously performed demonstrations. The research and literature shows a clear importance on the discussion process as a key component in the science inquiry process.

## METHODOLOGY

### Introduction

A detailed methodology has been developed in order to answer question about methods of improving the effectiveness of a chemistry demonstration. Several data sources will be utilized in the research analysis. These sources include student interviews, a student survey and questionnaire and analysis of several assessment tools both formative and summative.

### Participants

My capstone project was conducted in early March during a 3 week unit titled “Chemical Reactions and Types.” My classes involved with the project included juniors and seniors enrolled in the two sections of Chemistry C offered at Hesperia High School. Chemistry C is a semester-long, 18 week, elective class. The two sections of Chemistry C were taught during 1<sup>st</sup> Hour and 6<sup>th</sup> Hour and contain 20 and 17 students, respectively. The students enrolled in both sections are somewhat representative of the student body at HHS. According to the Hesperia High School Counseling Office, less than 60% of HHS graduates are college bound in any one given year. Typically 80% or more of the students enrolled in Chemistry C have higher education plans following graduation from HHS. However, the students enrolled in Chemistry C this year have a wider range of post high school plans. Compared to previous years a much lower percentage of students have higher educational goals. The dramatic change in class dynamics this year is due to fewer science electives offered at our small, rural high school and an increase in graduation requirements; 3 years of science are required to receive a high school diploma in

Michigan. I do have a good relationship with a majority of these students. Part of these great relationships, I attribute to having had most of them during their freshman year (Chemistry A and Physics A) and for the prerequisite course Chemistry B.

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained.

### Intervention

The primary intervention strategy or treatment that will be implemented during the project is the use of a student Demo Sheet. Appendix A, B and C provide examples of the three Demo Sheets utilized during the intervention. A Demo Sheet will require students to document observations during the demonstration and record individual questions and prompts to discuss within a small group setting. As well, the Demo Sheet will provide students with several connections between chemistry content and the targeted chemistry objectives. The Demo Sheet will also serve as a written archive of the demo itself and assist students in making connections between real-world applications, the demonstration and chemistry content. The intervention will also include several other teaching strategies, including student participation in the actual demonstration, small group discussion following the demonstration, and a whole-class “debriefing” session or discussion.

Demonstrations can serve many purposes in the science classroom, such as acting as a motivational device, arousing curiosity or gaining the attention of students (Roadruck 1993). Demos can also help students see abstract science ideas in concrete examples (Ogborn et al., 1996; Shakhshiri, 1992) and enhance students’ learning of

science concepts (Chiappetta & Koballa, 2002; Shakhashiri, 1992). The Demo Sheet will provide students a chance to document the visual experience of the demonstration and discover the connection between the demo and the science objectives being taught through the demonstration. The Demo Sheet will be provided to each student prior to the group discussion session.

Following the demonstration, students will be assigned to working with a team of four to five other students in which to share their observations and assist each one another in answering the questions on the Demo Sheet that make connections between science content and real-world chemistry applications. In other words, the primary focus of the team will be to discuss how the demonstration illustrates a specific science concept. A whole class “debriefing” session will follow the team discussion, in which any remaining questions can be elucidated. Also during the whole-class discussion, I will clarify the connection between the demonstration, chemistry content and real-world applications.

There are five types of chemical reactions taught during the unit Chemical Reactions and Types. The treatment and Demo Sheets will be used for three of the five demonstrations. The remaining two types of reactions will be classified as non-treatment demonstrations. These demonstrations will serve as comparison data for the treatment demo using the intervention strategies. The reaction types, corresponding demonstration titles and treatment use schedule are summarized in Table 3.

Table 3  
*Reaction Type, Demonstration and Treatment Use Summary*

<b>Reaction Type</b>	<b>Demonstration</b>	<b>Treatment Use?</b>
Combustion	Whoosh Bottle	yes
Single Replacement	Floating Tin Sponge	no
Double Replacement	M.O.M.	yes
Synthesis	Mrs. Simpson's Fried Egg Youtube.com Video	no
Decomposition	Elephant Toothpaste	yes

#### Data Collection

Several data collection methods will be used to determine the impact of Demo Sheets, team collaboration and student participation in the demonstration. These methods will help answer my primary project question, "How can the effectiveness of a demonstration be increased if students are required to record observations, answer questions and generate new questions in a written format [Student Demo Sheet] about how the demonstrations connects chemistry content to a real-world application?" These methods will also help answer the question, "Does student participation in the demonstration itself increase student focus and as a result of witnessing peer involvement increase the quality of observations?" and "Can small group discussion following a demonstration increase student understanding of the connection between the demonstration and real-world application of the chemistry content." The collection methods used in the study are summarized in the triangular matrix in Table 4.

Triangulation was utilized in the study to validate the data. The data collected during the study involved the use of both qualitative and quantitative collection methods. These

methods include student interviews, student surveys, teacher observation, and short-answer response and multiple choice format questions on a teacher-generated summative assessment.

Table 4  
*Triangulation Matrix*

Questions	Data Source 1	Data Source 2	Data Source 3
How can the effectiveness of demonstrations be increased using Demo Sheets?	Student-selected topic for short answer responses on summative assessment	Student Interviews	Student Surveys
How does group discussion following a demonstration increase student understanding?	Teacher observation and teacher field notes	Student Interviews	Student Surveys
Is the educational value of a demonstration sacrificed if presented as a video?	Student Questionnaire	Minute Paper	Quiz

Three data sources will be used as data collection methods in order to answer the primary research question, “How can the effectiveness of demonstrations be increased using Demo Sheets?” The three data collection methods were student interviews, student surveys and student selected short answer response questions on a teacher-generated summative assessment. Four students were selected, two students from 1<sup>st</sup> hour and two students from 6<sup>th</sup> hour to participate in interviews; one male and one female from each of the two course sections. The interviews were semi-structured in nature, allowing for specific, structured questions to be addressed with all interviewees but lenient enough with open-ended questions so that each student may freely respond and share their thoughts. For example, students were asked, “If you were the teacher, what would or could you do to help students get the most out of a key demonstration?” Additionally, the

interviews were conducted during the 30-minute seminar period, which is an academic support period immediately following lunch. The ten questions used during student interviews are listed in Appendix I as Student Interview Questions. The data collected through student interviews should be very valuable, informative and provide insight about student perception toward the methods used in conjunction with demonstrations, including the Demo Sheets.

All students participated in a survey, Appendix D, following the primary instruction for the Chemical Reactions and Types Unit but prior to the summative assessment for that unit. The survey serves as both a qualitative and quantitative data source. Students were asked to rate key components of the demonstrations they witnessed during the unit. Survey responses were evaluated using a Likert-type scale. The survey also included short answer-type questions in which students were asked about their favorite and least favorite demonstration. Students were asked to justify their selection. And lastly, the survey asked students, “Which demonstration helped you best learn what is involved with that specific type of chemical reaction?” Students were asked to justify or explain their selection.

Lastly, a student-selected short-answer response question on a teacher-generated summative assessment were used as a data source. The Chemical Reactions and Types Test is included in Appendix H. On the assessment Question #44 asks students the following short-answer response question:

You experienced five demonstrations that showcased each of the five types of chemical reactions. In a minimum of 4 complete sentences, please describe one of the five types of chemical reactions. Also explain what characterizes that specific

type of reaction, including the general reactant(s) and product(s) for that reaction type? Please include a reference example from the corresponding demo you saw in class. The five demos you witnessed were 1) Whoosh Bottle, 2) Floating Tin Sponge, 3) M.O.M. 4) Mrs. Simpson's Fried Egg and 5) Elephant Toothpaste.

The Demo Sheets and group collaboration can be evaluated by what demonstration or reaction type is selected for these short-answer response questions. In other words, when students are given the opportunity to explain which demonstration assisted them the most in learning the characteristics of a specific chemical reaction type, will they select one of the reaction types introduced with the treatment or without? Student responses will be evaluated using the following rubric, two points for correctly relating a reaction type to an in-class demonstration and two points for key characteristics of that reaction type.

My capstone project also aims to determine how effective group discussion is following a demonstration regarding student understanding of the science objective targeted with the demonstration. One data collection method that will be used is observation, both active and passive. I will, by the very nature of conducting the demonstrations, be involved in actively observing my students, their reactions and their level of understanding. I will also take on the role of passive observer following demonstrations as I watch student-to-student interaction and discussion. In addition, two other data collection techniques will be utilized to help answer the question, including a student survey following the week of demonstrations and student interviews.

Lastly, my project seeks to answer the question, "Is the educational value of a demonstration sacrificed if presented to students electronically, such as a YouTube video, versus in-person?" In other words, are the benefits of a demonstration, as listed in Table

1, lost if students only see a video of the demo instead of a live presentation? This question will attempt to be answered during week 3 of the curricular unit Chemical Reactions and Types. I have used two demonstrations in previous years to teach the concepts of chemical equilibrium and the relationship between surface area and reaction rate. Respectively, these two demonstrations are Chemical Equilibrium – An Aquarium Analogy and Does Steel Burn? The two sections of Chemistry C will lend themselves nicely to presenting the demonstrations in two different formats. Both sections will see the same demonstration. One section, however, will see the demonstration on video, whereas, the other section will see the demonstration live and in-person. Table 5 summarizes the demonstration schedule and format of presentation.

Table 5  
*Demonstration Format (Live vs. Video) and Schedule Summary*

<b>Demonstration</b>	<b>1<sup>st</sup> Hour</b>	<b>6<sup>th</sup> Hour</b>
Chemical Equilibrium – An Aquarium Analogy	live	video
Does Steel Burn? A Reaction Rate vs. Surface Area Demo	video	live

I think it is important that between the two sections of Chemistry C, the only variable that is changed is the format of demo presentation. Thus, I will serve as the presenter for all the demonstrations. As such, I will pre-record myself conducting the demonstration so that the demo can be presented in video format. These videos will not be available online for student viewing in order to prevent skewed results.

Again, three data sources were used as data collection methods in order to answer the third question. The three data sources include a questionnaire, a 10 question quiz and

a classroom assessment technique known as The Minute Paper. The student questionnaire will consist of 10 questions and will ask students about their level of agreement toward statements regarding the demonstration presented live and the demonstration presented in video format. The student questionnaire can be found in Appendix F. Second, a 10 question, multiple-choice format quiz will follow both the video presented demo and the live demonstration. The Reaction Rate and Equilibrium Quiz can be found in Appendix G. Question # 2 and 10 correspond to the demo titled Does Steel Burn? A Reaction Rate vs. Surface Area Demo. Whereas, Question #1 corresponds to the demonstration called Chemical Equilibrium – An Aquarium Analogy. Student responses to these questions will be compared between the class that was presented with the live demonstration versus the class that was presented with a video demonstration. Lastly, a classroom assessment called The Minute Paper will be used as a data collection method in order to qualitatively evaluate student understanding of chemistry content. The matrix summarizes the triangulated data for my focus and subsequent questions regarding increasing the effectiveness and student learning when using demonstrations in the science classroom.

## DATA AND ANALYSIS

### Introduction

The data collection for my capstone research primarily took place during a three week period from the end of March 2012 to the middle of April 2012. The research was conducted throughout the Chemical Reaction and Types unit. Twenty students in 1<sup>st</sup> hour Chemistry C and 17 students in 6<sup>th</sup> hour Chemistry C participated in the research. I made three claims involving the effectiveness of classroom chemistry demonstrations. The first

two claims involve the improved educational value of a demo through peer collaboration following a demonstration and the use of a student Demo Sheet. The three Demo Sheets used for the research are located in Appendices A through C. Lastly, the third claim involves the increased effectiveness of a live demonstration versus a demonstration delivered via an electronic or pre-recorded format.

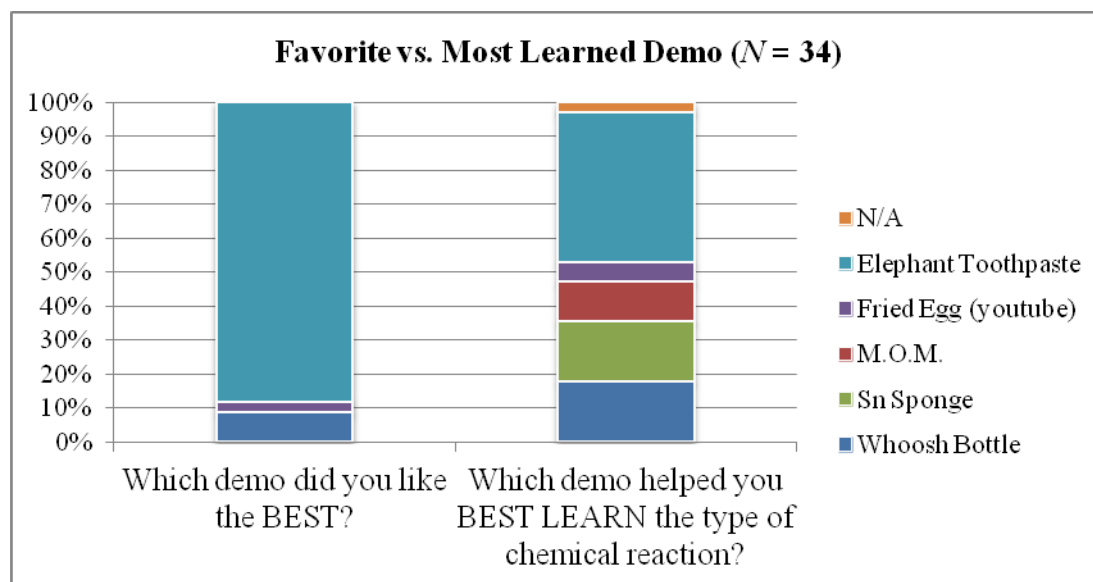
### The Effect of Demo Sheets on Student Learning After a Demo

In order to answer the primary research question, “How can the effectiveness of demonstrations be increased using Demo Sheets?” three data sources were used. Based on this data, I claim that requiring students to record observations and answer questions directly correlated to a demo and chemistry concept provided students with a deeper and longer lasting understanding of targeted science objectives. The three data collection methods were the Demo Evaluation and Student Survey, student interviews, and student-selected short-answer response questions on a teacher-generated summative assessment.

#### Demo Evaluation & Student Survey Analysis

All students, except one that was suspended for inappropriate behavior participated in the Demo Evaluation and Student Survey (Appendix D) following the primary instruction for the Chemical Reactions and Types Unit but prior to the summative assessment for that unit. The survey served as both a qualitative and quantitative data source. Students were asked to rate key components of the demonstrations they witnessed during the unit. Survey responses were evaluated using a Likert-type scale.

The survey also included short-answer type questions in which students were asked to consider not only their level of enjoyment, but also their level of understanding. Specifically students were asked, “Which demonstration helped you best learn what is involved with a specific type of chemical reaction?” Students were again asked to justify their selection. Although 30 students indicated that the Elephant Toothpaste was their favorite demonstration, only 15 students indicated that it was the demonstration that they learned the most from. Each of the other categories saw an increase between not being a demonstration favorite to being a demonstration that provided an understanding of the chemical reaction behind the demonstration. Figure 2 visually represents student opinions of which demo was their favorite versus which demonstration helped them best learn the type of chemical reaction involved with the demonstration.



*Figure 2.* Student Survey Results for Favorite Demo versus Most Learned Demo.

Students provided several reasons in their justification for why they initially selected the Elephant Toothpaste Demonstration as their favorite but then indicated

another demonstration as the one that best helped them learn the type of chemical reaction. One student that reported on the most educationally beneficial demonstration that was not his/her favorite said, “I believe the double-replacement [M.O.M. Demo] made a clearer understanding of [how] two compounds [when combined] made two different compounds. I just wasn’t sure how it worked and then I was able to visually see it.”

The final short-answer question on the student survey asked students, “Which demonstration was least helpful to learn what is involved with that specific type of chemical reaction?” Students felt that the least helpful demonstration was the double-replacement reaction demo (M.O.M. Demo). This was also student’s least favorite demonstration. One student stated, “The M.O.M. demo was dull and I lost interest in the relevance of the experiment. The more entertaining the experiment the more I want to know more about it. If the experiment includes unforeseen reactions and explosions I like it.” Several other students echoed these sentiments about the lack of “wow factor” involved with the double-replacement reaction demo.

### Student Interviews

Four students, two male and two female, were interviewed after the five day instructional unit Types of Chemical Reactions. The interviews were semi-structured in nature, allowing for specific, structured questions to be addressed with all interviewees but lenient enough with open-ended questions so that each student could freely respond and share their thoughts. These students saw a different demo each day that focused on one of the five general types of chemical reactions. Three of the five days (Monday, Wednesday and Friday) utilized a Demo Sheet in addition to a whole-class discussion

following peer collaboration and the treatment. Additionally, the scheduled interviews were conducted during both the researcher's and student's lunch period. The ten questions used during student interviews are listed in Appendix I as Student Interview Questions.

When interviewed and asked about the purpose of the Demo Sheets, Student B said, "Oh, I think it was just to help us get the concepts better. It helped me anyways." Student C said, "So, then we can, um, because I know we were just talking, like we would just think then just sit there [listening to a teacher explain what was witnessed]. But when you actually ask us the questions on the worksheets it gives us more to think about... what happened and what you think actually went on." Three students seemed to believe in the educational value of the Demo Sheets. Contrarily, Student A seemed to view the writing assignment as a form of "busy work" instead of a guide for discussion and record of observation.

Overall, students seemed to have a positive outlook toward the Demo Sheets. They valued the questions and getting to interact with their peers to figure out the missing answers and ideas that connect the demonstration to a real-world chemistry application. Students seemed more relaxed and willing to participate in their assigned teams when they knew the Demo Sheet would be reviewed and discussed as a whole class. This provided additional time to engage with the questions, content and targeted objectives.

#### Student Short-Answer Question Responses on Summative Assessment Analysis

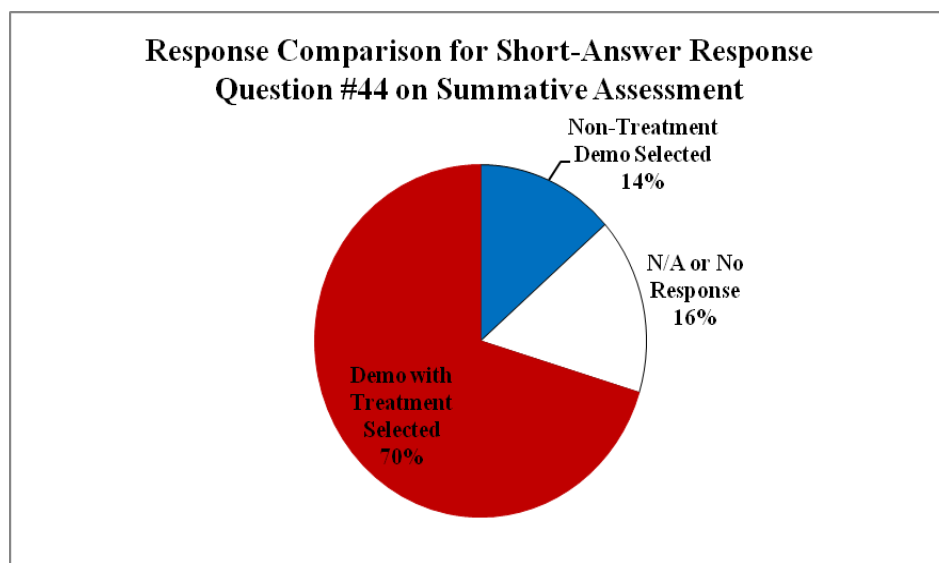
Lastly, on the Chapter 11 Chemical Reactions and Equations summative assessment, students were allowed to choose one of the five reaction types to explain on a short-answer response question. The Chemical Reactions and Types Test is included in

Appendix H. On the assessment Question #44 asked students the following short-answer response question:

You experienced five demonstrations that showcased each of the five types of chemical reactions. In a minimum of 4 complete sentences, please describe one of the five types of chemical reactions. Also explain what characterizes that specific type of reaction, including the general reactant(s) and product(s) for that reaction type? Please include a reference example from the corresponding demo you saw in class. The five demos you witnessed were 1) Whoosh Bottle, 2) Floating Tin Sponge, 3) M.O.M. 4) Mrs. Simpson's Fried Egg and 5) Elephant Toothpaste.

In other words, when students are given the opportunity to explain which demonstration assisted them the most in learning the characteristics of a specific chemical reaction type, will they select one of the reaction types introduced with the treatment or without?

Seventy percent of students selected a chemical reaction/demonstration that included the treatment when asked to select the reaction type that they felt they could best explain along with its associated characteristics. Fourteen percent of students selected a chemical reaction/demonstration that did not include the treatment. Figure 3 graphically represents a comparison of students that selected a chemical reaction taught with the treatment versus a chemical reaction that was not taught using the treatment. Sixteen percent of students were classified as "Not Applicable or No Response." Students in this category either did not answer the question or thoroughly mixed around the reaction type with key characteristics of a different type of reaction.

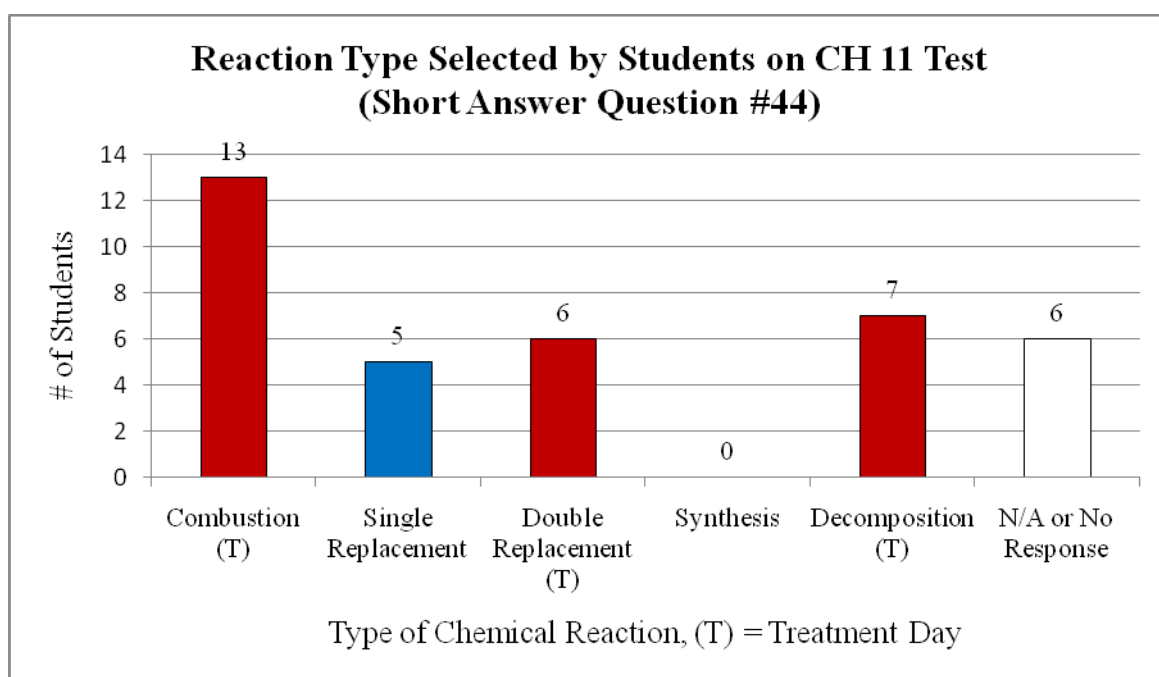


*Figure 3.* Demo with and without Treatment Comparison for Short-Answer Response Question #44 on Summative Assessment, ( $N = 37$ ).

For example, one student wrote, “One of the demonstrations in class was the Elephant Toothpaste Demo. In this demo, the reaction was double-replacement. Double replacement reactions consist of two different, ionic aqueous compounds. The first element of the first compound in the reactants must be more reactive in order for the reaction to take place.” This student received 2.5 out of 4 score for this response because he correctly describes what is required for a double replacement reaction, except for the last sentence, which relates to a single replacement reaction. Additionally, the in-class double replacement demo was the M.O.M. Demo not the Elephant Toothpaste Demo.

Sixteen students selected and described the combustion reaction (Whoosh Bottle Demo) to explain. Figure 4 provides a comparison of the reaction type selected by students on the short-answer question. The reaction types taught with the treatment are coded with a “T” and color-coded dark red. Seven students felt they could best explain the key characteristics associated with a decomposition reaction. One student wrote “The

Elephant Toothpaste Demo was an example of a decomposition reaction. In this demo [NaI] was used as a catalyst to speed up the reaction. By doing this the compounds broke down quickly and the new product[s] formed. The characteristic that is specific to this type of reaction is that something breaks down into new products.” Six students felt they could best explain a double replacement. One student wrote, “One of the demonstrations that we saw in class was the M.O.M. Demo. The M.O.M. Demo is an example of a double replacement reaction because the reactants exchange their parts to form a precipitate. Precipitates are common results in double replacement reactions. Both of the reactants and both of the products were compounds.”



*Figure 4.* Comparison of Reaction Type Selected by Students on Short Answer Question.

No students selected the synthesis reaction (Mrs. Simpson’s Fried Egg Demo) and only five students selected the single-replacement reaction (Floating Tin Sponge Demo); both did not include the treatment.

### The Effect of Peer Discussion on Student Learning After a Demo

An additional sub-question, “How does group discussion following a demonstration increase student understanding?” utilized data gathered using the Demo Evaluation Student Survey and student interviews. Teacher field notes and observation were also used for analysis of this research question. Therefore, I claim that when students are provided time to collaborate with their peers using a structured guide, like a Demo Sheet, they will gain a deeper and longer lasting understanding of the targeted science objectives.

### Demo Evaluation & Student Survey Analysis

In the Likert-type survey questions students used a scale of 4 (very important) to 1 (not very important) in order to rank possible features used in science demonstrations. Figure 5 illustrates what students feel is the most important feature of a science demonstration. On a scale out of 4, students gave an average score of 3.4 toward the importance of a teacher led, whole-class discussion following a demonstration. Students equally scored the importance of time to collaborate with peers, student participation in the demonstration itself and the use of a written document, like a Demo Sheet to record observations, ranking these features 2.9, 2.9 and 2.8 respectively. So although it required additional class time, students seemed to value the time to discuss what they had just witnessed with their peers. I also thought students might view the Demo Sheets as additional “busy work.” However, the survey indicates that students felt the Demo Sheets were as valuable to the success of a demo as student participation in a demo and time to collaborate after a demonstration with peers.

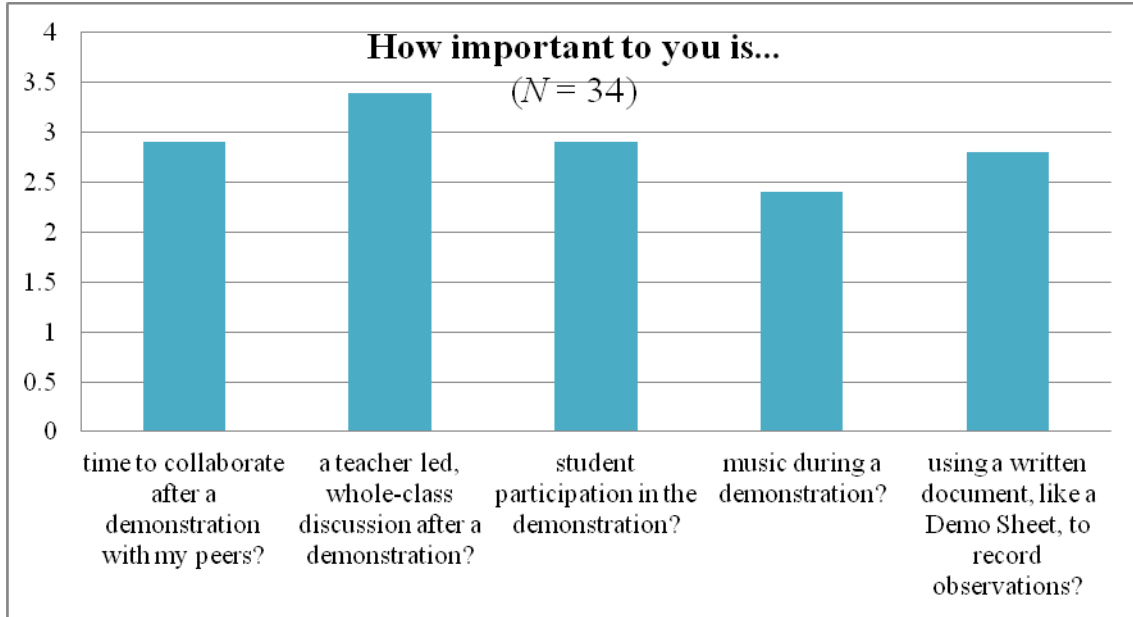


Figure 5. Student Perceived Key Features of Science Demonstrations.

### Student Interviews

When interviewed and asked about the benefits of a whole-class discussion following a demonstration versus collaboration time with peers following a demonstration, there was not a consensus in responses. “Cayla” said peer collaboration time is more beneficial, “Derek” and “Alex” thought a whole-class discussion was more beneficial and “Brooke” thought having a little of each would educationally be the most valuable. Brooke elaborated by saying “I think you can do both that way if you don’t know something within the group then you can get something clarified.” Derek felt that a whole-class discussion is best “because then you know you’re discussing the right things and not something that is false.” Alex seemed a little frustrated with the group of assigned peers. Alex said, “A lot of it for me is with the groups, you tend to learn stuff, but when you’re writing it down, there is a difference between writing what you are saying, and writing something down just to get it done. Whereas with classes you have

input & you're reading what's being put on the board and writing it down. You're going to have kids that won't participate either way. So if you were going to write something down on the board & talk about it, I think it would be better." This student also felt that a whole-class discussion allows the whole class to hear from a lot more students. Alex also suggested that participation points could be awarded in order to encourage participation in whole-class discussion.

The general trend among the interviewees was that a whole-class discussion is more valuable than time to collaborate with peers following a demonstration. However, this opinion may be due to the fact that their groups were pre-assigned and not self-selected. Likewise, in a whole-class discussion I serve as a discussion mediator, guide and as an authority figure in terms of the content and this maybe providing students with a higher degree of comfort.

#### Teacher Observation of Peer Collaboration

I took on the role of passive observer following the demonstrations and watched student-to-student interactions and discussions within their assigned peer-collaboration teams. Teams were assigned based upon their assigned seating arrangement, to prevent the need for a tremendous amount of movement around the room. Each team consisted of three to four students. Due to various student absences, each team's "roster" remained mostly the same throughout the treatment.

On Day 1 of the treatment, students were uneasy about the task, "Think about the demonstration you just witnessed. Then use the related Demo Sheet as a guide to discuss the questions with your assigned group." Students were reluctant to turn their chairs and face one another. I had to verbally announce that "you should be facing your teammates

in order to have a discussion with them.” It was observed throughout the week that the majority of the low-achieving students did little to move the team forward in a constructive manner. However, the vast majority of students thoroughly completed the Demo Sheet. Only two students, from both classes didn’t finish the Demo Sheet; they were missing a response for the question: “What’s the next question?”

Overall, teams worked very well to stay on task and complete the Demo Sheet on treatment days. I think that many students would have a difficult time completing the Demo Sheet individually. Students were able to discuss possible ideas for the questions without having the teacher “spoon-feed” them the answer. Additionally, using existing assigned seats to arrange students into their teams limited the physical disruption and transition time between the demo and peer discussions. I assigned teams in order to prevent preexisting social connections and excessive alternative discussions topics from occurring. As one student stated, “If you actually let other people pick, sometimes they’ll just talk [about something other than what they’re supposed to be talking about].”

#### The Educational Value of a Video (versus Live) Demo

The final research sub-question, “Is the educational value of a demonstration sacrificed if presented as a video?” focused on the analysis of a student questionnaire, a student-centered assessment technique called the Minute Paper and a quiz. I claim that there is more educational value in a live demo versus a demonstration presented in video format. I claim that students will have a deeper and longer lasting understanding of the targeted science objectives when the demonstration is presented in person versus in a video format.

Two demonstrations were used to teach the concepts of chemical equilibrium and the relationship between surface area and reaction rate. Respectively, these two demonstrations are Chemical Equilibrium – An Aquarium Analogy and Does Steel Wool Burn? The two sections of Chemistry C lent themselves adequately to presenting the demonstrations in two different formats. Both sections saw the same demonstration presented by the teacher-researcher. However, 1<sup>st</sup> hour saw the demonstration on video, whereas, the 6<sup>th</sup> hour saw the demonstration live and in-person. Table 6 summarizes the demonstration schedule and format of presentation.

Table 6  
*Demonstration Format (Live vs. Video) and Schedule Summary*

<b>Demonstration</b>	<b>1<sup>st</sup> Hour</b>	<b>6<sup>th</sup> Hour</b>
Chemical Equilibrium – An Aquarium Analogy	live	Video
Does Steel Burn? A Reaction Rate vs. Surface Area Demo	video	Live

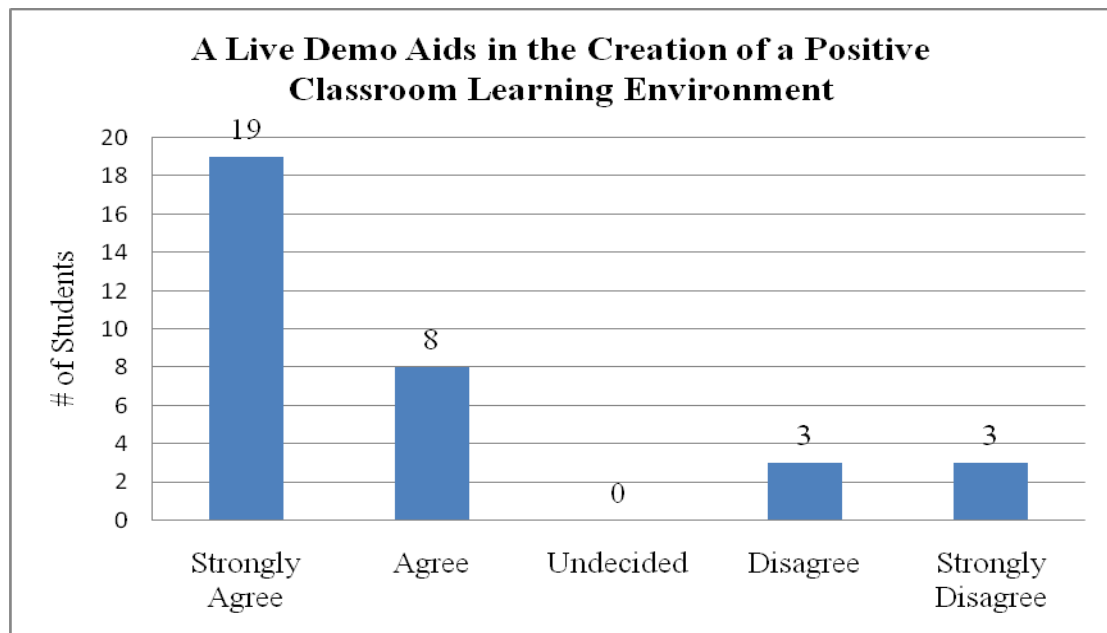
#### Live versus Video Student Questionnaire Analysis

The student questionnaire consisted of 10 questions and asked students about their level of agreement toward statements about the demonstration presented live and the demonstration presented in video format. The student questionnaire can be found in Appendix F. On the questionnaire a rank of 1 corresponded to a strong feeling of agreement, whereas a rank of 5 corresponded to a strong feeling of disagreement.

The most common response from students when asked if a live demonstration focused their attention on the chemistry topic(s) of the day was a level of strong agreement. And not surprisingly, when asked about judging a teacher's attitude during a

live versus video demonstration, students felt that a teacher's attitude is more evident during a live demonstration. Although not strongly, students did most often agree that "a video demonstration can serve as a substitute for a live demonstration that is too costly and/or dangerous for students." On average, students also agreed that "the quality of discussion following a demonstration is more important than the format (live or video) of the demonstration." Figure 6 indicates the level of student agreement when asked if a live demonstration aids in creating a positive classroom learning environment.

As communicated through the Live versus Video Student Questionnaire on question after question, students have an overwhelming preference to demonstrations conducted in real-time versus demonstrations shown in a video format.



*Figure 6. Student Opinion of a Live Demo's Ability to Create a Positive Classroom Learning Environment, (N = 33).*

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### Reaction Rate & Equilibrium Quiz Analysis

Two questions on a 10 question multiple-choice format quiz titled Reaction Rate and Equilibrium Quiz compared the demo presented in video format to the live demonstration. The Reaction Rate and Equilibrium Quiz can be found in Appendix G. Question #10 corresponded to the demo Does Steel Wool Burn? A Reaction Rate vs. Surface Area Demo. Whereas, Question #1 corresponded to the demonstration called Chemical Equilibrium – An Aquarium Analogy. Student responses to these questions were compared between the class that was presented with the live demonstration versus the class that was presented with a video demonstration.

The class that viewed the Equilibrium Demonstration live had a Mean score of 89% ( $N = 18$ ) with a Standard Deviation of 32.34 on Question #1. The class that viewed the Equilibrium Demo on video had a Mean score of 80% ( $N = 15$ ) with a Standard Deviation of 41.40. The difference between these two groups was not significant,  $t(31) = 0.6926$ ,  $p = 0.49$ .

Analysis of Question #10 showed that students in 1<sup>st</sup> hour, who viewed a prerecorded or video version of the 2<sup>nd</sup> demo, which focused on the relationship between reaction rate and surface area, had an Mean score of 89% ( $N = 18$ ) with a Standard Deviation of 32.34. Sixth hour saw the 2<sup>nd</sup> demo live and had a Mean score of 93% with a Standard Deviation of 25.82. The difference between these two groups was not significant,  $t(31) = 0.4299$ ,  $p = 0.67$ . Table 6 provides a visual representation of the statistical analysis comparing Question #1 and Question #10.

Table 7  
*Statistical Analysis Summary of Equilibrium Quiz (Question #1 and 10)*

	Question #1 (Equilibrium Demo)		Question #10 (Reaction Rate & Surface Area Demo)	
	1 <sup>st</sup> Hour <b>LIVE</b>	6 <sup>th</sup> Hour <b>VIDEO</b>	1 <sup>st</sup> Hour <b>VIDEO</b>	6 <sup>th</sup> Hour <b>LIVE</b>
<i>N</i>	18	15	18	15
Mean	89%	80%	89%	93%
Standard Deviation	32.34	41.40	32.34	25.82
Hypothesized mean difference	0		0	
Value ( $d_f = 31$ )	0.6926		0.4299	
P – value	0.49		0.67	

For both questions, the class that witnessed the demonstration live had a higher mean score for the corresponding question on the Reaction Rate and Equilibrium Quiz. A two-paired t-test analyzed the two independent samples and compared the differences between the means, assuming equal variance. The p – values of 0.49 and 0.67 for question #1 and #10, respectively, indicate that the hypothesized mean difference of 0 can be accepted. In other words, there is no statistical significance to support the fact that when students saw a demonstration live, versus prerecorded, they had a higher likelihood of answering a question correctly that is directly related to the demo. However, the high p-values could also be the result of having such small sample size.

### The Minute Paper Analysis

A classroom assessment called The Minute Paper was used as a data collection method in order to qualitatively evaluate student understanding of chemistry content. The Minute Paper was used two weeks following the live and video demonstrations due to Spring Break. Students were asked to think back to the Dueling Aquarium Demonstration (first hour saw it live and sixth hour saw it on video) or Reaction Rate and Steel Wool Demonstration (first hour saw it on video and sixth hour saw it live). Then students were asked to select one of the two demonstrations and write three sentences that describe what they learned from the demonstration.

Only 26% of students in 1<sup>st</sup> hour selected the Equilibrium-Aquarium Analogy Demo, which was the demo viewed live, in which to write about. First hour saw the Reaction Rate and Steel Wool Demonstration on video and 74% chose to explain this demo. Similarly, the majority of 6<sup>th</sup> hour (88%) selected the Reaction Rate and Steel Wool Demonstration Demo, which was the demo viewed live, in which to write about. Only 12% of students (or 2 out of 14 students) selected the Equilibrium-Aquarium Analogy Demo to explain. Figure 7 depicts a visual representation and comparison of which demonstrations students selected, within each class period, for the Minute Paper.

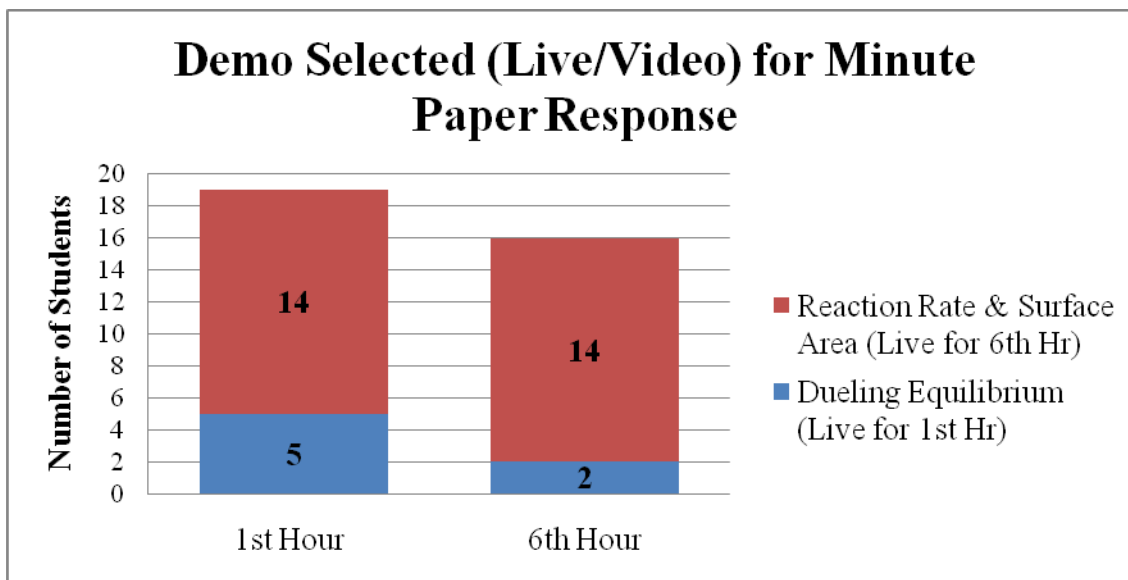


Figure 7. Demo Selected (Live/Video) for Minute Paper Response, ( $N = 35$ ).

I was very surprised by student's selection. The hypothesis was that students would select the demo that they saw live in their respective classes. However, the majority of students in both classes selected the Reaction Rate and Steel Wool Demo. I decided to request my student's help in identifying a reason for the majority in both classes selecting the same demo on the Minute Paper assessment. So the following day, I returned the Minute Papers to students (they identified their papers by handwriting) and without explanation simply asked them to provide a reason for selection.

A few students identified the reason for their selection was due to the format of presentation. One student wrote, "I picked the Aquarium demo because I watched it live and it was the easiest to remember."

The majority of students said that they picked the Reaction Rate and Surface Area (Does Steel Wool Burn?) Demo regardless of the presentation format (live versus video) but instead because this demonstration was "more interesting," or "more exciting." One student said they picked the Steel Wool Demo because "I thought it would be easier to

explain.” Another student said, “I picked the Steel Wool Demo because there was a lot of moving things and flames catching things on fire which peaks my interest.”

Regardless of the demo and concept selected to explain, students did a fantastic job with this simple and quick assessment technique. Students were able to clearly and accurately describe a demonstration and make a connection to the correct chemistry concept; and this occurred two weeks after the demonstration.

### INTERPRETATION AND CONCLUSION

A demonstration is a very powerful tool in the science classroom. Demonstrations can bring reinforcement and dynamic validation to static concepts described in scientific literature. They can excite students and peak interest. For a tool that can have such a powerful impact on the learning of our students, it only makes sense to enhance the instrument and give our students a truly rewarding and lasting educational experience.

I believe that requiring students to record observations and answer questions directly correlated to a demo and chemistry concept would provide students with a deeper and longer lasting understanding of targeted science objectives. Likewise, I claimed that when students are provided time to collaborate with their peers using a structured guide, like a Demo Sheet they will have a more valuable learning experience. And lastly, I claimed that when a demonstration is presented in a live format, as opposed to a video or prerecorded format, students will form a better understanding of the science content that the demonstration is connected. The first two claims are supported through triangulated data collection methods; students will have a deeper, longer-lasting understanding of a

concept when placed in a peer discussion group and given a written resource with prompts that guide discussion.

Demo Sheets and peer collaboration time increase the effectiveness of a classroom science demonstration. These two elements of a demonstration were used in conjunction with each other for the treatment so it is impossible to identify which factor caused an increase in learning and retention. According to student feedback and assessment analysis, chemical reactions taught using demonstrations that included the treatment were retained longer and gave students a better understanding of the characteristics associated with that particular reaction type. Students valued the Demo Sheets and felt that they served as a guide for peer discussion. Students were able to clearly indicate their favorite and least favorite demonstration. Elephant Toothpaste Demo (decomposition reaction) was an overwhelming favorite and the M.O.M. Demo (double replacement reaction) was not favored. However, when students were asked to explain the characteristics associated with a reaction type and include an in-class demo as an example, the majority of students did not write about the decomposition reaction. Several students did write about this popular demonstration but the majority of students wrote about the combustion reaction. On this assessment, seventy percent of students selected one of the reaction types taught with the treatment. Only 14% of students selected a reaction type taught without the treatment. When surveyed, students articulated the importance of the “wow factor” associated with a demo. And although students indicated that the M.O.M. demo was their least favorite demo and “not very exciting” as indicated by one student, multiple students selected this reaction type when asked to explain one of the five general chemical reactions. In their response, these students

demonstrated a thorough understanding of the key elements of a double replacement reaction.

Lastly, I claim that a demonstration performed live possesses more educational value than a demonstration pre-recorded or shown on video. The final question asked, “Is the educational value of a demonstration sacrificed if presented as a video?” Again triangulation was used to research the final question. Three data student data collection methods were used, including a student questionnaire, a student-centered assessment technique called the Minute Paper and a quiz.

Student opinions and thoughts toward a live versus pre-recorded demonstration were echoed repeatedly on the student questionnaire; students believe a demonstration performed live is more educationally beneficial and not surprisingly, more interesting. Students also felt that a live demonstration, as opposed to a video format, aids in creating a positive classroom learning environment.

Interestingly, on the Reaction Rate and Equilibrium Quiz students in their respective classes were able to more accurately answer the question related to the demo they witnessed live. Eighty-nine percent of the students in 1<sup>st</sup> hour answered the question relating to the demo they saw live correctly, whereas, 6<sup>th</sup> hour saw the demo on video and had an average of 80%. Sixth hour saw the second demonstration live and 93% of students answered the corresponding question correctly. Eighty-nine of the students in 1<sup>st</sup> hour answered correctly and they saw the demonstration presented on video. Two pair t-tests on each question produced high p-values, which indicate no statistical significance in the difference between the classes. However, I think that the high p-value could be caused by such a small sample size. Ultimately, I believe that first hour did better than

sixth hour on the equilibrium-related question because first hour saw the demonstration live. Likewise, I think sixth hour did better than first hour on the surface area and reaction rate question because sixth hour saw the demonstration live.

The third data collection method, the Minute Paper, yielded little evidence to support my claim. The Minute Paper is a classroom assessment technique. I claimed that when asked to write about either the live demo or video demo, students would write about the demo they saw live and the associated chemistry concept. However, the vast majority of students in both classes chose to write about the relationship between reaction rate and surface area, as seen live by sixth hour and on video by first hour. I do not believe that this data rejects the claim that live demonstrations are more educationally beneficial but the data analyzed from the Minute Papers do not support the claim.

## VALUE

The data collected through this research, “Increasing the Effectiveness of Classroom Chemistry Demonstrations,” validates the claim that requiring students to record observations and answer questions directly correlated to a demo and chemistry concept provides them with a deeper and longer lasting understanding of targeted science objectives. Furthermore, the data validates the claim that when students are provided time to collaborate with their peers using a structured guide, like a Demo Sheet students will have a more valuable learning experience. Lastly, additional research is necessary to validate and support the claim that a demonstration presented in a live format, as opposed to a video or prerecorded format, allows students to form a better understanding of the curriculum-aligned science content.

The data supporting the use of a record sheet/discussion guide is positive, as is allowing students an opportunity to discuss what they just witnessed following a classroom demonstration. Prior to the action-research process, I had non-substantiated ideas about how to make my chemistry demonstrations more effective. The AR process is very rewarding, as an educator is able to prove (or disprove) the success of student achievement related to classroom techniques and teaching methods or activities. I think the AR process has had a positive impact on my teaching style and reflection of my methods. I was able to prove through actual student achievement numbers and data that my classroom teaching methods were having a direct, positive and lasting educational impact on my students. I don't foresee myself going through the lengthy and time-consuming process of an entire action-research study in the near future but I do think I will be collecting more data and assessing students through a wider variety of techniques. I also think I will spend more time reflecting on how my teaching style and methods impact the learning of my students; constantly and consistently asking myself, "What would make that [activity, demo or lesson] better?"

Several new questions have been generated from the research and data collected. First, which is more important peer collaboration time or requiring students to document their observations on a record sheet, like a Demo Sheet? Additionally, do the findings apply to all science disciplines? In other words, would biology or physics students benefit from peer collaboration and use of a record sheet? Lastly, if a demonstration was performed at the end of a class period, could the important discussion portion following a demo be "flipped" and be performed in virtual, on-line discussion groups? What impact would this type of arrangement have on the quality of learning?

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APPENDICES

APPENDIX A

DECOMPOSITION REACTION STUDENT DEMO SHEET

## DEMO: Elephant Toothpaste

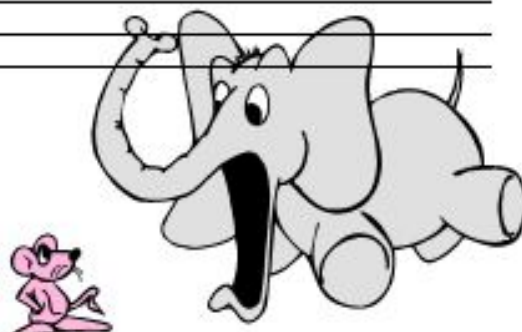
Name \_\_\_\_\_

Date \_\_\_\_\_ Hour \_\_\_\_\_

- Please record your observations of the *Elephant Toothpaste* Demo below. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- The *Elephant Toothpaste* Demonstration involved mainly one single compound, hydrogen peroxide ( $\text{H}_2\text{O}_2$ ), which was broken down into two different products. The bubbles indicate that one of the products was a solid, liquid, gas.  
circle one
- Below please identify the general format for this type of reaction knowing that you only started with **one reactant** and ended up with **two products**. Circle one.
 

A. $\text{A} + \text{B} \rightarrow \text{AB}$	D. $\text{AB} + \text{CD} \rightarrow \text{AC} + \text{BD}$
B. $\text{AB} \rightarrow \text{A} + \text{B}$	E. $\text{AB} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
C. $\text{AB} + \text{C} \rightarrow \text{AC} + \text{B}$	
- Below please identify the type of reaction that the Elephant Toothpaste Demo illustrated knowing that you only started with **one reactant** and ended up with **two products**. Circle one.
 

A. Single Replacement Reaction	D. Combination Reaction
B. Double Replacement Reaction	E. Decomposition Reaction
C. Combustion Reaction	
- The *Elephant Toothpaste* Demo involved a chemical, potassium iodide (KI), which was not involved directly with the chemical reaction. What is the special name for a chemical that speeds up the rate of the reaction? \_\_\_\_\_
- With your prior knowledge of oxygen gas, how could you test for the presence of  $\text{O}_2$ ? \_\_\_\_\_  
\_\_\_\_\_
- What is special about the hydrogen peroxide packaging/bottle that you get at the supermarket? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- Drugstore  $\text{H}_2\text{O}_2$  will not keep indefinitely. Why? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- What's the next question? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



APPENDIX B

DOUBLE REPLACEMENT REACTION STUDENT DEMO SHEET

**DEMO: M.O.M.**

Name \_\_\_\_\_

Date \_\_\_\_\_ Hour \_\_\_\_\_

- Please record your observations of the *M.O.M.* Demo below. \_\_\_\_\_  
\_\_\_\_\_
- Milk Of Magnesia** abbreviated \_\_\_\_\_, is the common name for magnesium hydroxide.
- Magnesium hydroxide was one of the products; in fact, it was the precipitate. What is a precipitate? \_\_\_\_\_  
\_\_\_\_\_
- Are precipitates soluble or insoluble? \_\_\_\_\_
- Magnesium hydroxide is primarily used to alleviate constipation, but can also be used to relieve upset stomach and \_\_\_\_\_. *M.O.M.* can come in chewable-tablet, capsule, and liquid forms, and is also available in different flavors. In years past *M.O.M.* was advertised with the following slogan: "Take MOM in the PM, for BM (\_\_\_\_\_) in the AM."
- The chemical formula for magnesium hydroxide is \_\_\_\_\_ because the Mg ion is 2+ and the OH ion is -1.
- Is the *M.O.M. Demo* a chemical or physical change? How do you know? \_\_\_\_\_  
\_\_\_\_\_
- The chemistry behind this demonstration involved a **COMPOUND** reacting with another **COMPOUND**, which then yielded two **NEW** compounds. Below please identify the general format for this type of reaction. Circle one.
 

A. $A + B \rightarrow AB$	D. $AB + CD \rightarrow AC + BD$
B. $AB \rightarrow A + B$	E. $AB + O_2 \rightarrow CO_2 + H_2O$
C. $AB + C \rightarrow AB + C$	
- Based upon your observations and answer to question #6, identify the type of reaction that the *M.O.M. Demo* illustrated knowing that you started with **two reactants** and ended up with **two products**. Circle one
 

A. Single Replacement Reaction	D. Combination Reaction
B. Double Replacement Reaction	E. Decomposition Reaction
C. Combustion Reaction	
- What's the next questions? \_\_\_\_\_  
\_\_\_\_\_



APPENDIX C

COMBUSTION REACTION STUDENT DEMO SHEET

## DEMO: Whoosh Bottle

Name \_\_\_\_\_

Date \_\_\_\_\_ Hour \_\_\_\_\_

- Using all of your senses, please record your observations of the *Whoosh Bottle* Demo below. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- The flammable liquid used in the demonstration was ethyl alcohol, which is also known as ethanol. Ethanol,  $C_2H_5OH$ , was one of the two reactants. Because you saw the ethanol burn, what must have been the other reactant? \_\_\_\_\_
- When the demonstration was complete, you saw Mrs. Sherburn dump a liquid from the bottle. Please describe at least two physical properties of the liquid. \_\_\_\_\_  
\_\_\_\_\_
- From your experience(s), what do you think could be the identity of that liquid? \_\_\_\_\_
- Because you know both reactants (ethanol and something required for burning) and possibly what the unidentified liquid product was, please identify the general format for this type of reaction. Circle one.
 

A. $A + B \rightarrow AB$	D. $AB + CD \rightarrow AC + BD$
B. $AB \rightarrow A + B$	E. $AB + O_2 \rightarrow CO_2 + H_2O$
C. $AB + C \rightarrow AC + B$	
- The type of reaction illustrated by the *Whoosh Bottle* Demo occurs in our automobile engines. Below please identify the type of reaction that was demonstrated with the *Whoosh Bottle*. Circle one.
 

A. Single Replacement Reaction	D. Combination Reaction
B. Double Replacement Reaction	E. Decomposition Reaction
C. Combustion Reaction	
- The *Whoosh Bottle* Demo cannot be repeated immediately. Refer to your answer for Question #5 and the products of that reaction to explain why the demonstration cannot be repeated immediately? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- This type of reaction also involves heat energy. Based on your observations, does this type of reaction require heat energy or does it release heat energy? \_\_\_\_\_
- What's the next question? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



APPENDIX D

STUDENT DEMO EVALUATION AND OPINION SURVEY

# Demo Evaluation & Student Survey

Student ID# \_\_\_\_\_

Date \_\_\_\_\_ Hour \_\_\_\_\_

Your opinion is very valuable and will help improve future classroom demonstrations, student learning and classroom teaching methods. However, your participation in this research survey is voluntary and participation or non-participation will not affect your grade or class standing.

Demonstrations are used frequently by science teachers as a way to connect conceptual ideas and science objectives to real-world applications. In your opinion, what makes a demonstration most effective FOR YOU? On a scale of 1 – 4, rate each potential component of a demonstration.

1 = not very important and 4 = very important.

## How important to you is...

- |   |   |   |   |   |
|---|---|---|---|---|
| 1. Time to collaborate after a demonstration with my peers?   | 1 | 2 | 3 | 4 |
| 2. Teacher lead, whole-class discussion after a demonstration?  | 1 | 2 | 3 | 4 |
| 3. Student participation in the demonstration?  | 1 | 2 | 3 | 4 |
| 4. Music?   | 1 | 2 | 3 | 4 |
| 5. Using a written document, like a Demo Sheet, to record observation, new questions and make connections to real-world applications? | 1 | 2 | 3 | 4 |

Monday –	Combustion (Demo: “Whoosh Bottle”)
Tuesday –	Single Replacement (Demo: “Floating Tin Sponge”)
Wednesday –	Double Replacement (Demo: “M.O.M” Demo)
Thursday –	Synthesis (Demo: Mrs. Simpson’s Fried Egg Demo – A Youtube Video)
Friday –	Decomposition (Demo: “Elephant Toothpaste”)

6. The 5 different chemical reactions and the demonstrations that were used this week to illustrate those reaction types are listed above. Which demonstration did you like the best? Why? \_\_\_\_\_
- 
7. The 5 different chemical reactions and the demonstrations that were used this week to illustrate those reaction types are listed above. Which demonstration did you like the least? Why? \_\_\_\_\_
- 
8. Which demonstration helped you best learn what is involved with that specific type of chemical reaction? Why? This may or may not be different from #7 but please explain. \_\_\_\_\_
- 
9. Which demonstration was the least helpful to learn what is involved with that specific type of chemical reaction? Why? This may or may not be different from #8 but please explain. \_\_\_\_\_
-

APPENDIX E

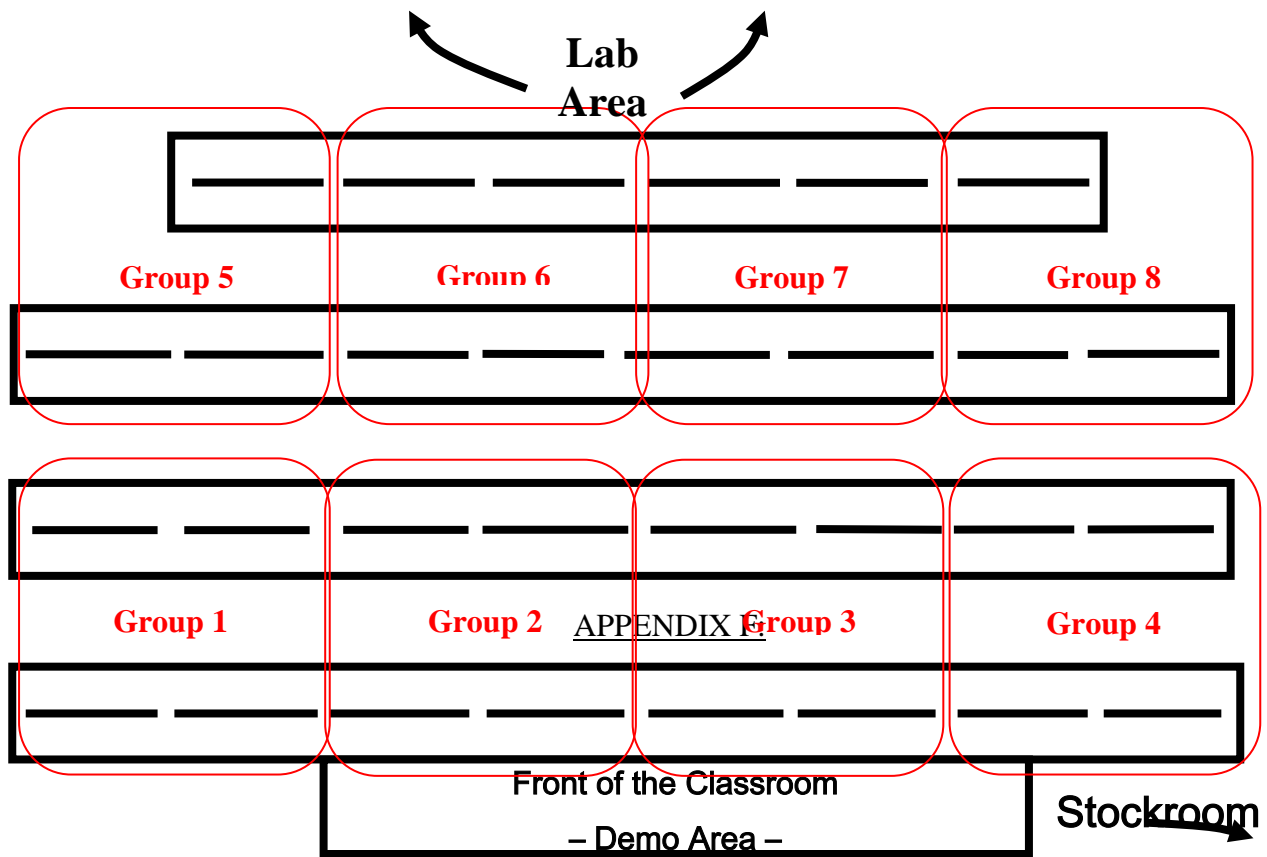
STUDENT GROUP OBSERVATION CHECKLIST  
AND MAP OF CLASSROOM

# Group Discussion Observation Checklist

Class: Chemistry C Hour: \_\_\_\_\_ Date: \_\_\_\_\_

Demonstration: \_\_\_\_\_

Behavior and Activities	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
All group members actively participate								
Figure things out without minimal teacher help								
Stay on task								
Each member completes Demo Sheet								
TOTAL								



APPENDIX F

LIVE VERSUS VIDEO DEMONSTRATION  
STUDENT QUESTIONNAIRE

# Live versus Video Student Questionnaire

Student ID# \_\_\_\_\_

Date \_\_\_\_\_ Hour \_\_\_\_\_

**Directions:** On a scale of 1 – 5 please indicate your level of agreement with the following statements.

1 = Strongly Agree

2 = Agree

3 = Undecided

4 = Disagree

5 = Strongly Disagree

- |   |   |   |   |   |   |
|---|---|---|---|---|---|
| 1. A video demonstration focuses my attention on the chemistry topics of the day.   | 1 | 2 | 3 | 4 | 5 |
| 2. A live demonstration focuses my attention on the chemistry topics of the day.  | 1 | 2 | 3 | 4 | 5 |
| 3. A video demonstration can serve as a substitute for live demonstration that is too costly and/or dangerous to students.        | 1 | 2 | 3 | 4 | 5 |
| 4. A teacher's attitude toward science is most evident during a live demonstration.   | 1 | 2 | 3 | 4 | 5 |
| 5. A teacher's attitude toward science is most evident during a video demonstration.  | 1 | 2 | 3 | 4 | 5 |
| 6. A live demonstration best helps me make connection to textbook concepts.   | 1 | 2 | 3 | 4 | 5 |
| 7. A video demonstration assists in creating a positive classroom feeling and sense of community.                                 | 1 | 2 | 3 | 4 | 5 |
| 8. A live demonstration assists in creating a positive classroom feeling and sense of community.                                  | 1 | 2 | 3 | 4 | 5 |
| 9. I become more engaged when I'm allowed or my classmates are allowed to participate in a demonstration.                         | 1 | 2 | 3 | 4 | 5 |
| 10. The quality of discussion following a demonstration is more important than the format (live or virtual) of the demonstration. | 1 | 2 | 3 | 4 | 5 |

APPENDIX G

CHEMICAL EQUILIBRIUM AND REACTION RATE QUIZ

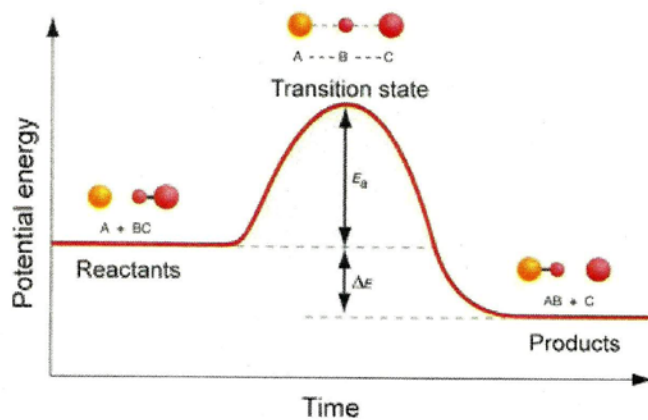
Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_ ID: A

### Reaction Rates & Equilibrium Quiz

#### Multiple Choice - 1 point each

Identify the choice that best completes the statement or answers the question.

- \_\_\_\_\_ 1. The Aquarium Analogy demonstration illustrated which of the following chemical reaction concepts?
- Catalysts decrease the time it takes to reach equilibrium.
  - Chemical equilibrium occurs when the rates of the forward reaction and reverse reaction are equal.
  - The temperature of the water is affected by the color of the liquid at standard temperature and pressure (STP) only.
  - None of the above.
- \_\_\_\_\_ 2. Which of the following factors affect the speed of a reaction?
- particle size
  - viscosity
  - time
  - density
- \_\_\_\_\_ 3. When bonds are broken and new bonds are formed a(n) \_\_\_\_\_ occurs.
- all of the above
  - equilibrium
  - reaction
  - solubility fluctuation
- \_\_\_\_\_ 4. According to the illustration, what type of reaction is shown?



- exothermic
  - endothermic
  - both a and b
  - neither a or b
- \_\_\_\_\_ 5. If a chemical reaction produces heat and gets warm to the touch, the reaction is a(n) \_\_\_\_\_ reaction.
- exothermic
  - reversible
  - endothermic
  - mechanical

Name: \_\_\_\_\_

ID: A

6. Based on the data below, what is the rate of French fry consumption?

Fries Eaten	0	20	30	40
Time (minutes)	0	4	6	8

- a. 12 fries/minute    b. 5 fries/minute    c. 0.20 fries/minute    d. 40 fries/minute

7. A(n) \_\_\_\_\_ lowers the activation energy needed for a reaction to take place.

- a. product    b. catalyst    c. reactant    d. equilibrium shift

8. What is the **reverse** equation for the combination of solid iron and oxygen gas to form solid iron(III) oxide?

- a.  $4\text{Fe(s)} \rightarrow 2\text{Fe}_2\text{O}_3\text{(s)} + \text{O}_2\text{(g)}$     c.  $2\text{Fe}_2\text{O}_3\text{(s)} \rightarrow 4\text{Fe(s)} + 3\text{O}_2\text{(g)}$   
b.  $2\text{Fe}_2\text{O}_3\text{(s)} + 2\text{O}_2\text{(g)} \rightarrow 4\text{Fe(s)}$     d. none of the above

9. The French chemist Henri Le Chatelier proposed that a change in equilibrium can be caused by \_\_\_\_\_

- a. a change in pressure    c. a change in concentration  
b. a change in temperature    d. all of the above

10. Steel wool fibers will ignite easily whereas a ball of steel wool will not. This illustrates how \_\_\_\_\_ effects reaction rate.

- a. temperature    c. surface area  
b. mass    d. malleability

APPENDIX H

CHEMICAL REACTIONS AND TYPES  
SUMMATIVE ASSESSMENT





Name: \_\_\_\_\_

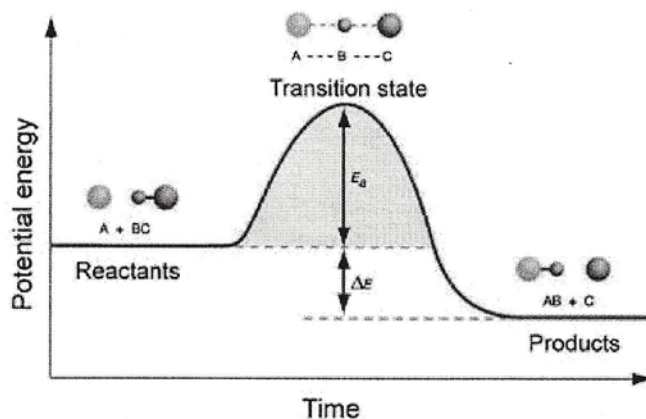
ID: A

- \_\_\_\_ 16. This symbol ( $\rightleftharpoons$ ) indicates that \_\_\_\_.
- heat must be applied
  - an incomplete combustion reaction has occurred
  - a gas is formed by the reaction
  - the reaction is reversible
- \_\_\_\_ 17. A catalyst is \_\_\_\_.
- the product of a combustion reaction
  - not used up in a reaction
  - one of the reactants in single-replacement reactions
  - a solid product of a reaction
- \_\_\_\_ 18. Which of the following is the correct skeleton equation for the reaction that takes place when solid phosphorus combines with oxygen gas to form diphosphorus pentoxide?
- $P(s) + O_2(g) \rightarrow PO_2(g)$
  - $P(s) + O(g) \rightarrow P_5O_2(g)$
  - $P(s) + O_2(g) \rightarrow P_2O_5(s)$
  - $P_2O_5(s) \rightarrow P_2(s) + O_2(g)$
- \_\_\_\_ 19. What are the coefficients that will balance the skeleton equation below?
- $$AlCl_3 + NaOH \rightarrow Al(OH)_3 + NaCl$$
- 1, 3, 1, 3
  - 3, 1, 3, 1
  - 1, 1, 1, 3
  - 1, 3, 3, 1
- \_\_\_\_ 20. What are the coefficients that will balance the skeleton equation below?
- $$N_2 + H_2 \rightarrow NH_3$$
- 1, 1, 2
  - 1, 3, 3
  - 3, 1, 2
  - 1, 3, 2
- \_\_\_\_ 21. When the equation  $Fe + Cl_2 \rightarrow FeCl_3$  is balanced, what is the coefficient for  $Cl_2$ ?
- 1
  - 2
  - 3
  - 4
- \_\_\_\_ 22. When the equation  $KClO_3(s) \rightarrow KCl(s) + O_2(g)$  is balanced, the coefficient of  $KClO_3$  is \_\_\_\_.
- 1
  - 2
  - 3
  - 4
- \_\_\_\_ 23. In every balanced chemical equation, each side of the equation has the same number of \_\_\_\_.
- atoms of each element
  - molecules
  - moles
  - coefficients

Name: \_\_\_\_\_

ID: A

- \_\_\_ 31. Use the activity series of metals to complete a balanced chemical equation for the following single replacement reaction.  
 $\text{Ag}(s) + \text{KNO}_3(aq) \rightarrow$   
 a.  $\text{AgNO}_3 + \text{K}$   
 b.  $\text{AgK} + \text{NO}_3$   
 c.  $\text{AgKNO}_3$   
 d. No reaction takes place because silver is less reactive than potassium.
- \_\_\_ 32. In a double-replacement reaction, \_\_\_\_\_.  
 a. the reactants are usually a metal and a nonmetal  
 b. one of the reactants is often water  
 c. the reactants are generally two ionic compounds in aqueous solution  
 d. energy in the form of heat or light is often produced
- \_\_\_ 33. The reaction  $2\text{Fe} + 3\text{Cl}_2 \rightarrow 2\text{FeCl}_3$  is an example of which type of reaction?  
 a. combustion reaction  
 b. single-replacement reaction  
 c. combination reaction  
 d. decomposition reaction
- \_\_\_ 34. The equation  $\text{Mg}(s) + 2\text{HCl}(aq) \rightarrow \text{MgCl}_2(aq) + \text{H}_2(g)$  is an example of which type of reaction?  
 a. combination reaction  
 b. single-replacement reaction  
 c. decomposition reaction  
 d. double-replacement reaction
- \_\_\_ 35. The equation  $\text{H}_3\text{PO}_4 + 3\text{KOH} \rightarrow \text{K}_3\text{PO}_3 + 3\text{H}_2\text{O}$  is an example of which type of reaction?  
 a. double-replacement reaction  
 b. combination reaction  
 c. decomposition reaction  
 d. single-replacement reaction
- \_\_\_ 36. The equation  $2\text{C}_3\text{H}_7\text{OH} + 9\text{O}_2 \rightarrow 6\text{CO}_2 + 8\text{H}_2\text{O}$  is an example of which type of reaction?  
 a. combustion reaction  
 b. single-replacement reaction  
 c. double-replacement reaction  
 d. decomposition reaction
- \_\_\_ 37. According to the illustration, what type of reaction is shown?



- a. exothermic      b. endothermic      c. both a and b      d. neither a or b

Name: \_\_\_\_\_

ID: A

- \_\_\_ 38. The Aquarium Analogy demonstration illustrated which of the following chemical reaction concepts?
- Catalysts decrease the time it takes to reach equilibrium.
  - The temperature of the water is affected by the color of the liquid at standard temperature and pressure (STP) only.
  - Chemical equilibrium occurs when the rates of the forward reaction and reverse reaction are equal.
  - None of the above.
- \_\_\_ 39. Which of the following factors affect the speed of a reaction?
- particle size
  - viscosity
  - time
  - density
- \_\_\_ 40. When bonds are broken and new bonds are formed a(n) \_\_\_\_\_ occurs.
- all of the above
  - equilibrium
  - reaction
  - solubility fluctuation
- \_\_\_ 41. Steel wool fibers will ignite easily whereas a ball of steel wool will not. This illustrates how \_\_\_\_\_ effects reaction rate.
- temperature
  - mass
  - surface area
  - malleability
- \_\_\_ 42. If a chemical reaction produces heat and gets warm to the touch, the reaction is a(n) \_\_\_\_\_ reaction.
- exothermic
  - reversible
  - endothermic
  - mechanical

**Essay - 4 points**

43. Predict the precipitate that forms when aqueous solutions of silver nitrate and potassium phosphate react to form products in a double-replacement reaction. Please **describe** ...

1) how to you were able to determine the products and which substance would be the precipitate. (2 points)  
 2) how to you were able to write the complete chemical equation describing this reaction. When you type your balanced equation, remember to indicate which product is the precipitate with a "(s)." (2 points)

**FYI: You can't show subscripts in Examview so just type the number - don't worry about the size of the number.**

44. You experienced five demonstrations that showcased each of the five types of chemical reactions. In a minimum of 4 complete sentences, please describe one of the five demonstrations and explain what characterizes that specific type of reaction. Please include the general reactant(s) and product(s) for that reaction type? Feel free to use the demo you saw in class as an example. The ones we did were: 1) Whoosh Bottle, 2) Floating Tin Sponge, 3) M.O.M., 4) Mrs. Simpson's Fried Egg Youtube Video and 5) Elephant Toothpaste. [4 points]

APPENDIX I

STUDENT INTERVIEW QUESTIONS

## Student Interview Questions

Student Name: \_\_\_\_\_

Class: Chemistry C

Hour: \_\_\_\_\_ Gender: \_\_\_\_\_

1. Do you think that chemistry demonstrations help you better understand key chemistry concepts?
2. Why? What is so special about a demonstration?
3. Think about a memorable chemistry demonstration for Chemistry A, B or C. What demonstration are you thinking of?
4. What made it so memorable?
5. Do you remember what chemistry concept was being taught with that demonstration? If so, please explain.
6. What was the purpose of the Demo Sheets used this past week?
7. Did you find Demo Sheets useful?
8. What seems more beneficial to you, peer collaboration time following a demonstration or a whole class explanation from the teacher?
9. If you were a chemistry teacher, what key elements would you include when doing a demonstration to help ensure that your students “got it?”
10. When you think of chemical reactions, what is the first thing that comes to your mind?