EVALUATION OF A NOMENCLATURE ACTIVITY IN MULTIPLE CHEMISTRY CLASSROOMS

by

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July 2013
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In this study, a chemistry nomenclature classroom activity was evaluated in three different schools with a total of 205 students. The activity was evaluated to test the relevancy of the activity to students’ lives, the effect on their motivation, and the retention of nomenclature concepts. The activity was shown to be relevant in the students’ lives by using everyday household products which then showed a slight increase in the students’ motivation for the subject of chemistry.
INTRODUCTION AND BACKGROUND

Project Background

Chemistry is all around us. In fact, everything is made from elements. As Theodore Gray simply states, elements are “everything you can drop on your foot” (2009, p. 5). In my years of teaching, I have found that my chemistry students complain that they do not see the relevance of chemistry to their lives. Statements like this have been heard in class “When will we ever use this in real life?” or “I will never have to think about these little symbols (chemical symbols) ever again after chemistry class.” When students do not see the application of a subject in their lives, it seems like they are less motivated to engage or to persevere through tougher concepts. Part of the chemistry teacher’s role is to show the students that chemistry is part of everything they are, do, see, and sit on. To do this, teachers need to constantly find or make activities that make chemistry relevant to the students’ lives as well as engage and motivate the students to learn more about the building blocks the world is made of. To help students make the connection to chemicals in their world and to help them practice the skill of chemical nomenclature, I developed a chemistry classroom activity and tested it in a number of classrooms. My goals were to study the effectiveness of the activity, how it made connections to students’ lives, and how the activity may have changed their motivation towards the subject of chemistry. I also studied the effects of this activity on student achievement in learning chemical nomenclature.

The nomenclature activity that I created and used last year in my classroom used household items such as deodorant, baking soda, bleach, window cleaner and household medicines. Working in pairs or small groups, the activity asked the students to find
chemical compound names they recognized and then to write the correct chemical formulas for those compounds. The students looked at about 20 different items with the goal of finding at least 15 different chemical compounds. They then wrote the name of the compound, the product it was found in, wrote the chemical formula and classified the compound as covalent or ionic or both. The activity used in this study was an improved version of a past activity which was modified to include additional questions at the end of the activity for the students to answer. The intent was for these questions to serve as a mechanism by which they would reflect on what they had learned in this activity.

Focus Question

The goal of this research was to test the activity described above in multiple classrooms and to study the impact of this activity, on both teachers and students, in order to maximize its effectiveness and to develop more activities similar to it in the future. The main question that was addressed in this research was: “What is the impact when a nomenclature activity with real life connections is utilized in a high school chemistry class?” Four sub questions helped me to further elucidate adequately answer the focus question:

1) How does this activity relate chemical nomenclature to the students' everyday lives?

2) How does relating chemistry to students’ lives in this activity affect student motivation?

3) How does this activity affect the students' comprehension and retention of chemical nomenclature?

4) What is the impact of this activity on the teacher and the teacher's methods?
School Demographics

I piloted my activity in three schools: Black Forest Academy in Kandern, Germany, TCA (abbreviated for privacy reasons) in Colorado Springs, Colorado and Sandra Day O’Connor High School in Phoenix, Arizona. I wanted to have a variety of schools situated in different contexts. The schools were found through my personal contacts.

Black Forest Academy (BFA) is a 1-12 international Christian boarding school with about 230 students in the high school. BFA is located in Kandern, Germany. This school serves mainly missionary families who reside in Europe, Asia, and Africa. One hundred and fifty of the high school students live in the school’s dorms and 80 students live locally with their parents. The ethnic composition of the students is 81% Caucasian, 13.2% Asian, 0.5% Hispanic, 0.5% African American and 4.8% other. The activity was implemented in three of the sophomore/junior level chemistry classes with a total of 50 students.

TCA is a public charter school with about 600 students, and is located in Colorado Springs, Colorado. The school strives to support the whole child and supports a unique school environment in which students adhere to a dress code and have character education woven throughout their classes. The ethnic composition of the student body is 89.2% Caucasian, 6.5% Hispanic, 2.5% African American, 2% Asian and 0.2% other. Five percent of students are provided a free or reduced lunch. The activity was implemented in four of the sophomore level chemistry classes with a total of 57 students.

Sandra Day O’Connor High School is an American public high school with 2522 students, and is located in suburban Phoenix, Arizona. Sandra Day O’Connor High
School is a school with a high socio-economic environment in which over half of the students go on to attend a college after high school. The ethnic composition of the school is 77% Caucasian, 14% Hispanic, 5% Asian, 3% African American and 1% other. Two percent of the school receives free or reduced lunch. The activity was implemented in three of the sophomore level chemistry classes with a total of 98 students.

The teachers in the schools scheduled the activity in different places in their curriculum during this study. The teachers from TCA and Sandra Day O’Connor schools used the activity as a review of the previously taught nomenclature unit. Both teachers taught nomenclature in the first semester and then piloted this activity early in the second semester. The teacher from BFA scheduled the activity at the end of the nomenclature unit which was also early in the second semester. Therefore, in all cases, all of the students had been previously taught nomenclature. TCA and Sandra Day O’Connor students may have had more exposure to nomenclature than the BFA students.

CONCEPTUAL FRAMEWORK

Activities and laboratory experiences are an important component of science classes. These experiences give students a chance to learn or observe concepts in a physical hands-on way. It is important to have these experiences in our classrooms since our students have different learning styles; therefore we need to try to teach in many different styles to help all of our students as much as possible. Science is observing the world around us, and through observing we can start to develop theories about how the world works. When developing a new activity, a teacher needs to understand what they want the activity to accomplish for their students. By incorporating aspects of the
students’ daily lives in this activity, I was hoping to produce a lasting learning experience, which would result in an increase in student motivation for learning. In order to help design and evaluate this activity, multiple different subjects were researched including the relevance of activities and their effect on student motivation, defining and measuring student motivation and evaluating activities for classroom use.

One objective of the activity was to give students an opportunity to demonstrate their knowledge of chemical nomenclature using everyday household products and to see the connection between the science classroom and their everyday lives. By relating the classroom material directly to their lives, I was hoping to see a rise in interest, motivation and student performance. This is a common goal held by many educators (Hulleman & Harackiewicz, 2009). Hulleman and Harackiewicz conducted a study “designed to help students make connection between their high school science classes and their lives” (2009, p. 1411). The study was conducted with 262 high students from various science classes. Hulleman and Harackiewicz found that “encouraging students to make connection between science course material and their lives promoted both interest and performance for students with low success expectancies” (2009, p. 1411). This means that students who believed they would not succeed actually showed increased interest and achievement when they felt material was relevant. Many times in classes, there are different groups of students: high achieving students, students that are average, and the lower achieving students who seem to either lack interest or lack skills needed to succeed. By using relevant activities, a teacher may see an increase in performance and interest in these last two groups of students. The high achieving students may not show an increase in interest or performance but they will continue to show high achievement.
One other important finding of the Hulleman and Harackiewicz study was that “students can become energized if they believe they can be competent in science and can successfully perform classroom tasks” (2009, p 1410). This is called self-efficacy, which both Velayutham, Aldridge and Fraser, (2011) and Glynn and Koballa (2006) referred to in the questionnaires they developed to measure motivation as being one of the factors that affect student motivation. Velayutham et al. stated that “self-efficacy is a stronger predictor of achievement and engagement in science-related activities than is gender, ethnicity, or parental background” (2011, p 2163). Implementing an activity in which the students will connect the science concepts to daily life and one that is challenging yet achievable will help promote achievement, motivation, and interest in the classroom.

One of the goals of my activity was to increase student motivation in science. There is a connection between relative scientific concepts to achievement and motivation which was studied by MSSE graduate Brianna Jean James (2011). In James’ study, the connections between achievement and gender, science interest, and relevancy to student’s lives future and present were investigated. Seventy-two freshman physical science students were asked to take a single post-test motivational survey. This survey was also coupled with summative and formative assessments from the class. Correlations between the answers given to the motivational questions were shown in a table of bivariate correlations. The most significant correlation found was that when science was relevant, students found it easier to remember and were more likely to enjoy the subject. The highest correlation was shown to be that if the students thought it was easy to remember, they were also more likely to enjoy it. James concluded that “students that believe science is relevant were not significantly more likely to achieve higher, but those who
believed that it was relevant to their career or relevant to their lives after high school were likely to achieve higher” (2011, p. 28). Essentially, the results showed a timeframe split: if the student perceived it relevant in general including present time, the student was not necessarily going to show higher achievement; but if the student viewed it as valuable in the future they showed higher achievement.

Motivation is not always clearly defined or easily measured. How one defines motivation affects how it can be measured in a study. Glynn and Koballa (2006) stated “motivation is an internal state that arouses, directs and sustains students’ behavior” (p. 25). Schunk (2004) stated that “motivation is the internal circumstance that instigates and focuses goal-oriented behavior” (as cited in Velayutham, Aldridge, & Fraser, 2011, p. 2161). Both studies concluded that motivation is an internalized state that affects outward behavior. These internal and external processes are important to learning because they push the student to learn and continue to learn even when the concepts are difficult. Teachers want to find ways to direct these processes to help students engage with and apply the material to their lives or in new ways in the future. This is a hard task. As cited in Velayutham, et al., “Theobald (2006) asserts that stimulating students’ motivation to learn remains one of the greatest challenges for teachers” (2011, p. 2161). As these researchers discussed, student motivation is one of the most necessary but also one of the most difficult aspects of student learning to understand and impact.

These motivational processes have external characteristics that are seen in student behavior. So then, how does one adequately measure motivation? Velayutham et al. (2011) studied many motivational questionnaires, including two that were focused on student motivation in science-related fields, to create a new motivational questionnaire
called the Students’ Adaptive Learning Engagement in Science Questionnaire (SALES). SALES is based on four areas of motivational behaviors or attitudes: “learning goal orientation, task value, self-efficacy, and self-regulation of effort” (Velayutham et al., 2011, p. 2167). Learning goal orientation is developing ways to learn and master tasks and skills. These questions ask about a student’s overall goal in relation to the subject being taught. Task value is the student’s perceived value in the task, either for the future or currently: if it is more valued then they will be more apt to complete it despite the difficulties. Self-efficacy is the student’s belief that they are able to complete the task with the desired results. Lastly, self-regulation is the external behavior towards the work needed to complete the tasks of the subject.

In SALES, there are 32 questions with eight questions in each of the four categories. Each question is answered using a five point Likert scale of strongly agree (5) to strongly disagree (1). This questionnaire was tested in multiple different settings to achieve its final form. First, a small group of 52 students was tested to “examine face validity of the survey to ensure that students had interpreted the items in the ways that were intended by the researchers” (Velayutham et al. 2011, p. 2168). Then it was tested with 1360 students to collect final data on the instrument. The SALES instrument greatly influenced the creation of the pre and post activity survey questions in my research project. Many of the questions that were written were modeled after the questions in this survey especially in the questions addressing learning goal orientation and task value.

Another questionnaire was developed by Glynn and Koballa called the Science Motivation Questionnaire (SMQ) (2006). This was one of the questionnaires Velayutham et al. (2011) researched in their SALES study. This questionnaire measures
six areas of motivation: “intrinsically motivated science learning, extrinsically motivated science learning, relevance of learning science to personal goals, responsibility (self-determination) for learning science, confidence (self-efficacy) in learning science, and anxiety of science assessment” (Glynn and Koballa, 2006, p. 26). The SMQ has 30 questions that are answered on a five point Likert scale. Unlike the SALES, the questions of the SMQ were not divided into separate categories. The SMQ instrument also helped to influence the question in the pre and post activity survey in this study.

Part of the methodology and data collection in my activity involved measuring student motivation. These SALES and SMQ questionnaires helped significantly in developing an instrument to determine the motivation of students during the nomenclature activity; many of my questions are based on these two reliable questionnaires. These questionnaires are focused on the science field specifically, and how students approach science as a whole but not exactly on a given activity. Therefore, for my purposes these instruments were edited, combined and modified to focus on the effect on motivation of the specific activity and not just science in general.

Finding the best activity to use in the classroom may be a hard and time consuming job for the teacher, and even when an activity is chosen it may not work. Brownstein, Feldkamp-Price, and Rillero (1994) developed a method to determine a good activity for a specific context: the “Science Activity Filter (SAF)”. The SAF utilizes six questions to determine the appropriateness of an activity:

- Is the activity safe? Does the activity stimulate learning? Is the time needed for the activity balanced by the amount of student learning? Is the cost of the activity
balanced by the amount of student learning? Is the level of difficulty appropriate for the students? Does the activity work? (p. 25)

These are good questions to consider when making or choosing an activity. After the teachers facilitated the nomenclature activity, similar questions were part of the teacher interview and teacher survey. By answering these questions, the teachers evaluated the efficacy and appropriateness of this activity in their chemistry classrooms and curriculum.

As seen from these studies, developing an appropriate activity that is relevant to students’ lives can affect student interest and motivation in many ways. These studies also showed that motivation is a difficult concept to measure, but the researchers were able to identify external characteristics to help measure students’ motivation for science.

METHODOLOGY

In order to evaluate this nomenclature activity, my goal was to have teachers utilize it in multiple classrooms in three different schools. By evaluating the activity in multiple classrooms, I hoped to gain an understanding of how well the activity worked, not only in my classroom and curriculum, but also whether it was an effective tool for teachers in various settings. I was not physically present when the activity was tried in these classrooms. 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 (Appendix A). All administrators from the schools approved the research done in their schools. The students’ work was coded in order to keep their identities protected.
In order to answer the research question and sub questions, I used a number of different data collection instruments including student pre and post activity surveys, student pre and post activity assessments, a teacher survey and also a teacher interview. Each data collection device had different goals in order to adequately answer the sub questions (Table 1).
Table 1  
*Data Collection Devices*

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Data Collection Devices</th>
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<tr>
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<td><strong>Overall: What is the impact when a nomenclature activity with real life connections is utilized in a high school chemistry class?</strong></td>
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<tr>
<td><strong>Sub Question #1:</strong> How does this activity relate chemical nomenclature to the students' everyday lives?</td>
<td></td>
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<tr>
<td><strong>Sub Question #2:</strong> How does this activity affect motivation of students in the subject of chemistry by relating it to their lives?</td>
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<tr>
<td><strong>Sub Question #3:</strong> How will this activity affect the students' comprehension and retention of chemical nomenclature?</td>
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<tr>
<td><strong>Sub Question #4:</strong> What is the impact on the teacher and the teacher's methods?</td>
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The Student Pre and Post Assessments were short 8 question quizzes (Appendix C). Each had 6 multiple choice questions which assessed students’ knowledge of differences between covalent and ionic compounds, as well as naming and writing
formulas for ionic and covalent compounds. Each also had two questions that asked students to write the formulas of ions in an ionic compound and the formulas for an ionic and covalent compound. The only difference between the two assessments were the compounds that students named, otherwise they were identical to each other in regard to the concepts that they tested. The Post Assessment was given two weeks after the activity in an attempt to measure student retention of the material.

The Student Pre and Post Activity Surveys goal was twofold; they determined whether the student believed the activity related chemistry to their lives and also whether their motivation changed because of this activity. Each survey contained 30-35 questions (Appendix D). Most of the questions were seven –point Likert style, where the students had to rate a statement on a scale from -3 (strongly disagree) to 3 (strongly agree) with 0 included (neutral). Some of these questions were then followed by a qualitative question in which the student was asked to explain their responses. There were also some qualitative questions at the end of each survey. In order to ensure that the instrument was reliable and valid, many of the questions were based on similar questions from the Students’ Adaptive Learning Engagement in Science Questionnaire (SALES) (Velayutham et al., 2011) and the Science Motivation Questionnaire (SMQ) (Glynn and Koballa, 2006). The SALES had four areas of motivation that were measured in the questionnaire: learning goal orientation, task value, self-efficacy and self-regulation (2011). The Pre Activity and Post Activity Survey questions were styled after some of the SALES questions. Some questions were repeated on both surveys. Many of the Post Activity Survey’s questions were written to focus on evaluating the activity in terms of
how it affected student motivation. By comparing responses from the two surveys, I hoped to see a change in motivation in the students, whether positive or negative.

The Teacher Survey and Interview were used to gather the teachers’ observations of the student reactions to the activity and to measure the effect of the activity on the teachers themselves. The teacher survey had 25 questions that were written in a Likert style, using the same scales as the students’ surveys, -3 (strongly disagree) to 3 (strongly agree) with 0 included (neutral). The questions on the survey were based on the Science Activity Filter (SAF) developed by Brownstein, Feldkamp-Price, and Rillero (1994) which helped to establish reliability and validity of the instrument. This helped to evaluate the activity in terms of safety, meaningful student learning, cost, and effectiveness. Using these categories, questions also pertained to ease of setup, administration, and grading. Additional questions about relevancy to students’ lives were asked. The teacher interview questions consisted of background of the classroom curriculum, activity improvements, student attitudes toward the activity, and relation of the activity to students’ lives.

The study began when the teachers conducted the activity during one class-period, typically 40-50 minutes. In this class period, the students worked in pairs to find 15 different chemicals from the labels of 15-20 different household products. The products were provided by the teacher in their original labeled containers during the activity time. Students also completed the Student Activity report (Appendix B). The students had to find 15 different compounds that they knew and that were familiar to them based on their knowledge of nomenclature. The students wrote the name of each compound and the product in which they found it; so it was possible that they could have found the same
compound in different products. Then they wrote the formula for the compound and classified it as an ionic or covalent compound. For example: a student may have looked at a box of Kraft Macaroni and Cheese and the ingredients included: enriched macaroni product, riboflavin, cheese sauce mix, salt, sodium tripolyphosphate, citric acid, lactic acid, sodium phosphate, calcium phosphate. From their chemical nomenclature lessons, they should have been able to recognize and write the formula for three compounds on that list: salt (sodium chloride), sodium phosphate and calcium phosphate. Then they would write the formula for each of these compounds and classify them as ionic or molecular compounds. The activity also included some short answer questions and reflection questions which made the students provide more information and reflect on some of the compounds they found. These questions included looking at what kinds of compounds were more prevalent in products, ionic or covalent compounds. There were several optional research questions which the teacher could choose to assign to the students. These questions were more in-depth about specific compounds, and required that the student utilize the internet or other research materials. None of the teachers chose to assign these research questions because of time constraints in their classrooms. The students either turned in the activity report at the end of the period or the next day, depending on what each teacher preferred, for the teacher to assess. Since there were large variations in how teachers taught these concepts, the products they chose for the activity, and how the teachers administered the activity, the students’ activity reports were not used as a data collection device in this study. The variations listed above rendered the activity itself unreliable as a data collection instrument in this study.
Prior to the activity both the teachers and students completed assessments, surveys, and other forms to provide a baseline of information and background. Each teacher filled out a contextual information sheet about their school and classes. A student roster was also completed by the teacher. The teacher was given instructions on how to administer all the materials and activities and how to send all the materials back once the materials were completed.

The students filled out a pre-assessment and pre-activity survey before the activity was administered which gave baselines on student motivation and understanding. The pre-activity survey had contextual questions that each student answered along with questions about previous grades. After the activity, the teachers and students filled out data collection devices to record the effect the activity. Soon after the activity, a day to week after, students filled out the Post Activity Survey. About two weeks following the activity, the teacher had the students complete the post-assessment to evaluate the students’ retention of the information. All of the teachers also completed their teacher survey and sent all the materials to me including a copy of each student’s activity report. I coordinated with each teacher to find a time when I could interview them after the activity was conducted in their classroom. These interviews were done individually over the phone or via Skype. All student surveys, assessments, and work were coded so that I, as the researcher, never knew the students’ names, but the identification codes did link the work back to a student for comparison.
DATA AND ANALYSIS

Activity’s Relevancy to Students’ Lives

Relating the activity to a student’s life helps put the concepts in contexts they already understand and provide a framework for understanding the concept. The first subquestion of this research was to determine whether this activity was relevant to the students’ everyday lives and in what way(s) it was relevant. Questions from the Pre and Post Activity Surveys, Teacher Survey, and Teacher Interview were used to investigate this question. The Pre and Post Activity Surveys had a number of questions focused on relation of this activity to the students’ lives.

In the Post Activity Survey, three questions were related to the relevance of this lab to the students’ lives (Figure 1). For all three questions, the Agree response categories were all over 50%. When responding to the statement, *This lab was relevant to my life*, 56% of students responded in the Agree categories, about 27% responded neutrally and 17% in the Disagree categories. When asked why they answered the way they did, one student who answered with a 2 (agree but not strongly) stated, “Most of the stuff tested is stuff I use every day.” Another student who answered 3 (strongly agree) stated, “Because it was about products in everyday things.” Another student responded with a 0 stated “Because I’m not sure when in our daily lives, we would need to find a chemical equation for daily products.” One student who answered with a -3 (strongly disagree) stated, “I understand it was trying to show what happens in all the daily products, but I am not particularly interested in that at all.” The positive responses showed that this lab was relevant because it included common household items; whereas the neutral or
negative responses showed either indifference or lack of relevance because the students believed they would never repeat the activity in their daily lives. To respond to this idea that student thought that they would never repeat this activity in real life, I believe that there are classroom activities in all curricular areas which may never be repeated in their daily lives but some activities have aspects that teach skills which may be applied in a different way to their lives. Based on the majority of positive responses to these three question I believe that the students felt that this lab was relevant to their lives.

Figure 1. Student responses to questions valuating the relevance of the activity, (N=205).

This question was followed by: This lab was relevant because we used items seen in many homes. The responses to this were 79% in the Agree categories, about 17% neutral and 5% in the Disagree categories. The students did see this activity as relevant
to them because they saw products commonly used in households, but the products may not be products that they specifically use. One teacher in the teacher interview stated “The materials were not hard to find but next time I want to find more teenage appropriate items that they use. Students did not know what milk of magnesia or drain cleaner was, but they will learn soon enough.” The percentage of responses in the Agree categories was higher for this question than for the previously analyzed question. The students saw that the activity was relevant because they used products found at home but the activity itself may not be something they will do in their life right now or in the future.

Students also responded positively overall to a third question: This lab helped me see chemistry in my everyday life. About 70% of students responded in the Agree categories, 20% responded neutrally, and 9% responded in the negative categories. One goal of teaching is to open students’ eyes to the world around them and how different school subjects factor into and are useful in their lives. The responses to this question showed that it succeeded in connecting chemistry to their lives. The students were again asked why they responded the way they did to this question. Two students, who both responded with a 3, stated: “I had no idea elements could be in cereal and that everyday items that I eat contain chemicals” and “I didn’t necessarily realize all the ingredients/elements put into foods.” One student, who responded with a -1 stated, “I don’t think I see products differently than I did before.”

Teachers were also asked in their surveys and interviews whether they thought the lab was relevant. All three teachers responded positively, each with a different number in the Agree category. The teacher in Germany stated, “I found this project very relevant,
but I’m wondering if my students weren’t as engaged because they use so many German products. This would be much more difficult to accomplish if we did use German products. A conundrum.” The international lifestyle of these students changed how this teacher responded. As quoted earlier, another teacher responded with a 2 because she chose products that teenagers do not generally use. Teachers also responded to the question: *The activity placed students in a situation relevant to life and in which science knowledge could be applied.* The three teachers responded with two 2s and one 3. Therefore, the responses on the student surveys and the teacher surveys, have shown that students see this activity as relating to their everyday life by using household items, and they made a connection from the chemical concepts to ingredients of these items. The activity did show an increase in how much the students think about chemistry in their lives.

**Effects on Motivation of Relating Activity to Students’ Lives**

The next research sub question asked how this lab affected student motivation by relating the topic to their lives. Since this question dealt with the vague and yet multifaceted concept of motivation, there were many survey questions devoted to it. The Pre Activity Survey had questions from all four areas of motivation that Velayutham et al measured in their SALES questionnaire: learning goal orientation, task value, self-efficacy and self-regulation (2011). These questions were asked to understand each student’s attitude toward science and labs in general. Even though the survey contained questions from all categories, how relevancy affects motivation is classified in the task value category. The questions that were analyzed from the Pre Activity Survey focus on
task value; specifically, how relevant tasks affect motivation and how tasks with future
significance affect motivation.

Students were asked two questions in the Pre Activity Survey that focused on how
relevancy and interest affecting motivation. These questions were compared to questions
on the Post Activity Survey that were written to specifically evaluate the activity’s
relevance to students’ lives and how it affected their interest in the subject of chemistry
(Figure 2).

![Figure 2](image-url)

*Figure 2.* Student responses to relevant ask value questions, (N=205).
When responding to the statement, *Labs that are relative to my life interest me,* about 61% responded in the *Agree* categories, about 27% responded neutrally and about 12% responded in *Disagree* categories. This response shows that when a classroom activity or lab makes a connection to the students’ lives in some way, interest in the subject is created. With a large neutral response, about half as many as the agree response, it may show that interest depends on what the connection to their lives is or how that connection is made. The students were also asked to respond to the statement, *When a task is interesting, I am motivated to complete it.* This question was given on both surveys, and had the highest average in responses with a 2.33. Ninety-one percent of students answered in the *Agree* categories with over 60% in the highest *Agree* category. This again shows very strong correlation between student interest in a task and their motivation to complete the task.

Students were also asked, *What makes a class topic relevant to you?*, which had numerous responses but some general trends were seen. Many students responded that the task needed to relate to everyday lives or careers. For example, two students wrote, “When it relates to my everyday life” and “If it helps me with what I want to do in the future.” One student, who wants to pursue a career in psychology, stated, “it doesn’t really. But in the future, if psychology requires writing prescriptions then I will use this a lot.” Other students did the same by relating the activity to future careers they are looking into such as engineering, cosmetology, science, and medicine. Many students also stated that interest in a subject makes it relevant to them. Some students just answered either “I don’t know” or “nothing really” or “I don’t care.”
Comparing the Pre Activity Survey questions on task value to the similar Post Activity Survey questions specifically showed some interesting trends. As seen from question #11 on the Post Activity Survey, which was discussed in an earlier section, students were asked to evaluate the activity with the statement; *This lab was relevant to my life.* Fifty-six percent of students responded in the *Agree* categories, about 27% responded neutrally and 17% in the *Disagree* categories. It is interesting to compare it to Question #21 on the Pre Activity Survey; the neutral category is exactly the same number. The *Agree* categories are a little less and the *Disagree* categories grew a bit from the Pre Activity Survey to the Post Activity Survey. With over 50% agreeing that this activity/lab was relative to their life, and since a majority of the students also responded in the *Agree* categories in the previous Pre Activity Survey questions (#21 and #28), a logical line of reasoning can be made: if the students thought this lab was relevant to them, then it interested them and, therefore, they were motivated to complete it. But that logical jump may be too much to assume if we look at question #14 on the Post Activity Survey. Students responded to the statement, *This lab increased my interest in chemistry.* Only about 37% of the students responded in the *Agree* categories, 41% responded neutrally and 21% responded in the *Disagree* categories. All three categories were close with no overwhelming agreement or disagreement. This may be because it was a single activity in their chemistry curriculum. Having one activity change their interest in a subject matter such as chemistry may be difficult to do. The response to this question, therefore, is not too surprising. The results from this last question do not necessarily negate entirely the logical conclusion from the other three questions.
As observers and administrators of the activity, the teachers also evaluated the relevancy of the lab to the students. Teachers responded in agreement to the two applicable questions on the teacher survey. To the question, *The activity was relevant to students' lives*, all teachers responded in the Agree categories but each with a different number (1, 2, 3). To the question, *By using everyday materials this activity helped interest students in chemical identification*, two teachers responded with 2s in the middle agreement category, and the last teacher responded with a neutral response. They said that the students did not necessarily show too much interest in the subject after this activity.

Tasks can also have value if a student sees that they may be useful to them in the future. This value may motivate a student to complete the task or invest the time to learn a particular concept. Students were asked whether they were motivated to learn something they will need for the future (Pre Activity #29). Comparing this to how the students evaluated how this activity will relate to their future (Post Activity #18 and #20) will show if there is a correlation between perceived future use of and motivation to learn concepts in the activity (Figure 3).
Figure 3. Student responses to future use of concepts and skills, $(N=205)$.

Students were asked, *I am motivated to learn something I will use in my future career* in question #29 of the Pre Activity Survey. Eighty-six percent responded in the *Agree* categories, 12% responded neutrally to the statement and only 2% responded in the *Disagree* categories. This showed that students were very motivated to learn something if they know it will be useful in their future.

On the Post Activity Survey, students were asked to evaluate the activity in response to the statement; *I had to use a skill in this lab I will have to use in the future.* Forty-three percent of student responded in the *Agree* categories, 33% responded neutrally and 24% responded in the *Disagree* categories. The students were also asked to respond to the statement, *Understanding chemical names is important to my future career.* Only 35% responded in the *Agree* categories to this question, with 33%
responding neutrally and 33% responding in the *Disagree* categories. Based on these questions, it seems that students were indecisive regarding whether the skills and concepts in this activity will be useful to them in the future. The data showed that students are motivated in multiple ways: interest in the topic, relevancy of a topic and future use of the topic or skill. Of these three ways, the only positive majority shown was in the relevancy category. The students were motivated to do this lab because it was relevant to them, not because they were interested or they perceived it useful in their future.

**Activity’s Effect on Student Retention and Comprehension**

To determine retention and comprehension of content in this activity, a Pre Assessment and Post Assessment were administered. The post assessment was delayed two weeks after the activity to allow for an accurate measure of retention. Student comprehension on both the Pre Assessment and Post Assessment resulted in low scores with both averages just above 6 out of 10 (Figure 4).
The assessments were similar to each other with multiple choice questions phrased the same, with only the chemical named changed. There was a slight drop in scores from the Pre Assessment to the Post Assessment in considering comprehension of the information (6.35 to 6.15 average). Between the two assessments, the only noticeable change was that there were more students as lower score outliers. Eighteen students on the Pre Assessment earned a 3 or less, whereas, on the Post Assessment, 24 students earned a score of 3 or less. Both assessments included questions for which the students needed knowledge of basic polyatomic ions (acetate, phosphate, sulfate, nitrate, and ammonium) and different teachers approach the memorizing and knowledge of these polyatomic ions differently which may account for low scores. During the two weeks between the assessments, the students may have had differing amounts of review of the

Figure 4. Scores of pre assessment and post assessment, (N=205, 195).
material based on the curriculum plan of the teacher. For most of the classes, the teachers did not state whether they explicitly reviewed this material. Not reviewing nomenclature for two weeks could provide a reason for the slight drop in scores.

There was one question that the students had trouble with on both assessments. This question asked the student to write the formula for two ions in an ionic compound. Answers varied from “I don’t understand the question” to the formula of the compound but not the ions to the correct ionic formulas. It seems that students had a difficult time understanding what ions are and what their formulas are in ionic compound. This skill of determining the ions in an ionic compound was not focused on in this activity; it is typically part of the ionic naming process. This is a skill that may need to be focused on in the future.

In every classroom, there was at least one perfect score on each assessment, therefore showing that these topics were taught in each classroom. The results showed that the activity did not help with comprehension since there was no positive change in the average of scores. This lack of positive change in the average could be for various reasons. This activity was written in a way that it did not teach the nomenclature rules but after the students have some knowledge of the rules, it did give students practice finding and formulating known compounds. The activity by itself did not teach the nomenclature rules. If the skill of naming chemicals was weak to begin with, as seen with an average of 6.35, a two week time delay would only allow for loss of knowledge without a review of the concepts. Two teachers also used this activity as a review of concepts and skills that were previously taught the semester before, therefore the skills may not have been reviewed or easily remembered or used with exceptional proficiency.
Retention is a measure of change between two assessments. To retain information, a student needs to complete two assessments with the same score or better. Change from one assessment to the second was calculated for each student (Figure 5).

**Figure 5.** Change in students’ scores from pre assessment to post assessment, (N=186).

Seventy-four students received a higher score on the Post Assessment than the Pre Assessment, 37 students showed no change in score in the two weeks, and 75 students’ scores fell in the two weeks between assessments (N=186). Therefore, between the two assessments, 60% of the students who took both assessments had the same score or better. This result did not show a drastic change in the average or a drastic number of students who improved in score. As seen more students lowered in score than improved, it was only the no change in score that caused a majority to ‘retain’ the conceptual
information. Therefore, the results show that this activity, by using everyday materials, may not actually help to improve retention of the nomenclature concepts.

**Activity Impact on Teacher and Teaching Methods**

When teachers assign a laboratory experience or activity, it not only affects the students but there are also some effects on the teacher. An activity may give students a great learning experience, but may be very work intensive for a teacher in terms of safety, setup, administration, and grading. Questions on the teacher survey and interview asked about the activity’s effect on their safety, setup, and grading. The teachers all responded in a positive way on the teacher survey, indicating that the activity was safe for them and the students. One teacher even stated, “I did not even have to open any of the chemicals. Everything stayed in their respective containers.” Since the students are looking at the labels this was to be expected.

When asked about the setup and administration of the activity, the teachers’ responses were all positive. When responding on the Teacher Survey to the question, *The setup of this activity was teacher friendly*, teachers responded with two 2s and one 3. They were again asked to rate the setup of the activity in the interview on a one to ten scale, one being difficult and ten being easy; one responded with an eight, another with a ten and, the third responded with a three. But the teacher who responded with a three stated “Since the school is in Germany, it was hard to find American products with the ingredient list in English. But now that I collected them it will be a lot easier next year so it will become an 8 next year.” Also for administration, all of the teachers responded with threes on the survey question, *The activity was easy to administer and supervise.* One teacher said that they had the students arranged in a circle with the teacher in the
center, so they could easily walk to any group in need of help and the students could easily rotate around the circle to the next group of products.

When rating how easy the activity was to grade, the teachers gave mixed results in both the surveys and interview. In the survey, when asked to respond to the statement, *This activity did not take that much time to grade*, the three teachers gave ratings of -1, 0, and 1. In his interview, the teacher who was neutral explained that he did not grade the lab, but, that if he did, it would be easy to grade. The teacher that responded with a -1 (slightly disagree) stated “I am a first year chemistry teacher and am not well versed which makes grading more difficult; it will be much easier when I have more experience.” The last teacher stated “There are different chemicals that students find on the products that fall into grey areas in the nomenclature rules that make it a little more difficult to grade but overall not bad.”

Lastly, the teachers were asked if they would use this activity or something similar in their classroom again. All teachers responded with threes, the strongest agree response. Throughout the teachers’ surveys and interviews, all teachers were quite positive about this activity in its ease of setup, administration, and grading. One teacher said that because of the nature of teaching nomenclature, she has resorted to worksheets for students to practice their skills. She stated, “students were more engaged in this activity than a normal worksheet. The interest level varied with the overall interest higher than normal.” The overall impact of this activity on the teachers and their teaching methods was positive. Each teacher is going to adopt an activity to fit their own teaching style and needs. Getting feedback from these teachers will help me to strengthen and improve the future use of this activity in my classroom.
INTERPRETATION AND CONCLUSION

The purpose of this study was to answer “What is the impact when a nomenclature activity with real life connections is utilized in a high school chemistry class?” by looking at student motivation, comprehension, activity relevance to students’ lives, and the impact on the teacher. By examining different aspects pertaining to relevancy and motivation, the data gave some unique insights into how students are motivated by activities in the classroom. Fifty-six percent (N=207) of the students thought the lab was relevant to their life but 37% of the students thought that the lab increased their motivation for the subject of chemistry. Although 37% is not a majority of the students, this is substantial since it was only one activity that increased their motivation for the whole subject of chemistry. Changing a curriculum to incorporate many relevant activities may show an increase in motivation for a majority of the students. However, exploring this single activity gave insights into how to design future activities to produce greater impact in students’ lives.

The results of the student and teacher surveys showed that the activity had relevance to the students’ lives. The students responded that using items that they know, have seen, and used in their homes made the activity relevant. It also encouraged them to start thinking about chemistry in the world around them. Some of the teachers stated that multiple times students would say, “I did not know that was in there” or “Why are there so many chemicals in this product?” The surveys showed that about 80% of the students thought this was a relevant activity because it used everyday items. But the data also showed that 24% of students felt that the activity and skills taught in the activity - looking at ingredient lists for chemical compounds, writing their correct formula and classifying
them - was not an activity that will be useful in their future. This exact activity may not be something most students will ever do again, but I think it did encourage interest in chemistry and connected it to the world around them. There is always going to be a small percentage of students who are difficult to engage and motivate, so a small percentage of negative responses is to be expected.

Once it was found that this activity related to students’ lives, it was also shown that it had mixed results in changing the motivation of students. Motivation is very important in any classroom or learning situation, therefore having feedback from the students regarding how classroom activities motivate them was helpful. Two different aspects of motivation were investigated: relevance and future use. Thirty-seven percent of students overall showed a small increased interest in chemistry because the activity was relevant to their lives. They agreed (86%) that if a subject is interesting and useful in their future they would be motivated to complete it. They were evenly distributed in the three categories – agree (35%), neutral (33%) and disagree (32%) – when asked whether they thought chemical naming was important to their future career. With this distribution, future use was not necessarily a motivating factor in this activity. Relevance was a more effective motivating factor. This shows that we as teachers need to show connections and relevance between our content and students’ lives as often as possible.

Students showed a connection to the products and the materials used in the research, and this connection did help with retention of the concepts for many of the students. From the Pre to the Post Assessments, 60% of the students did score the same or better. Sixty percent is more than half, but not necessarily a significantly high amount. This study did not investigate whether retention rate shown was significant to other
activities or normal retention of concepts in any other two-week period of time. Nor was there a control group to compare data with. Again, this study only showed the retention after a single activity and only during a single two-week period. Retention rate may improve with more relevant activities to reinforce nomenclature concepts. Another Post Assessment four weeks after the activity may have given more insight into retention of the concepts in the activity. Therefore a 60% retention rate of the concepts may or may not be significant.

The one part of this research that was definitely positive and expected was how this activity affected the teacher and their methods. All of the teachers found the activity very safe, as well as easy to setup and grade. One teacher stated, “I thought one class period of review of names, formulas and ionic vs. covalent was well spent.” All teachers stated that they would use the activity again next year in some form because of how it related chemistry to students’ lives. Each teacher stated some improvements they would make to improve the activity and class environment in which it was administered. One teacher found that the activity took too long in their classroom. They stated that they would cut down the amount of compounds the students needed to find. They also found that with large classes of students, such as theirs, to move the students around the room to the different products made the classroom environment chaotic. They implied that next year they would pass the products to different groups instead of the groups moving to the products. The teacher in Germany found that finding the products in English was difficult and would need to plan to seek out these items with labels in English out prior to using the activity again. The third teacher found that their students did not follow the directions well and suggested that the directions be listed in bullet points. Most of these
improvements suggested by the teachers were mainly adaptations that they would make in their own teaching environment. This is to be expected since each teacher has to adapt activities to their own teaching environment, style, and curriculum. For this study and for the purpose of maintaining validity and reliability of the research, I had to ask each teacher to follow my instructions and implement the activity as I designed it. In reality, and according to best practices, teachers would adapt and modify this activity, as well as others, to best suit their classroom and students. When developing activities for multiple classrooms, it is very important to understand that activities are more a framework of how to present a class with a hands-on opportunity to use or gain conceptual knowledge. The activity will need to be adapted for each classroom environment that it will be used in.

VALUE

When used in my classroom I thought the activity helped my students to realize that the chemical language and chemical compounds that they were learning about are used in common household items such as deodorant and suntan lotion. I felt that they were more motivated since the activity made chemistry relevant. By applying this activity to classrooms other than my own classroom and curriculum, I hoped to learn how this activity may affect other classrooms.

I wanted to know how students view the relationship between science and their lives, and then understand how this relationship can improve students’ interest and motivation to better understand and retain science concepts. In this study, I found that students relate science to their lives in many different ways. Students in this study showed that relevancy is more than just using everyday materials in the lab activity. The
results from the data and the students’ own comments made me understand that they are motivated to learn skills that relate to their future careers and lives.

One of the qualitative questions on the Pre Activity Survey asked what they were hoping their future career would be. Students’ responses varied but included athletic training, cosmetology, chemistry, engineering, teaching, writing, and politics. Many of these careers have a scientific aspect to them. Students then made connections between chemistry and future careers in other questions. This study reminded me that as a teacher, I need to know my students and learn about them and their goals for the future. Then I need to continually find or develop activities that make connections to their future occupations. All teachers need to remember that we are not teaching a subject but we are teaching students who will have a future. We need to find ways to make our subject relevant in their lives, both now and in the future.

I would like to find ways to improve this activity as a way to improve relevance between the skills used in the activity and future lives and careers. One way may be to place the activity in a context of a role-play. Students may be asked to determine which products, of those provided, are safe for someone who is on a restrictive diet which can not include certain chemical compounds or elements. This is a taught behavior, which many people have to employ in their lives due to various medical conditions. Another way to relate this activity to real life is to have students bring in their own products and share them with the class. This would cause students then to look around their own homes at products that they use, to read labels, and to think about what is in the products they use. Lastly, the activity did include a couple of optional research questions, which asked the students to research uses of some of the compounds they found in the activity.
None of the teachers decided to assign this part of the activity, due to time constraints, but I believe this would help students see and understand some of the uses of the chemicals found in these products.

This study did show that students struggled to retain the concepts of chemical nomenclature over a period of time. Chemical nomenclature is a topic that my students have always struggled to retain. It is the basic language of chemistry that is used to determine what compound is being investigated and what is in that compound. Even though I have reviewed the material multiple times it is still a difficult concept to retain. This study has shown that even with an activity that relates to the students it did not necessarily help students’ retention of the concepts. This study reminded me that repetition and reinforcement aids retention. Giving students more real world “hooks,” such as this activity, to “hang” the nomenclature concepts on might improve retention.

There are some improvements to this activity that I could make in the future to improve retention of the nomenclature concepts. One way would be to check the comprehension of the skills and concepts at some time during the activity to make sure everyone is using the concepts correctly. I would stop the students after they have written the formulas for five compounds. Then, as a class, we would check to see that they are writing the formulas correctly. This would help the students know the proper use of the skill so that they hopefully comprehend and retain the concept properly. Another way would be to have repeated checks of nomenclature knowledge and skill after the activity in the form of homework, quizzes or other assessments.

Though the data for comprehension and retention did not necessarily show that this activity helped student retention of concepts, one question that came to mind was,
“How and why does one retain information?” This was followed by the question, “What aspect of an activity creates an environment for a student to retain information?” These questions may lead into another research topic in the future and would help to continue to provide insight into developing new, more effective classroom activities.

I believe this study also helped to confirm James’ conclusion in her study. As stated earlier, James concluded, “students that believe science is relevant were not significantly more likely to achieve higher, but those who believed that it was relevant to their career or relevant to their lives after high school were likely to achieve higher” (2011, p. 28). In my study, 56% of students thought the lab was relevant to their life but only 33% thought it used a skill that would be used in the future. As seen from the retention data, the average assessment score decreased over the two week period between the pre and post assessments. If more of the students thought this activity contained a skill they would use in the future there may have been a noticeable increase in the scores between the assessments. As a teacher, I need to continue to find ways to connect chemistry to various occupations in order to show that chemistry is relevant to students’ future lives and careers. I also need to help my students see that chemistry is all around them.

This research taught me that making a relevant activity is more than just using commonly used materials. Students also want to connect the skills they learn with their future in some way. It also showed me that students are motivated in many different ways and relevance is just one such motivational factor. For some students, I need to help them see chemistry in action around them and as a part of their lives – i.e. chemicals in products they use, baking a cake, digesting food, cleaning objects, etc. For other
students, I need to help them see how their interest in chemistry might be used in future careers. I need to understand that different students will be motivated by different aspects of the subject I am teaching and how it is presented. These insights will help me to create more activities for my class that engage the students in chemistry and connect it to their lives in multiple ways. Hopefully by having a curriculum filled with activities that are relevant to their lives both now and in the future, the students will be motivated and retain information. I hope that these activities will spur their curiosities to explore beyond the curriculum and ask questions about the world around them.

Teaching is a dynamic field and teachers are constantly looking for new ideas to implement in their classroom to effectively engage students in learning. I hope this study provided insights into students’ perception of one classroom activity which could then influence other classroom activities by helping teachers create relevant classroom activities that motivate students and help increase students’ leaning.
REFERENCES CITED


APPENDICES
APPENDIX A

IRB CONSENT
INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

MEMORANDUM

TO: Michael Greenhoe and W. J. Woolbaugh
FROM: Mark Quinn, Chair
DATE: November 30, 2012
RE: "Evaluation of a Nomenclature Activity in Multiple Chemistry Classrooms" [MG113012-EX]

The above research, described in your submission of November 30, 2012, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

_____ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

_____ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior; unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects’ responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects’ financial standing, employability, or reputation.

_____ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

_____ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

_____ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

_____ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

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

STUDENT ACTIVITY
### Naming Chemicals in Our Life

You will be given several products commonly used in daily life. In groups of two, using only a periodic table, locate fifteen compounds in the given products of which you can determine the chemical formula. Write what product(s) it is found in (if found in multiple products list all), and the chemical name in the ingredients list on the package. Determine the chemical formula and whether it is an ionic or covalent compound. Some compounds will be written in an improper chemical way, please correct the name if needed. You must find at least one acid and covalent compound.

(1 point for every correct formula and classification)

+1 for every corrected name

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<th>Chemical Formula</th>
<th>Ionic or Covalent</th>
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Short Answer Questions

1. What was the most prevalent element in all the compounds you found today?

2. What type of compound was most prevalent, ionic or covalent?
   ______________
   Suggest a practical reason why this might be?

3. Which type of chemical compound was easier to formulate from the name, ionic or covalent? _____________ Explain why?

4. Name one compound that contained a polyatomic ion. ______________
   What is the charge of the polyatomic ion?

   What is the formula for the polyatomic ion?

   Draw the Lewis structure for the polyatomic ion.
**Reflection:**

1. Were any of the products you investigated a product you currently use in your home? What one(s)?

2. Did you experience a "Wow, I didn't know that!" moment during your investigation. Did you learn something you want go home and tell your parents about?

3. How does this activity make you think about chemistry in the physical world?
**Research Question(s)**

These question(s) will require you to use additional outside resources (books or websites, etc) to find the answer. Please list the resources you used at the end of your answer (for website: Title of Page and address, for print: Title and author).

1. Pick one compound you found in your investigation and briefly answer the following questions.
   a. Why is it used in that particular product?
   b. Where is this compound usually acquired in order to put it in this product?
      (mines, oceans, extracted from urine, radioactive fallout, banana leaves, etc., etc.)

2. Pick one compound, whose name you did not recognize, or did not know how to formulate and briefly answer the following questions.
   a. Give the name.
   b. What was the product it was found in?
   c. Write-the chemical formula.
   d. What is it typically used for?
APPENDIX C

STUDENT PRE AND POST ASSESSMENTS
Student Pre Activity Assessment

1) Which compound is a covalent compound?
   a) barium sulfate
   b) iron (III) oxide
   c) sodium acetate
   d) silicon dioxide

2) Sodium acetate is a compound that is in common reusable hand warmers. How many atoms are in one formula unit of sodium acetate?
   a) 4
   b) 6
   c) 7
   d) 8

3) What is the correct formula for sodium acetate?
   a) NaCH₃COO
   b) NaAc
   c) Na₃AcO₄
   d) SCH₃COO

4) What is the correct formula for the sulfate ion?
   a) SO₄⁻²
   b) S⁻²
   c) SO₃⁻²
   d) SO₄⁺³

5) Sulfuric acid is used in lead acid batteries and drain cleaners. What is the correct formula for sulfuric acid?
   a) H₂S(aq)
   b) H₂SO₄(aq)
   c) SO₄(aq)
   d) H₄SO₅(aq)

6) Dintrogen oxide is a compound used as laughing gas and speeding up engines. What is the correct formula for dinitrogen monoxide?
   a) NO₂
   b) N₂O
   c) N₂O₂
   d) (NO)₂

7) Many ionic compounds split into ions when dissolved in water. What are the formulas for the two ions in ammonium chloride?

8) What are the formulas for the following compounds?
   Iron (III) oxide
   nitrogen dioxide
1) Which compound is an ionic compound?
   a) nitrogen triiodide
   b) carbon tetrachloride
   c) sodium acetate
   d) silicon dioxide

2) Copper(II) sulfate is used as fungicide and herbicide, sometimes used in fish tanks or cows hooves to kill fungus. How many atoms are in one formula unit of copper(II) sulfate?
   a) 4
   b) 6
   c) 7
   d) 8

3) What is the correct formula for copper(II) sulfate?
   a) CuSO₄
   b) CuSO₃
   c) Cu₂SO₄
   d) Cu₂S

4) What is the correct formula for the phosphate ion?
   a) PO₂⁻
   b) P³⁻
   c) PO₄³⁻
   d) PO₃⁴⁺

5) Hydrofluoric acid is used mostly in glass etching. What is the correct formula?
   a) HFO₄(aq)
   b) H₂F(aq)
   c) H₂FO₃(aq)
   d) HF(aq)

6) Danduff shampoos like Selsun Blue, include selenium disulfide as an active ingredient. What is the correct formula for selenium disulfide?
   a) SeS₂
   b) Se₂S
   c) (SeS)₂
   d) Se(SO₄)₂

7) What are the formulas for the ions in copper (II) nitrate?

8) What are the formulas for the following compounds?
   sulfur trioxide
   sodium phosphate
APPENDIX D

STUDENT PRE AND POST ACTIVITY SURVEYS
**Student Pre Activity Survey**

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

The information given is ALLOWED or NOT ALLOWED (circle one) to used in this research study.

**Student Demographics**

Gender (circle): M / F  
Age: ______  
Grade in School (circle): Fr. / So. / Jr. / Sr.

Previous Semester’s Grade in Chemistry class _________ (letter)  
Previous Semester’s Lab Grade _________ (letter)

This survey consists of several statements made about your science class and the labs in the class. Please circle one number on the scale for each question that best represents your attitudes. There is no right or wrong answers. Please answer all questions.

<table>
<thead>
<tr>
<th></th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I enjoy chemistry.</td>
<td>-3 -2 -1 0 1 2 3</td>
<td></td>
</tr>
<tr>
<td>1a In the previous question, why did you select that answer?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>I think about chemistry in my everyday life.</td>
<td>-3 -2 -1 0 1 2 3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Chemistry is applicable to my life.</td>
<td>-3 -2 -1 0 1 2 3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I am motivated when I can apply a science topic to everyday life.</td>
<td>-3 -2 -1 0 1 2 3</td>
<td></td>
</tr>
<tr>
<td>4a In the previous question, why did you select that answer?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Understanding chemistry is important to me.</td>
<td>-3 -2 -1 0 1 2 3</td>
<td></td>
</tr>
<tr>
<td>5a In the previous question, why did you select that answer?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Statement</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>6</td>
<td>I think I will use some knowledge of chemistry in my future career.</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>7</td>
<td>I lose interest in chemistry because it is not relative to me.</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>8</td>
<td>The skills and concepts I learn in chemistry class are applicable to my life.</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>9</td>
<td>I think chemistry is boring.</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>9a</td>
<td>In the previous question, why did you select that answer?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Chemistry is confusing to me.</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>11</td>
<td>Chemistry encourages me to think.</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>12</td>
<td>I enjoy science labs.</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>13</td>
<td>Labs increase my interest in chemistry.</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>13a</td>
<td>In the previous question, why did you select that answer?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>I enjoy labs because they are hands on.</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>15</td>
<td>Chemistry labs are applicable to my life.</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>16</td>
<td>I have used a chemical in chemistry lab that I have used at my house.</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>17</td>
<td>I enjoy labs because I get to work with other people.</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>18</td>
<td>When I use an item in lab that is in my everyday life, it interests me.</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>19</td>
<td>I lose interest in labs because they are difficult.</td>
<td>-3</td>
<td>-2</td>
</tr>
</tbody>
</table>
20. Labs help me understand topics taught in class. 

21. Labs that are relative to my life interest me. 

21a In the previous question, why did you select that answer? If needed give an example of a lab that was relative to your life. 

22. Labs teach me skills I will use in my future career. 

23. I work hard in chemistry because I want a good grade. 

24. I work through hard tasks, even when I do not like them. 

25. I keep working on tasks until I finish what I am supposed to do. 

26. Even when chemistry labs are not interesting, I keep working until I am done. 

27. Even if science is hard, I know I can learn it. 

28. When a task is interesting, I am motivated to complete it. 

29. I am motivated to learn something I will use in my future career. 

30. I work hard on tasks when I get to work with other people. 

31. What may be your future career as of this point? 

32. What makes a class topic relevant to you? 

33. What was your favorite lab you did this year? Why?
34. What motivates you to do well at something?
**Student Post Activity Survey**

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

The information given is **ALLOWED** or **NOT ALLOWED** (circle one) to used in this research study.

This survey consists of several statements made about your science class and the labs in the class. Please circle one number on the scale for each question that best represents your attitudes. There is no right or wrong answers. Please answer all questions.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I enjoy chemistry.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>2</td>
<td>I think about chemistry in my everyday life.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>3</td>
<td>I enjoy science labs.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>4</td>
<td>Labs increase my interest in chemistry.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>5</td>
<td>I enjoy labs because they are hands on.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>6</td>
<td>Chemistry labs are applicable to my life.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>7</td>
<td>Labs that are relevant to my life increase my interest in chemistry.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>8</td>
<td>This lab was boring.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>9</td>
<td>This lab was difficult.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>10</td>
<td>This lab made me think.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>11</td>
<td>This lab was relevant to my life.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
</tbody>
</table>

11a In the previous question, why did you select that answer?

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>This lab was interesting.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>13</td>
<td>This lab was relevant because we used items seen in many homes.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td>---</td>
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<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>14</td>
<td>This lab increased my interest in chemistry.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>15</td>
<td>This lab was enjoyable because I worked with other people.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>16</td>
<td>This lab helped me better understand chemical naming.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>17</td>
<td>This lab helped me to see chemistry in my everyday life.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
</tbody>
</table>

17a In the previous question, why did you select that answer?  

<p>| | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>I had to use a skill in this lab I will have to use in the future.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Understanding chemical names is important to me.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Understanding chemical names is important to my future career.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>I like to look at labels on items searching for something I know now.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>If the class did more labs with items I know, I would be more interested.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>This lab did not affect my interest in chemistry.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Categorizing items is a relevant skill to me.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Learning relevant skills motivates me.</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

25a In the previous question, why did you select that answer?  

26. What was one thing you liked about this lab?  

27. What did you not like about this lab?
APPENDIX E

TEACHER SURVEY
Teacher Survey

This survey is based on Brownstein, Feldkamp-Price and Rillero’s Science Activity Filter (1994), which has six categories to determine the appropriateness of an activity for use in a classroom. Each category has questions that pertain to attitudes of both teacher and students towards the activity.

When asked about student attitudes please give your best answer based on your observations of your students. This survey consists of several statements made about the given activity setup and use in your class. Please circle one number on the scale for each question that best represents your attitudes. There are no right or wrong answers. Please answer all questions.

Safety

<table>
<thead>
<tr>
<th></th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Additional Comments:

Meaningful Student Learning

<table>
<thead>
<tr>
<th></th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6a In the previous question, why did you select that answer?

<table>
<thead>
<tr>
<th></th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7a In the previous question, why did you select that answer?

<table>
<thead>
<tr>
<th></th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The activity placed students in a situation relevant to life and in which science knowledge could be applied.

**Time Needed vs. Student Learning**

<table>
<thead>
<tr>
<th></th>
<th>The activity (just the activity) took too much classroom time compared to amount of student learning it stimulated.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

10a. In the previous question, why did you select that answer? Give an example of how the activity could be adjusted.

<table>
<thead>
<tr>
<th></th>
<th>The amount of teacher preparation time was too much based on the amount of student learning stimulated.</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>This activity did not take that much time to grade.</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>This activity kept students busy during the allotted activity time.</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

**Cost vs. Student Learning**

<table>
<thead>
<tr>
<th></th>
<th>The expense of this activity was appropriate to the resulting student learning.</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

14a. In the previous question, why did you select that answer?

**Difficulty Level**

<table>
<thead>
<tr>
<th></th>
<th>This activity is age appropriate for the students it was given to.</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

15a. In the previous question, why did you select that answer?

<table>
<thead>
<tr>
<th></th>
<th>The instructions were easily understood and carried out by the students.</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>The skills required for this activity were equivalent to the students’ skills at the time of the activity.</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td></td>
</tr>
</tbody>
</table>
**Activity Effectiveness**

<table>
<thead>
<tr>
<th></th>
<th>Response</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>This activity was effective in reviewing nomenclature concepts.</td>
<td>-3</td>
</tr>
<tr>
<td>19</td>
<td>By using everyday materials this activity helped interest students in chemical identification.</td>
<td>-3</td>
</tr>
<tr>
<td>19a</td>
<td>In the previous question, why did you select that answer?</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>I would like to use this activity (or something similar) in my classroom again.</td>
<td>-3</td>
</tr>
</tbody>
</table>

**Additional Questions**

<table>
<thead>
<tr>
<th></th>
<th>Response</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>The post activity questions were good review for the students.</td>
<td>-3</td>
</tr>
<tr>
<td>22</td>
<td>The setup of this activity was teacher friendly.</td>
<td>-3</td>
</tr>
<tr>
<td>23</td>
<td>The activity was easy to administer and supervise.</td>
<td>-3</td>
</tr>
<tr>
<td>24</td>
<td>I enjoyed seeing the students work through this activity.</td>
<td>-3</td>
</tr>
</tbody>
</table>

Any Additional Comments:
Teacher Interview

1.) How long have you been teaching chemistry?

2.) What level of education do you have?

3.) Are your classes mostly lecture/lab, etc.?

4.) What do you do in your school to attract students to chemistry?

5.) Explain how you prepped the students for this lab? Prior lessons?
   
   i. Probe: Was the lab effective in giving students a place to practice their skills taught in earlier lessons?

   ii. Probe: Did it fit well in your curriculum or teaching sequence?

   iii. Probe: Did you change the lab in any way from the printed form? Why?

6.) What did you like about this lab?

   i. Probe: Would you use it again next year? Why or why not?

7.) What do you think needs improvement in this lab?

8.) Generally how does your class respond to labs? Do they enjoy them? How did they respond to this lab? Can you give me any examples?
9.) Why do you do labs in your class?
   i. Probe: What is one of your labs that students usually enjoy?

10.) How do you relate the chemical topics to students’ lives? Labs? Do you feel this lab did that?
   i. Probe: How did the students respond to this?

11.) From your observations, were students engaged and interested in the lab?
   i. Probe: How could you tell, please provide examples?

1. More than usual? Unusual observations?

12.) On a 1-10 scale, 1 being difficult and 10 being easy, please rate the ease of setting up this activity?
     ___
   i. Probe: Why did you rate it this way?

13.) On a 1-10 scale, 1 being difficult and 10 being easy, please rate the ease of grading this lab?
     ___
   i. Probe: How could the grading of the lab be improved and still provide good feedback to the students?

14.) Would you use this lab again? Why or Why not?
    i. Probe: What changes need to be made to refine it?

15.) Any other comments?