

THE EFFECTS OF USING RUBRIC-BASED FORMATIVE ASSESSMENTS WITH  
FEEDBACK TO CLOSE THE LOOP OF UNDERSTANDING ON STUDENTS'  
UNDERSTANDING OF HIGH SCHOOL CHEMISTRY CONCEPTS

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## ABSTRACT

Over the past years teaching chemistry, I have noticed there are some topics which constantly pose a challenge to students. From my own observation and interaction with my students, I have always thought that my students understand the concepts I am teaching. However, when it comes to taking tests and doing assessments in these areas students do not seem to demonstrate the knowledge and understanding required. Through my readings, I have noticed the use of rubrics as an important assessment technique, which can help students perform well on a given task. As a result, I have decided to investigate what will be the effect of using rubric-based formative assessment on students understanding and motivation to learn chemistry. I chose my 10<sup>th</sup> grade chemistry class as the focus on my project. Baseline comparison data were collected during a nontreatment unit on atomic structure through the use of pre, post and delayed concept map, interviews, surveys, and traditional assessments test. I then implemented two treatment units that utilized rubric-based assessment. The first treatment unit focused on ionic bonding and compounds and the second focused on covalent bonding and compounds. These two treatment units incorporated the use of pre, post, and delayed concept maps, interviews, survey, projects, labs, unit test and self-reflections journal. After I analyzed pre and postunit concept maps, interviews and surveys, I determined that the implementation of rubric-based assessment did not have any significant improvement on students understanding. The data from the post and delayed assessment concept maps, interviews, surveys and unit test indicated that students' long-term memory increased. Students' responses on the student survey, and my reflective journal entries indicated that students were responding very positive to the different types of assessments being utilized with the incorporation of rubrics and that their long-term memory, attitude, motivation were increased. As a result, my attitude and motivation towards teaching chemistry also increased.

## INTRODUCTION AND BACKGROUND

Over the past years teaching chemistry, I have noticed there are some topics such as, chemical bonding, writing formulas, and balancing equations, which constantly pose a challenge to students. From my own observation and interaction with my students, I have always thought that my students understand the concepts I am teaching. However, when it comes to taking tests and doing assessments in these areas students do not seem to demonstrate the knowledge and understanding of these areas. As an educator, I strive to ensure that my students perform at the best of their ability and I constantly try to incorporate new methods and strategies to improve their understanding of concepts. Through my readings, I have noticed the use of rubrics as an important assessment technique which can help students perform well on a given task. The effectiveness of rubrics is well established in much of the research, which focuses on the impact of rubrics on students' academic performance. This topic is important to my students and me because it enables me to better understand how to assess students' learning more effectively, while providing students with a different way to assess their own work and learning.

For the purpose of this project, a rubric is a scoring tool that is used to evaluate students work. Rubrics divide an assignment into its component parts and provide a detailed description of what constitutes acceptable or unacceptable levels of performance for each of those parts. In my project rubrics were used with formative assessment to evaluate students' performance on a given task or a set of tasks with feedback to close the loop of understanding. Formative assessment is used in this project to provide feedback during instruction to adjust ongoing teaching and learning and to improve students' understanding of concepts and achievement of intended instructional outcomes.

This capstone project focused on investigating what would be the effects of using rubric-based formative assessments with feedback to close the loop of understanding on students' understanding and motivation. My focus question is: What are the effects of using rubric-based formative assessments with feedback to close the loop of understanding on students' understanding of high school chemistry concepts? My subquestions are: what are the effects of using rubric-based formative assessments with feedback to close the loop of understanding on students' long-term memory of concepts; what are the effects of using rubric-based formative assessments with feedback to close the loop of understanding on students' attitude and motivation to learning chemistry concepts; and what are the effects of using rubric-based formative assessments with feedback to close the loop of understanding on my attitude and motivation to teach chemistry?

For this capstone project, I choose one of my Grade 10 classes at St. Augustine's College. St. Augustine's College which is a private catholic high school, located in Nassau, The Bahamas. The school has a population of approximately 850 students from Grades 7-12. The population is predominately middle-class African Bahamians. This is a low achieving 10<sup>th</sup> grade, with many students who are easily distracted and struggle with concepts. Chemistry is compulsory for all students in Grade 9 but is optional in the 10<sup>th</sup> grade. The majority of students who opted to do chemistry in the 10<sup>th</sup> grade achieved an average grade of B. During this capstone project, students studied atomic structure and chemical bonding.

## CONCEPTUAL FRAMEWORK

Five main themes are focused on in this literature review, these include: The effects of formative assessment on student understanding of concepts, effect of formative assessment with

feedback on students' long- term memory, the use of rubric with formative assessment, effect of rubric on students' learning and motivation, and teachers' attitude and motivation towards the use of rubrics. The above themes were chosen because they are directly related to my focus question and subquestions. I have evaluated literature, which helped me to determine the effects formative assessment and rubric have on students' learning of concepts, long - term memory, and motivation. In addition, I wanted to consider what effects formative assessment and rubric were having on the motivation and attitude of other teachers.

Formative assessment provides feedback to students to close the loop of understanding. Closing the loop involves communicating to students about their responses on a given task or assessment according to Nichol and Macfarlane-Dick (2006). The specific feedback provided by teachers can be in the form of comments on tests and assignments. These comments, according to Boston (2002), will indicate errors and specific suggestions for improvement and encourage students to focus their attention on the task rather than simply getting answers. The feedback received by teachers from students is equally important as feedback given by teachers. Dodge (2009) explained how feedback from students can be used to target specific areas for improvement. He argued that "if teachers know how students are succeeding and where they are having trouble, they can use this information to make adjustments in lesson" (p.2).

The impact of formative assessment with feedback to close the loop of understanding on students' understanding of concepts is well documented. According to the Centre for Educational Research and Innovation (OECD) policy report (2005), formative assessment has been shown to be highly effective in raising the level of student attainment, increasing equity of student outcomes, and improving students' ability to learn. The OECD report further went on to explain that "Schools which use formative assessment show not only general gains in academic

achievement, but also particularly high gains for previously underachieving students” (p.2). They go on to report that, “attendance and retention of learning are also improved, as well as the quality of students’ work” (p.2).

Since formative assessment is entirely concerned with feedback received from students and teachers, many researchers have attempted to look at how effective this feedback is and how it can be improved. According to Nichol and Macfarlane-Dick (2006), for feedback to be truly effective as a formative learning tool, both the instructor and the student need to understand what to do with it. Nichol and Macfarlane-Dick (2006) reviewed recent research on formative assessment and postulate that such assessment can be used to help students understand concepts and also become independent, self-regulated learners. Based on their findings, the authors proposed seven principles of effective feedback which can help students understand concepts: clarifying goals, developing reflection, delivering information about student learning, encouraging dialogue, encouraging motivation and self-esteem, helping students move from current performance to desired performance, and providing information to the teacher to shape the teaching (Nichol & Macfarlane-Dick, 2006).

While many researchers showed the benefit of formative assessment and its contribution to student understanding of concepts, others painted a different picture. In an article written on formative assessment, Gibbs and Simpson (2004) made reference to a study conducted on students and lecturers’ perception of formative assessment with feedback on student learning and understanding of concepts. In the survey of 130 students and 80 lecturers at the University of Strathclyde, wide discrepancies between students and lecturers were revealed. Most lecturers responded that formative assessment helps students to understand concepts and improve learning. Among the students surveyed, 30% reported that formative assessment with feedback

never helped them to understand concepts, also while 63% of lecturers responded that feedback frequently from formative assessment prompts discussion with tutor, only 2% of students responded the same way and 50% of students responded that feedback never prompted discussion (Gibbs & Simpson, 2004). Such a result does not look good for formative assessment and according to Black and William (1998) one contributing factor might be as a result of the quality and quantity of feedbacks that are provided to students which might not be helpful. Gibbs and Simpson (2004) also explain that because many teachers are faced with tremendous work load, it is very difficult to provide helpful feedback under such situations. Also, the problem with what students do with feedback was also highlighted. Nichol and Macfarlane-Dick (2006) stated that many students do not understand or often do not read feedback. Gibbs and Simpson reported, “Some students threw away the feedback if they disliked the grade, while others seemed concerned only with the final result and did not collect the marked work ”(p.8).

The feedback students receive from formative assessment can also affect students’ attitude and motivation towards their work and how well they retain and learn important concepts. In their article Gibbs and Simpson (2004) explained the effect feedback can have on some students:

Where assessment is largely norm-referenced and is used primarily to distinguish between students, a grade is likely to be perceived by the student as indicating her/his personal ability or worth as a person in relation to others. A poor grade may damage a students’ ‘self-efficacy’, or sense of ability to be effective. (p.8)

Black and William (1998) elaborated that feedbacks on formative assessment in many instances are perceived by students of their ability to learn and negative feedback may damage students' motivation. They went on to explain that in the absence of marks, students focus on feedbacks more carefully and use it to guide their learning. Because of this research evidence, some schools have adopted policies that all assignments should only have feedback and that no marks should be provided (Black & William, 1998). In an attempt to address many of the problems faced in formative assessment, Gibbs and Simpson (2004) outlined a number of conditions under which formative assessment can support learning:

Reactivating or consolidating prerequisite skills or knowledge prior to introducing the new material; Focusing attention on important aspects of the subject; Encouraging active learning strategies; Giving students opportunities to practice skills and consolidate learning; Providing knowledge of results and corrective feedback; Helping students to monitor their own progress and develop skills of self evaluation; Guiding the choice of further instructional or learning activities to increase mastery; Helping students to feel a sense of accomplishment. (p.9)

Formative assessment can have an impact on students' long-term memory of concepts. If learning has occurred, students must be able to use the information or skills after long periods of disuse (Doyle, 2008). Doyle went on to explain that students must also develop the ability to use information and skills to solve problems that occur in a context different from the context in which the information or skill was learned. The information and skills learned by students have a big effect on how it is retained. Doyle posits that "students need adequate time to learn new

information or skills, this includes time for self-reflection and evaluation on how best to organize it and also analysis of what is important to remember” (p.3). Boston (2002) describes how research on formative assessment has shown that students who understand the learning objectives and assessment criteria and have opportunities to reflect on their own work, show greater improvement in retaining information than those who do not. Another way in which formative assessment can impact student memory is how relevant and important the information is to students. Doyle (2008) stated “humans remember things more readily when they have the emotional connection of importance or relevance” (p.4).

Rubrics play an important role in formative assessment and have been used to provide teachers with appropriate feedbacks and a systematic way of grading students’ work. Rubrics list criteria and describe varying levels of quality, from excellent to poor, for a specific assignment and can be used in any discipline for a variety of different tasks (Andrade, 2000). White (2005) wrote that:

Rubric is a formative type of assessment because it becomes an ongoing part of the whole teaching and learning process. Students themselves are involved in the assessment process through both peer and self assessment...Authentic assessment therefore, blurs the lines between teaching, learning and assessment. (p.2)

Tuttle (2009) explains that formative assessment rubric is different from normal summative rubric because it puts emphasis on what a proficient answer looks like so that the student can improve. He goes on further to say “formative assessment rubric moves students from the theory of the rubric to the classroom practice so that students can change” (p.1). Formative assessment

rubrics contain suggestions for improvement for less than proficient areas. This, according to Tuttle (2009), will enable students not only to see a proficient response but they learn a strategy that will enable them to complete such responses accurately.

Rubrics, when used appropriately, can have a profound impact on student learning and attitude towards their work. Baron and Keller (2003) stated that “carefully developed rubrics can be used to accomplish two broad aims: to educate students and to judge their own work, thereby sending the message that ownership of their own learning is respected and valued” (p.4). This point was endorsed by Andrade and Du (2005) who stated that “when rubric is used as part of formative student centered approach to assessment; they have the potential to help students make dependable judgments about the quality of their work” (p.1). Andrade (2000) further argues that rubrics support thinking and learning by having students assess their own work against an instructional rubric.

A number of researchers have supported the benefits of rubrics on student learning and motivation. Andrade (2001) conducted a study on the impact of rubrics on eighth grade students’ writing and knowledge. Andrade concluded that simply handing out and explaining a rubric was associated with higher scores on one out of three essays written by students. The study also revealed that students who had received rubrics identified more of the criteria by which writing is evaluated suggesting that they were developing an understanding of the qualities of effective writing as defined by the rubrics they received. Andrade and Du (2005) reported on a study done by Schafer, Swanson, Bené, and Newberry (2001) into the effects of teacher knowledge of rubrics on student achievement. The research suggests that teaching teachers about the rubric used to evaluate student work on constructed response test items was associated with higher scores on high school algebra and biology tests.

While much has been said about the effect of rubric on student learning, there are also benefits to teachers. Baron and Keller (2003) reported teachers can benefit by gaining information to use in rubric revision, developing and sharing rubrics with colleagues, informing off campus audiences including practitioners in the field about the intended learning outcomes and standards. White (2005) also outlined several benefits rubrics can have on teachers. Teachers can allow assessment to be more objective and consistent, focus the teacher to clarify his/ her criteria in specific terms, and improve performance and attitude. Rubrics have also been shown to have remarkable impact on teacher's attitude and motivation. In a study conducted by Kutlu and Yildirm (2009) on primary school teachers' attitude towards rubric, the authors reported that teachers who use the rubrics in order to monitor the development of students' advanced thinking skills as well as in order to give feedback on student tasks have higher attitude scores on surveys conducted. Furthermore, the results also show that the teachers with higher number of students who use rubrics in order to grade their work have higher attitude scores, compared to teachers whose students do not use rubric.

In summary, the literature suggests that formative assessment with a rubric for the most part improve students' ability to learn. Students who use rubrics indicated that a rubric helped them focus their effort to produce work of high quality and earn better grades. While the majority of studies indicated positive aspects of rubrics and formative assessments, some literature suggest that the feedback received were not effective because in many cases students do not read feedback and negative feedback can be a deterrent to students' motivation to learn. In light of these findings, many researchers propose a number of guidelines teachers can use to effectively improve the use of rubrics and maximize the benefits of feedback.

## METHODOLOGY

### Project Treatment

For this capstone project, the treatment was implementation of rubric-based formative assessment with feedback to close the loop of understanding in my Grade 10 Chemistry class. The nontreatment unit did not use a rubric-based assessment; instead, a traditional assessment method, a unit test, was used without feedback. This project consists of three units. The first unit was the nontreatment and the second and third units were the treatment units.

The first unit taught was the nontreatment and focused on atomic structure and isotopes. For this unit students studied the structure of atoms, properties of electrons, protons and neutrons, isotopes, and uses of radioactive isotopes. Students began the unit by taking a student survey and preunit assessment. This consisted of students filling out a concept map. Six students were interviewed during this process and additional questions given to further gauge their knowledge. After listening to the instructions, students copied notes from the chalk board into their note books; also reference was made to their text book, *GCSE Chemistry* (Earl & Wilford, 2008) where additional notes and examples are found. Following this, students were given an in-class assignment covering atomic structures, ions, and isotopes. During this time, I walked around the classroom observing if students were on the right track and also clarifying any problems or misconceptions students had. As a performance assessment, the following period, students were given a lab activity to construct a model of an atom and arrange electrons in orbit. For this exercise students created a model of a known atom using cardboard and color markers. From their results, they wrote a summary applying relevant terms, and answering questions about their structure. This exercise demonstrates if students grasp the concept of how electrons

are arranged around the nucleus of an atom and also to familiarize students with the various concepts of atomic structure. The final assignment for this unit was a research paper which focused on Dalton's atomic theory. For this assignment students looked at the major points of Dalton's theory and examined those areas that underwent modifications or were proven to be incorrect with the advancement in science. The unit ended with a traditional postunit test covering all aspects of the unit.

The next unit was Treatment Unit 1 or the intervention and involved the implementation of rubric-based assessments with feedback. The unit focused on ionic bonding and compounds and began with a preunit assessment of student interviews and concept maps. For the treatment unit, students constructed their own concept maps with the terms that were introduced in the unit. In this unit students studied the changes that occur in atoms when elements of different types combine chemically, compounds formed when different types of atom combine, the forces that hold particles together in ionic compounds, arrangements of particles in ionic compounds and properties of ionic compounds. After copying notes from the chalk board, students were directed to their text books where further examples of ionic bonding are found. The following period, students were given a work sheet to draw different examples of ionic bonds and explain how each bonding occurs. For this worksheet students used a rubric which was given at the beginning of the period. I explained to students how to use the rubric. The rubric outlined the various steps taken in order to successfully draw bonding in ionic compounds.

The next class, students were given an assignment covering properties of ionic compounds; a rubric was given to students to help them complete this assignment. I also constructed another rubric which was used to grade the quality of work. In this assignment students answered questions relating to the electrical conductivity of ionic compounds, hardness

of ionic compounds, formation of ions and melting point. Since students had to research properties of ionic compounds, the following class I had them demonstrate the properties of ionic compounds, by doing a performance assessment lab exercise. For this lab exercise, students carried out tests on several compounds to determine if they were ionic compounds. They also used the characteristics of ionic compounds to explain the electrical conductivity of these compounds when solid and in aqueous solutions. For this lab students were given a rubric to guide them through the process and another rubric was used to grade students' lab reports. The final piece of rubric-graded performance work for this unit involved a poster project. Students were instructed to construct a poster depicting the importance and uses of three ionic compounds; they also looked at the bonding in these compounds and explained how the bonding gives rise to the characteristics and uses of these compounds. For this project, students used rubrics to construct and also grade their work. Each student was given 5 minutes to make an oral presentation on his/her poster. I gave each student a scoring rubric to evaluate his/her presentation. On the final day of the unit, students were given a postunit test.

The next unit was Treatment Unit 2 and involved the implementation of rubric-based assessments in major assignments and class work. The unit focused on covalent bonding and compounds and began with a preunit assessment, students' interview and students constructing concept maps. The unit began with an explanation and illustration of covalent bonding. Students were shown sample models of covalent bonds in the lab and were also directed to their text books where further examples of covalent bonding are illustrated. The next period I gave students a work sheet to complete examples of covalent bonding. For this work sheet, a rubric was given to students. The following class, students were given an assignment. This assignment covered the properties of complex and simple covalent compounds. In this assignment students

study the bonding in diamond and graphite and describe how the bonding gives rise to various properties such as electrical conductivity, strength, uses and arrangement of atoms. A rubric was given to students to complete this assignment and also to grade this piece of work. The following class, students were given a lab to demonstrate the properties of covalent compounds. For this lab students were given several unknown compounds. They then distinguished these compounds into ionic and covalent groups based on respective properties. For this lab students had in their possession a detailed rubric. I also developed a separate rubric, which was used to grade students' lab reports. The final piece of rubric-derived work was a poster students were asked to develop. This poster assignment focused on the importance and uses of covalent compounds. Students selected three common covalent compounds; they examined the bonding structure of these compounds and explained how the atoms' arrangements give rise to various uses and properties of these compounds. Again, each student was given 5 minutes to make an oral presentation on his/her poster. I gave each student a scoring rubric to evaluate and score the presentations. The unit ended with a postunit test.

To effectively close the feedback loop, I provided detailed feedback to students on all of the work given for the treatment units. Feedback in the form of comments was placed on students' assignments, posters, and lab reports. Also, for in class assignments, I worked examples on the chalk board and answered any questions and misconceptions students had. At the end of the treatment units, students were asked to develop questions based on the various concepts learned. Students were selected to read their questions to the class and also exchanged with their classmates for answering. The questions students formulated gave me an idea of students' understanding, comprehension, and analysis of the topics. In addition students were given various lab activities and other performance based assessments to help close the feedback

loop. Also, special rubrics were developed to receive feedback from students on given tasks. Feedback received was then used to make adjustments to ongoing lessons.

### Data Collection Instruments

The students chosen for this project came from my 10<sup>th</sup> grade Chemistry class. There are 20 students, 11 girls, and nine boys, and their ages range from 14-15. This class meets for four periods per week, on Tuesday for one period and Thursday for another period and Friday for two periods. Each period is 40 minutes. Most of the students enroll in our school in the seventh grade and none of the students are new to the school. All of the students in my class have completed Chemistry in the ninth grade. Chemistry is optional in the tenth grade and the majority of students who opted to select it would have achieved an average of B and above in the ninth grade. I have chosen this class because they seem to struggle the most when it comes to tests and understanding concepts. They are also easily distracted and a little talkative. The six students chosen for the interviews consist of one high-achieving boy and girl, average-achieving boy and girl, and low-achieving boy and girl. Interviews were conducted during students' home- room sessions or at the end of the school day.

The data collecting method used for this research were concept map, interviews, rubrics, surveys, short answer tests, student posters, and reflecting journaling done by myself. I utilized a wide variety of methods to enable triangulation between data, ensure that students learn important concepts and enable me to compare various data. Data were collected from both the nontreatment and treatment units to allow for comparison. The triangulation matrix shown in Table 1 summarizes the three sources of data that were identified for each question.

Table 1

*Triangulation Matrix of Data Collection Methods*

Project Questions	Data Sources		
	1	2	3
Focus Question: What are the effects of using rubric-based formative assessments with feedback to close the loop of understanding on students' understanding of challenging Chemistry concepts?	Short-answer portion: pre, post and delayed assessments and concept map	Interview questions, surveys, concept mapping assignments with rubrics	Concept Mapping pre, post, and delayed during interview process
1. What are the effects of using rubric-based formative assessments with feedback to close the loop of understanding on students' long-term memory of concepts?	pre, post and delayed assessments	pre, post, and delayed interview and assessment	Concept Mapping: pre, post, and delayed during interview and assessment.
2. What are the effects of using rubric-based formative assessments with feedback to close the loop of understanding on students' attitude and motivation to learning Chemistry concepts?	Students surveys, interview question	Student's surveys and interview questions.	Teachers' reflective journal with prompts
3. What are the effects of using rubric-based formative assessments with feedback to close the loop of understanding on my attitude and motivation to teach Chemistry?	Teacher reflection journal with prompts	Teacher reflection journal with prompts	Teacher reflection journal with prompts

For my focus question concerning the effect of rubric-based formative assessment with feedback on students' understanding of Chemistry concepts, I utilized pre and postunit concept maps and pre and postunit surveys. Students' short answer tests and assignments were also analyzed. Concept maps were selected because it enabled me to assess if students understood important concepts by comparing the pre and postunit concept maps scores for both treatment and nontreatment units. The students constructed their concept maps with the terms that were introduced on the first day of the unit. I calculated the average and percentage change from the

preunit and postunit concept maps to determine the overall impact of rubric on students' concepts. A copy of nontreatment unit's concept map terms can be found in Appendix A, Treatment 1 is in Appendix B and Treatment Unit 2 in Appendix C. Students' scores on tests were also analyzed. I compared students' test scores in the three units to determine which unit had the greatest effect on students' understanding. A copy of the nontreatment unit tests can be found in Appendix D, Treatment 1 is in Appendix E, and Treatment Unit 2 is in Appendix F. Students were also given class assignments, lab work and a poster projects in each unit. Assignments scores were calculated to determine which treatment had the greater effects on students' understanding. All major assessments for treatment unit 1 and 2 were scored using rubrics. A copy of the nontreatment unit assignments can be found in Appendix G and H, the Treatment 1 assignment is in Appendix I and J, and the Treatment Unit 2 assignment is in Appendix K and L. Students pre and postunit survey questions were utilized to help determine how students felt they learn best. Students' survey can be found in Appendix M. Interview questions were created to ascertain the degree to which students understand concepts. Interview questions can be found in Appendix N. Students were given three major labs for each unit, the nontreatment Unit lab did not use rubric while Treatment Unit 1 and 2 used rubric. The nontreatment lab can be found in Appendix O, Treatment1 lab is in Appendix P and Treatment Unit 2 lab is in Appendix Q. Students also constructed posters using rubrics to guide and grade their work. The Treatment Unit1 poster is in Appendix R and Treatment Unit 2 poster in Appendix S.

For the impact of using rubric-based formative assessments on students' long- term memory, I utilized post and delayed assessment concept maps, short- answer questions and interviews. The same concept maps, interview questions, and short- answer questions for the pre,

post, and delayed assessments were used. To assess students' long-term memory of concepts, data were collected 14 days after the end of unit.

The correct responses on the concept maps were scored and the average and percentage change from the postunit concept maps to the delayed assessment concept maps calculated. To assess the interview questions and concept map short-answer questions, I compared the post and delayed answers for each unit, and then compared the nontreatment to the treatment to see if rubric-based formative assessments with feedback, help students retain the most information.

Students' attitude and motivation were assessed through the use of a pre and postunit survey, pre and postunit interviews. The pre and postunit surveys include motivational and attitude questions that were compared to determine how students' motivation and attitude changed over the units. During the pre, post, and delayed interview process, similar questions were asked to also gauge how the students' attitude and motivation were affected during this process.

The final subquestion focused on the effect of rubric-based formative assessments with feedback on my attitude and motivation towards teaching. To determine this I completed reflective journals and also utilized students' pre and postunit surveys. Throughout the implementation of this project I looked for trends in my journaling to determine if my attitude and motivation changed with the implementation of rubric-based formative assessment with feedback. A copy of my reflective journal with prompts can be found in Appendix T.

This total project spanned a period of approximately two months for all units. A summary schedule of timeline is in Appendix U.

## DATA AND ANALYSIS

To determine the impact of using rubric-based formative assessment on students' understanding of concepts, I utilized pre and postunit concept maps, pre and postunit surveys, and interview questions. Table 2 shows the percent change data for the preunit concept map averages and postunit concept map averages for each unit and indicates the impact of the nontreatment and treatment strategies on students' learning of concepts.

Table 2

*Percent Change from Nontreatment Assessment and Treatment Units' Preunit and Postunit Concept Map Average (N=20)*

Description of data	Nontreatment	Treatment Unit 1	Treatment Unit 2
Preunit Average Score	68	82	80
Postunit Average Score	79	88	85
Percent change %	16.17	7.31	6.25

Data indicated that the percent change was actually higher for the nontreatment than the treatment units. The data also show the preunit average for the nontreatment was lower than the treatment units due to lower preunit scores. I found similar results when calculating the percent change for the short answers questions done during the interviews. These data are shown in Table 3.

Table 3

*Percent Change from Nontreatment Assessment and Treatment Units' Preunit and Postunit Average for Short Answer Interviews Questions (N=6)*

Description of data	Nontreatment	Treatment Unit 1	Treatment Unit 2
---------------------	--------------	------------------	------------------

Preunit Average Score	72	82	84
Postunit Average Score	81	89	87
Percent change %	12.5	8.53	3.57

After reviewing the data, I have come to the conclusion that there are a number of reasons why the data show this pattern. My students have not had much exposure with concept maps, which was important in the interview; this might account for the low scores in the nontreatment unit interviews. Students would have become much more familiar with concept maps for the treatment units. Students may have had much more knowledge by the treatment unit, which can also explain higher scores and an increase in performance in the interviews. When analyzing the interview data from the preunit to postunit concept maps for the nontreatment unit, most of my interviewees struggled with the concepts of the preunit concept map. The initial data were very low for the nontreatment, which produced higher percent change and larger gains in the postunit data.

For example, some students' responses were:

“I don't understand what some of the words mean.”

“I didn't know most of these.”

“You never taught us this”

I noticed an increase in students' confidence and ability between the postunit concept map interviews for the treatment units. During the postunit Treatment Unit 2 interview, students' responses indicated their improvement in understanding:

“I understand it much better than the first time”

“It is much easier because you explained the words to us in class.”

Since the treatment involved the incorporation of rubric-based formative assessment, students were asked on the pre and postunit survey, “Do rubric-based formative assessments motivate you to learn the material being taught?” Students’ responses were:

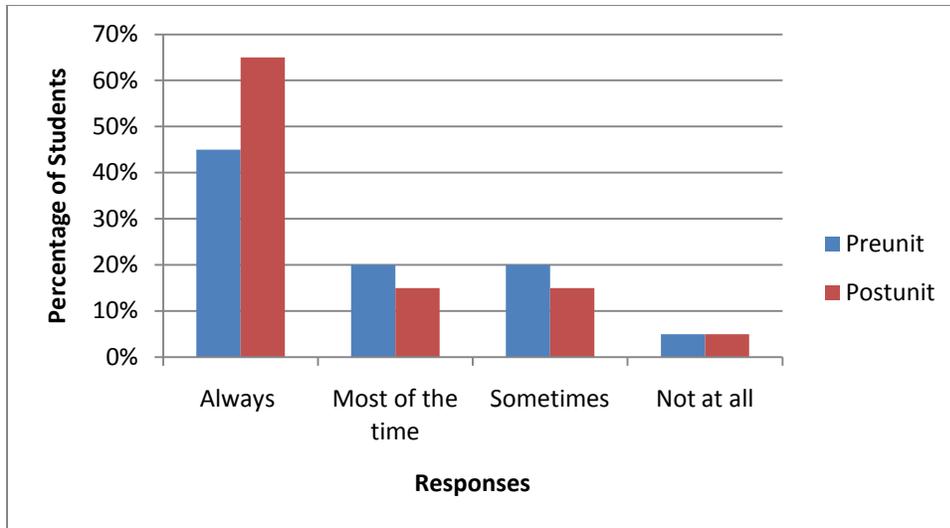
“Yes, you don’t do things that are wrong; you know what the correct answer is.”

“Yes, before rubric I sometime guess the answers, now I know what I have to do to get a good answer.”

“I can better understand how I get a grade.”

“I can use the rubric to follow the steps on drawing ionic and covalent bonds”

Another aspect of using rubric-based formative assessment was that students were given the opportunity to assess their own work. Figure 1 shows the preunit survey average and postunit survey average for student survey questions that asked “I enjoy grading my own work” . Preunit and postunit survey averages were calculated by using the Likert scale the data was coded according to the following with always= 4, most of the time =3, Sometimes =2 and not at all equaling =1.



*Figure 1.* Preunit Survey to Postunit Survey Responses to Questions on the Student Survey that asked if Students enjoy Grading their own Work (N=20)

Overall, the data suggested that students over the course of the capstone project grew to enjoy using rubrics to assess their work. The data also reveal that students' understanding of concepts increased when rubrics were implemented over the course of the treatment unit. Students' responses on the survey also gave a fair indication of how students felt rubric impacted their understanding of concepts. Some responses on students' survey were:

“I know what a correct answer looks like.”

“It helps me learn the steps much better.”

“I can remember what step I missed.”

“I can achieve my goal better.”

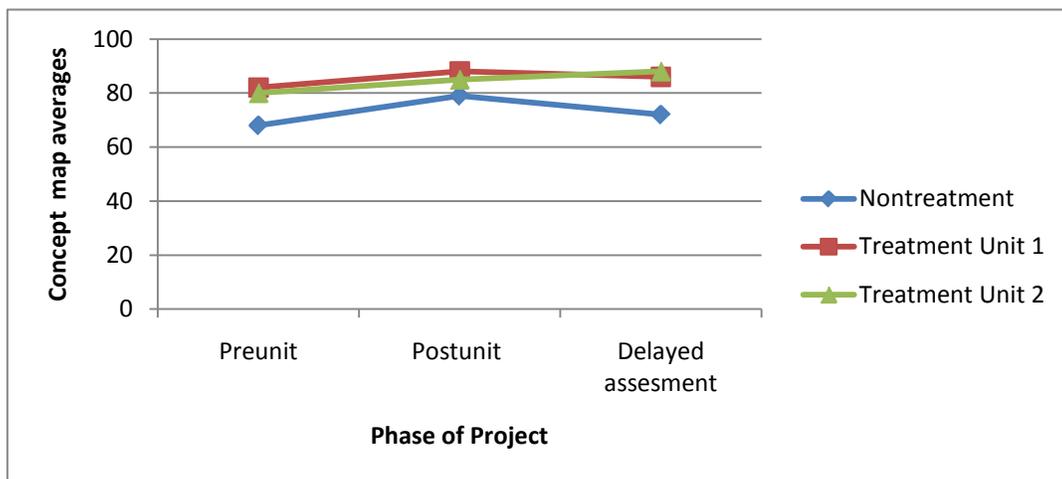
My first subquestion focused on the impact of rubric-based assessment of students' long-term memory. To answer this question, I utilized post and delayed assessment concept maps, post and delayed interviews, and post and delayed unit test questions. Table 4 shows the percent change from the postunit concept map average to delayed assessment concept map averages for each unit.

Table 4

*Percent Change from Concept Map Postunit Average to Concept Map Delayed Assessment Average in the Nontreatment and Two Treatment Units (N=20)*

Description of data	Nontreatment Unit Scores	Treatment 1 Unit Scores	Treatment 2 Unit Scores
Postunit average	79	88	85
Delayed assessment average	72	86	88
Percent change %	-8.8	-2.2	3.5

Data indicated that students' long-term memory show an increase in the treatment units compared to the nontreatment unit. It decreased slightly with Treatment Unit 1 and there was a slight gain in knowledge for Treatment Unit 2. This suggests that they had less long-term memory with the nontreatment unit and that the incorporation of rubrics helped them better remember. Figure 2 shows the comparison of all three assessments' concept map average scores to get a better overall view of how students did throughout all three phases of the project.



*Figure 2: Concept map averages in preunit, postunit, and delayed assessment for all three units (N=20).*

The assessment data and students' responses were an indication that students were better able to retain information taught when rubrics were incorporated into the treatment. After analyzing students' short-answer questions done during interview and also students' unit test, I also determined that students' long-term memory increased during the treatment unit phase. Table 6 displays data for students post and delayed assessments for short answer questions and Table 7 Figure 6.

Table 6

*Percent Change from the Postunit Averages to Delayed Assessment Averages for Concept Map Short - Answer Questions Answered by Students Interviewed (N=6)*

Description of Data	Nontreatment Scores	Treatment Unit 1	Treatment Unit 2
Postunit averages	78	84	86
Delayed assessment averages	72	86	85
Percent change %	-7.69	2.38	-1.16

Table 7

*Percent Change From the Postunit Averages to Delayed Assessment Averages for students unit test. (N=20).*

Description of Data	Nontreatment Scores	Treatment Unit 1	Treatment Unit 2
Postunit averages	75	78	76
Delayed assessment averages	72	84	76
Percent change %	-4	7.7	0

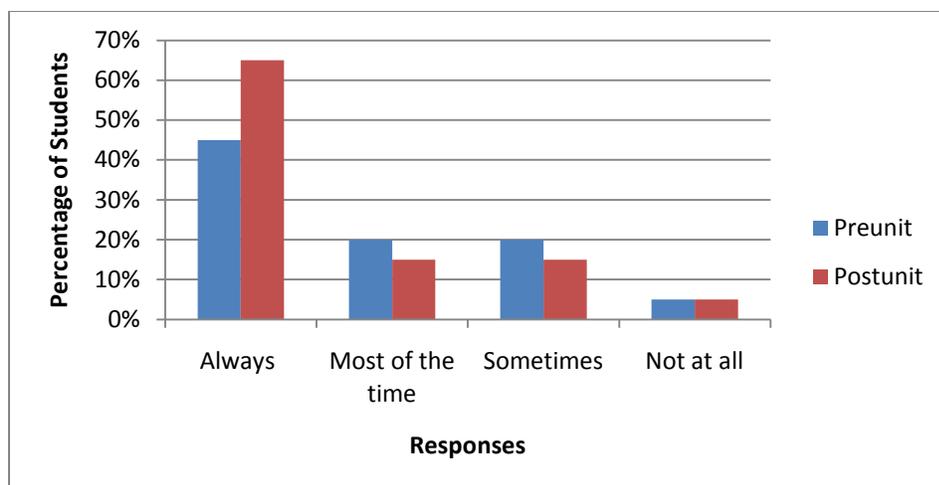
During the various phase of the project, I asked students about their perception of difficulty of explaining what they had learned. During the delayed assessment interview, students were asked if it was easier, harder, or the same to complete concept map. There were 63 % that thought it was easier in the nontreatment unit, 73% in Treatment Unit 1, and 74% in Treatment Unit 2. Students' confidence to learn the material definitely grew from my own observation. This level of confidence helped them to remember the material. Students' responses with respect to the treatment unit, which demonstrate their increase in learning and understanding were;

“I remember a lot more now than the last time.”

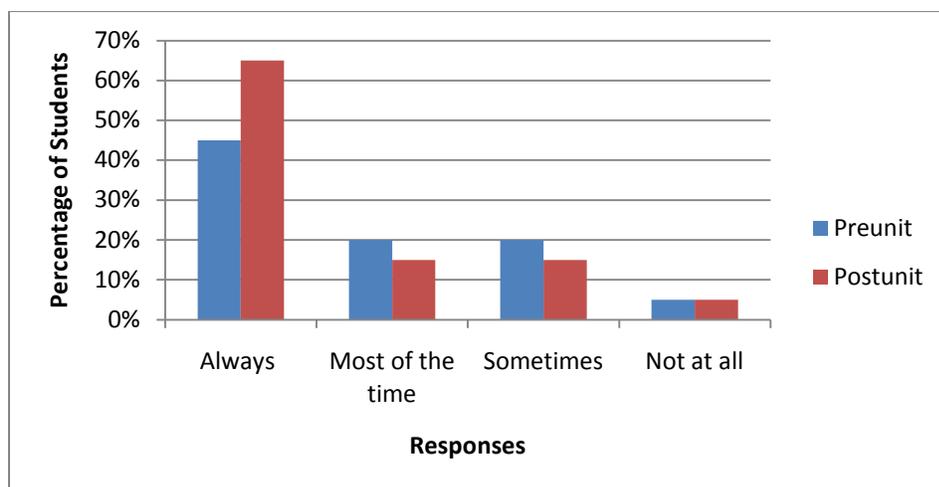
“I am better able to work out the problems.”

“I knew most of the words and can work many of the problems now, some problems I still have difficulties with.”

My second subquestion focused on the impact of using rubric-based assessment on students' attitude and motivation to learn science. To answer this question, I utilized students' responses in surveys they took before and after the capstone project and interviews done during the concept mapping activity. To assess if the students' attitude towards chemistry changed throughout this process, I focused on two main aspects in the students' survey: “I enjoy taking Chemistry” and “I can remember what I learn in Chemistry.” Figure 3 shows the preunit survey averages and postunit survey averages and percent changes for those two questions. Averages were calculated by using the Likert scale the data was coded according to the following with always = 4, most of the time =3, Sometimes =2 and not at all equaling =1.



*Figure 3.* Preunit Survey to Postunit Survey Responses to the Questions That Asked “I enjoy taking chemistry” (N=20)



*Figure 4.* Preunit Survey to Postunit Survey Responses to the Questions That Asked “I can remember what I learn in chemistry” (N=20)

On the whole, I believe students’ attitude and motivation to learn Chemistry was increased largely because they liked using rubrics to assess their work and also because they enjoyed concept maps. Students were better able to reflect on what was learned, which caused them to obtain better grades on tests. Since my treatment involved the incorporation of rubrics to assess students’ work, I asked students in the survey the following question: “Which method, test,

concept map or rubric-base assessment gauged your learning best? Explain”. Table 8 displays the percentage numbers to the responses to the two posed questions.

Table 8

*Percentage of the Student Responses to Which Method They Prefer Best: Rubrics, Concept Maps or Tests, and Which They Believe Gauges Their Learning Best (N=20)*

Survey Responses	Prefer Method	Gauges Learning the best
Tests	15%	26%
Concept Maps	38%	30%
Rubrics	47%	44%

Students’ responses that helped explain why they chose rubrics and concepts maps were.

“The rubric helped me understand better.”

“I enjoy making the concept maps, it was fun.”

“I think you should give us more rubric to work problems.”

“I can remember my work better when I use concept maps and rubrics.”

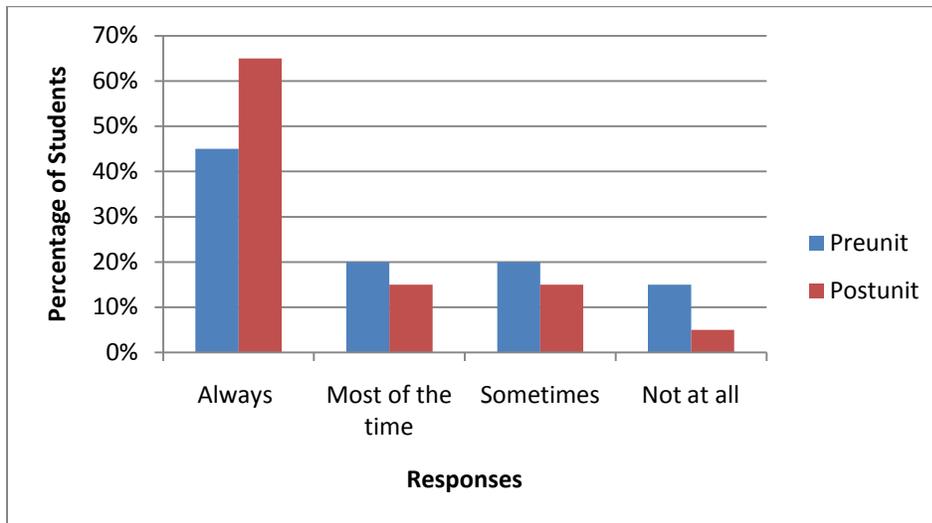
Students’ responses indicated that using rubric and concept maps helped them learn better and were not stressful. When students were asked: “What do you like about rubric-based formative assessment?” Some common responses students made were:

“Rubric helps me perform better on my test, because I know what the correct answer look like.”

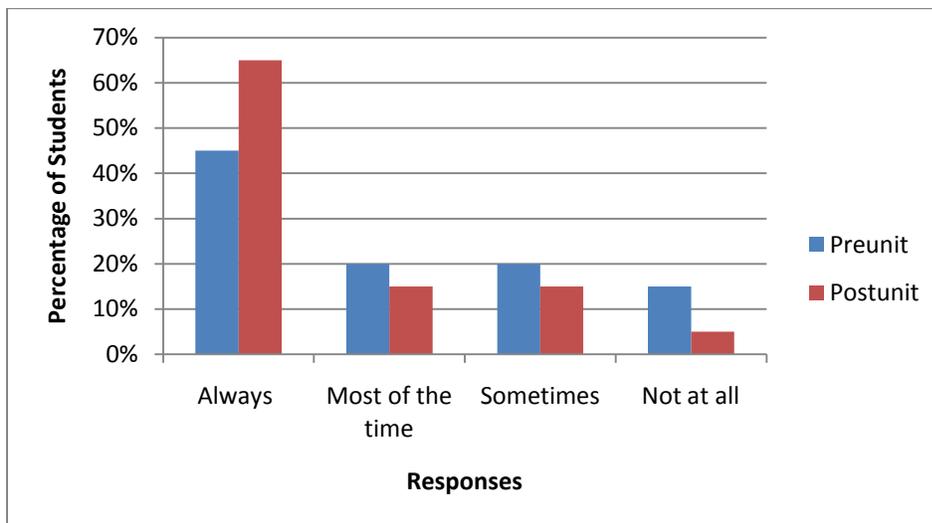
“Rubric helps me to solve the problems very well.”

This indicates to me that students’ performance on tests can greatly be improved if rubric is used throughout the lesson. It is also an indication that students are better motivated to take tests when they use rubric. One of the questions asked in the survey was: “I learned a great deal by doing

tests” and “Tests are challenging for me.” Figure 5 and 6 show the preunit survey averages and postunit survey averages and percent change for those two questions.



*Figure 5.* Percent Change for the Preunit Survey Averages to the Postunit Survey Averages to the Questions that asked if students learn a lot doing tests (N=20)



*Figure 6.* Preunit Survey Averages to the Postunit Survey Averages to the Questions that asked if doing tests are challenging (N=20)

Since the treatment incorporated the implementation of rubric, students were asked in the postunit survey, whether rubric-based formative assessments motivated them to learn. More than

86% of the students responded that rubric motivated them to learn subject material. Since my projects involved giving feedback to students on assignments and tests, students were asked in the survey if they received adequate feedback from rubric-based assessment. About 78% of students indicated that they received adequate feedback on tests and assignments. When asked if the feedback received from rubric-based assignment helps to clarify any confusion about the topics, about 76% of students indicated that feedback was useful. Some responses students gave were:

“The feedback helped me to see what I am doing incorrect.”

“Yes I am not confused about bonding anymore.”

“I think I can get it right the next time.”

While the majority of students indicated that adequate feedback was given and it was useful, a small number of students did not see it this way. Some students' responses indicated that they were still confused about various aspects of the lesson, some pointed out that more feedback should be given.

My last subquestion focused on the impact of rubric-based assessment on my attitude and motivation to teach science. To answer this, I analyzed students' surveys, interview questions, and my own reflective journaling entries. Overall, my attitude and motivation to teach using rubric was increased mainly because I saw that the students did better overall during the treatment units. Students were able to retain the information longer, and their attitude and motivation towards learning Chemistry increased during the treatment units. When I analyzed students' surveys, I discovered that students overall liked using rubric, particularly to grade their own work. I must admit I am not a big fan of students grading their own work. From reading

students' responses, I have become a little more motivated to include such strategies in my lessons in the future.

I analyzed my reflective journaling for trends and patterns and focused on how the lesson affects my feelings and motivation to teach. I also focused on students' motivation and interaction during the lesson. I found that during the nontreatment unit my motivation level was a bit low and at times I became frustrated and worried. I was very concern that students were not grasping the concepts quickly.

My responses during the nontreatment unit were:

“Students find doing concept map difficult, many students are complaining.”

“Students finished the concept map but I am not pleased with many responses.”

“The day was ok but it can certainly be better.”

My attitude and motivation increased during the treatment units; I was much more engaged in the lesson and had a general positive outlook. Some of my responses were:

“Students liked being creative and I was motivated to do this project with my other classes.”

“Yes, students are very motivated to learn the lesson.”

“Students seem to be very focused on the lesson, not too much misconception”

To the second prompt question concerning how I felt about teaching today, my responses during the nontreatment unit were:

“I am concerned that students are not getting the concept map correct.”

“I am a little frustrated today.”

“I hope I don't have to spend too much time on this section.”

During the treatment units, I was much more motivated to teach and my responses were:

“I am more relaxed, students are more engaged.”

“I believe the students will perform well on this section.”

“I believe everything will be ok.”

The responses indicated that my attitude and motivation at the beginning of the project were positive, I felt a little frustrated with the volume of work. I also was a little concerned at the beginning that students would not be able to finish concept maps successfully, which can severely affect the timing of my data collection. Towards the end of the capstone project students became much more familiar with concept maps and also were much more motivated to use the rubric. After seeing the results from students' assessment and observing that students' attitude and motivation increased, this caused my attitude and motivation to also increase.

#### INTERPRETATION AND CONCLUSION

In conclusion, it was determined that my students' long-term memory increased with the implementation of rubric-based assessment; however, I did not see any remarkable improvement in students' understanding of concept. Students' attitude and motivation increased during the treatment unit; this is because students' self-confidence increased and they were better able to remember their work. Students also enjoyed assessing their own work and using rubric to grade themselves. Overall, my attitude and motivation to teach science was increased during the treatment units because I saw how my students were performing better, remembering the information, and enjoying themselves.

This study has great implications and has the potential to change my teaching methods to ensure students' success since I have found that the implementation of rubric-based assessment increases students' academic growth. This project uncovered the need to assess students using

different methods and also to incorporate different teaching strategy compared to just giving students traditional tests and summative assessments. This project could be very beneficial for other teachers and administration particularly in my school. Using rubric-base assessment is not very popular in my school and can be helpful to show different ways that we can assess students to help them learn and develop self-confidence.

### VALUE

The value of this project is to provide information and data for other teachers for the implementation of rubric-based assessment into science class particularly Chemistry. There are a number of areas in this project where further research can be conducted. One such area includes looking at feedback students receive from rubric graded work and how this feedback is used and can be improved. This project is also of significant value to me since I have seen positive results in students' retention and motivation. My plan is to continue using rubric-based formative assessment in my classroom consistently and also to ensure that adequate feedback is given to students on their assessments and in a timely manner. I will also continue to study data to ensure that students are learning and retaining concepts. The changes I would make would be to definitely continue to interview students to check students' understanding. I usually ask the entire class about their understanding and never really try to have one on one interview. This project brings to light the importance of students' interview. Students are less intimidated by others and are able to point out what are their major misconceptions. Also, I think one area I could have improved on and will definitely look closely at in the future is how I can effectively close the feedback loop. I think I could have improved on this area by providing students with more hands-on activities. Also important, is getting students' view on how effective teacher's

feedback is. By conducting this project, it became clear to me that the feedbacks I gave to my students were one way and not a closed loop. I usually focus on students' feedback but never really explore if the feedback I am giving to my students is effective. I am now aware that I need to include detail feedback on students' assignments instead of just providing them with an oral response. Also, I have discovered that students are much more engaged when they are asked to provide criteria on grading their own work or assessing their classmates' work. I was quite surprised with some of the high expectations students had on grading their work.

This capstone project made me consider more ways to assess students' work instead of sticking to the one method. It has encouraged me to involve students more in assessing their work and reflecting on assignments and class activities. Also, instead of providing students with ways to do their work, this approach, challenges students to come up with alternative methods of assessing their own work. This will certainly stimulate critical thinking and ensure high standards. The most challenging aspects of this project were getting students familiar with constructing concept maps. This challenge was reduced by the treatment unit but there are a few students I am still concerned about. It was also challenging to get some students to reflect on what they have learned. Many of my students are so caught up in test scores that they do not process the information, instead they just regurgitate facts. I am still challenged to find ways to allow students to make linkages between concepts instead of just looking at each new concept I teach in isolation. This is vital if they are going to be successful in science.

This experience has certainly had a positive outlook on my professional development. I have always focused my attention on improving instructions to my students and basically concentrate on what goes on in the confines of my own classroom. This project made me realized that I also need to communicate my ideas, reflect and evaluate my practices with other

teachers. This will provide a way to form meaningful relationship with my co-workers where ideas can be share and put into practice. My work will no longer be in isolation, I plan to be much more interactive with colleagues about ways to best improve teaching and learning in my department.

I have learned much about how my students respond to different forms of instructions. One thing I have learned about myself during this project was that I was not always helping my students to succeed. I was mainly focusing on traditional assessments to test students' knowledge but not finding methods to enable students to understand and retain the concepts. As a result of this process, I will definitely use rubric in my classes so my students know what is expected of them and attain higher standards. From all indications students enjoyed using rubrics and this has motivated me even more to teach science. I look forward to share my results with fellow teachers and administrators.

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APPENDICES

APPENDIX A

## NONTREATMENT UNIT CONCEPT MAP TERMS

Please use the words in the box to make a concept map based on the unit topic. Don't forget to include connecting words. You may add more words to your concept map if you wish, but try to use all the words in the box.

**Concept map words for atoms and Nontreatment unit**  
**Begin with the word ATOMS**

Atoms	electrons	Valence shell
Isotopes	Positive	No charge
Proton	Negative	Nucleus
Neutron	Valence	Shell

APPENDIX B

## TREATMENT UNIT 1 CONCEPT MAP TERMS

Please use the words in the box to make a concept map based on the unit topic. Don't forget to include connecting words. You may add more words to your concept map if you wish, but try to use all the words in the box.

**Concept map words for Ionic bonding treatment unit**  
**Begin with the word Ionic Bond**

Form crystals	Ionic bond	stable
The octal rule	High melting point	Gain electrons
Metal	loose electrons	High boiling point
Conduct electricity		

APPENDIX C

## TREATMENT UNIT 2 CONCEPT MAP TERMS

Please use the words in the box to make a concept map based on the unit topic. Don't forget to include connecting words. You may add more words to your concept map if you wish, but try to use all the words in the box.

**Concept map words for Covalent bonding treatment unit 2**  
**Begin with the word Covalent Bond**

Covalent bond

Compounds are usually liquids or gases

Allotropes

To become stable

Low boiling and melting point

Simple

Electrons are share between atoms

Giant

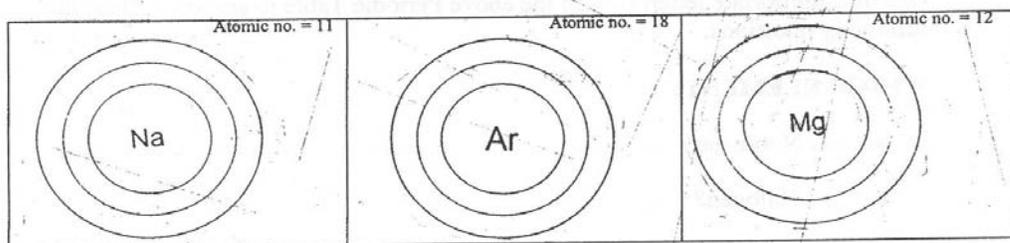
Force that keep atoms together

APPENDIX D

## NONTREATMENT SHORT ANSWER TEST

**Answer all questions.**

1. What does the atomic number represent? \_\_\_\_\_ or \_\_\_\_\_
2. What does the atomic mass represent? \_\_\_\_\_ + \_\_\_\_\_
3. The outer most electrons in an atom are call the \_\_\_\_\_?
4. How would you figure the number of protons or electrons in an atom?
5. A positive ion is called a \_\_\_\_\_ and a negative ion call an \_\_\_\_\_.
6. How would you figure the number of neutrons in an atom?
7. How many electrons can each level hold? 1st = \_\_\_\_\_ 2nd = \_\_\_\_\_ 3rd = \_\_\_\_\_
8. What term is used for the electrons in the outermost shell or energy level?  
\_\_\_\_\_
9. Complete the following atoms to show the arrangement of the electrons **and** the written configurations.



10. Complete the gaps in the Table below.

<b>Element</b>	<b>Atomic number</b>	<b>Mass number</b>	<b>Number of electrons</b>	<b>Number of protons</b>	<b>Number of neutrons</b>
Boron	5	11			
Aluminum	13				14
Potassium		31		19	20
Phosphorus			15		

10. Given the percentage abundance of  $^{20}_{10}\text{Ne}$  is 90% and that of  $^{22}_{10}\text{Ne}$  is 10 %, calculate the relative atomic mass of neon.

11. Explain two different uses of radioactive isotopes.

12. Explain why it is necessary to exercise caution when using radioactive isotopes.

APPENDIX E

## TREATMENT UNIT 1 SHORT ANSWER TEST

**Answer all questions.**

1. Some elements achieve stable electron configurations through the transfer of \_\_\_\_\_ between atoms.
2. By losing one valence electron, a sodium atom achieves the same electron arrangement as an atom of \_\_\_\_\_.
3. Is the following sentence true or false? An ion is an atom that has a net positive or negative electric charge \_\_\_\_\_.
4. An ion with a negative charge is called a \_\_\_\_\_.
5. An ionic bond forms when \_\_\_\_\_ are transferred from one atom to another.
6. Is the following sentence true or false? The lower the ionization energy, the easier it is to remove an electron from an atom \_\_\_\_\_.
7. Identify two factors that determine the arrangement of ions in an ionic crystal. (a) \_\_\_\_\_  
(b) \_\_\_\_\_
8. Is the following sentence true or false? The attractions among ions within a crystal lattice are weak. \_\_\_\_\_.

**Section B.**

1. Work out formula of the following compounds.
  - (a) Aluminum fluoride
  - (b) Magnesium chloride
  - (c) Calcium Nitrate
  - (d) Iron (II) nitrate
  - (e) Copper (II) carbonate
2. Draw diagrams to show the bonding in each of the following compound. Explain of the bonding occur in each.
  - (a) Calcium fluoride (CaF<sub>2</sub>)

(b) Copper(1) oxide ( $\text{Cu}_2\text{O}$ )

(c) Lithium Chloride ( $\text{LiCl}$ )

3. The element sodium and chlorine react together to form the compound sodium chloride, which has a giant ionic lattice structure.

(a) What type of structure do the elements (i) sodium and (ii) chlorine have?

(b) Draw a diagram to represent how the ions are arranged in the Crystal lattice of sodium chloride.

(c) Explain how the ions are held together in the Crystal lattice.

(d) Draw diagrams to show how the electrons are arranged in a sodium and chlorine ion. (the atomic number for sodium and chlorine are 11 and 17 respectively.)

4. Explain the following:

(a) A solid substance X melts at  $1290^\circ\text{C}$  but it does not conduct electricity when solid or molten.

(b) The melting point of water is much lower than the melting point of sodium chloride.

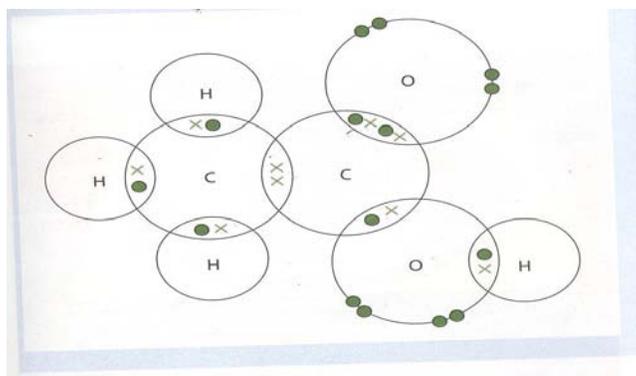
APPENDIX F

## TREATMENT UNIT 2 SHORT ANSWER TEST

Answer all questions

## SECTION A

1. A single covalent bond forms when \_\_\_\_\_ electrons are shared.
  2. A double covalent bond forms when \_\_\_\_\_ electrons are shared.
  3. A triple covalent bond forms when \_\_\_\_\_ electrons are shared
  4. Why isn't neon involved in any compounds? \_\_\_\_\_
  5. What does the electron dot diagram of an element show? \_\_\_\_\_
  6. What kind of bond is between the H and O in water? \_\_\_\_\_ Why? \_\_\_\_\_
  7. What type of bond is between the C and O in carbon monoxide? \_\_\_\_\_  
Why? \_\_\_\_\_
8. The diagram shows the arrangement of the outer electrons only in a molecule of ethanoic acid.



**Diagram adopted from GCSE Chemistry**

- (a) Name the different elements found in this compound
- (b) What is the total number of atoms present in this molecule?
- (c) Between which two atoms is there a double covalent bond?
- (d) How many single covalent bonds does each carbon atom have?
- (e) Write three properties you would expect this sort of substance to have.

9. Draw the diagrams to show the bonding in each of the following compounds. State the compounds that are ionic and are covalent.

- (a) chloromethane  $\text{CH}_3\text{Cl}$
- (b) Ethene  $\text{C}_2\text{H}_4$ .
- (c) Hydrogen sulphide  $\text{H}_2\text{S}$
- (d) Nitrogen  $\text{N}_2$

10. Write the chemical equation of the following reaction

- (a) Aluminum bromide
- (b) Sodium phosphate
- (c) Calcium hydroxide
- (d) Di phosphorus pentoxide
- (e) Boron trichloride

APPENDIX G

## NONTREATMENT ASSIGNMENT 1 ATOMS

**Answer all questions.**

1. Define or explain the meaning of the following terms;

- |                    |                        |                            |
|--------------------|------------------------|----------------------------|
| (a) Nucleon number | (d) Ion                | (g) Cation                 |
| (b) Proton number  | (e) Nucleus of an atom | (h) Anion                  |
| (c) Valency        | (f) Radioactivity      | (i) Electron configuration |

2. Use the information given in the table below to answer the questions below concerning the element **Q, R, S, T, and X**.

Element	Atomic number	Mass number	Electron structure
<b>Q</b>	3	7	2,1
<b>R</b>	20	40	2,8,8,2
<b>S</b>	18	40	2,8,8
<b>T</b>	8	18	2,6
<b>X</b>	19	39	2,8,8,1

- (a) Which element has 22 neutrons in each atom?  
 (b) Which element is a noble gas?  
 (c) Which two elements form ions with the same electron structure as neon?  
 (d) Which two elements are in the same group of the periodic table and which group is it?  
 (e) Place the elements in the table above into the periods in which they belong.  
 (f) Which is the most reactive metal element shown in the table?  
 (g) Which of the above elements is calcium?
3. (a)  $^{69}_{31}\text{Ga}$  and  $^{71}_{31}\text{Ga}$  are isotopes of gallium. With reference to this example, explain what you understand by the term isotopes.  
 (b) A sample of gallium contains 60% of the atoms of  $^{69}_{31}\text{Ga}$  and 40%  $^{71}_{31}\text{Ga}$ . Calculate the relative atomic mass of this sample of gallium.

4. Copy and complete the following table with reference to the periodic table in your text book.

<b>Element Name</b>	<b>Symbol</b>	<b>Atomic number</b>	<b>Mass number</b>	<b>Number of neutron</b>	<b>Electron configuration.</b>
		5	11		
			40	22	
		14	28		
		26		30	

APPENDIX H

## NONTREATMENT ASSIGNMENT 2 ATOMS

John Dalton was an English chemist who develops the atomic theory.

1. Write a brief history of John Dalton.
2. What are the main points outlined in Dalton's atomic theory?
3. What facts was Dalton's atomic theory was successful in offering explanations for?
4. What facts Dalton's atomic theory failed to explain?

APPENDIX I

## TREATMENT UNIT 1 ASSIGNMENT 1 IONIC BOND

**Answer all questions.**

1. Define or explain the meaning of the following terms;

- (a) Chemical bonds                      (c) Cation                                      (e) Valence electron  
(b) Ionic bonding                      (d) Anion                                      (f) noble gas

2. Atoms of elements X, Y and Z have 16, 17, and 19 electrons, respectively. Atoms of Argon have 18 electrons.

(a) Determine the formulae of the compounds formed by the combination of atoms of element;

- (i) X and Z  
(ii) Y and Z  
(iii) X with itself

(b) In each of the cases shown in a(i)-(iii) above, name the type of chemical bond formed.

(c) What properties you would expect to be shown by the compound formed in (i).

3. Draw “dots and cross” diagrams to show the bonding in each of the following compound.

Write the formula for each compound and explain how the bonding occurs.

- (i) Calcium fluoride  
(ii) Magnesium Chloride  
(iii) Aluminum oxide  
(iv) lithium chloride

## IONIC BONDING RUBRIC

## Rubric for drawing Ionic Bonds

1. Write the symbol of the element involved in the bond
2. Draw a circle around each element involved in the bond, this is the valence shell.
3. Use dots or "X" to represent the amount of valence electrons in the atoms. The number of valence electrons is equal to the group number. For example, hydrogen is in group IA (group 1) and it has one valence electron. Neon is in 0 (group 8) and it has 8 valence electrons. The only exception is He which is in group 8 but has 2 valence electrons.
4. Determine how many electron(s) need to be transferred from the metal atom to the non metal atom.
5. Draw lines to show the transfer of these electrons. Remember in ionic bond electrons are transferred from the metal atom to the non metal atom.
6. Show that the atoms involved have a full outer shell of eight electrons and satisfies the octal rule.
7. Redraw the non metal atom showing the full shell of electron, represent the electrons transferred with a different symbol, Example if two electrons are transferred then you can use "X" to represent these electrons and dots to represent the remaining six electrons.
8. Ensure you write the correct charges for each ion in the compound, remember the atom that lost an electron becomes a positive ion and the atom that gains becomes a negative. Place the symbol for the ion in brackets and write the charge of the ion as a superscript outside the bracket e.g  $[\text{Na}]^+$   $[\text{Cl}]^-$ .
9. Write the correct name of the ionic compound.

### IONIC BONDING ASSESSMENT RUBRIC

The following rubric was used to grade student's assignments on ionic bonding.

<b>Ionic Bonds</b>	<b>Poor 1</b>	<b>Fair 2</b>	<b>Good 3</b>
<p>An ionic bond forms when ion(s) in the outer ring of an atom bond with the outer ring of another atom that has enough space to accept the(se) electrons. Most atoms being studied in this chapter can complete their outer ring with 8 electrons</p>	<p>Student knows the basic concept that an ion is in the outer ring of an atom and has some knowledge of the bonding concept, but would have difficulty drawing an electron dot diagram of an atom let alone an ionic bond of two atoms.</p>	<p>Student understands that the ions in an atom's outer ring will bond with other atoms.</p>	<p>Student has a very good understanding of the ion structures in the outer rings of atoms</p>
	<p>Student confuses the charges of ions.</p>	<p>The student probably could draw correct electron dot diagrams 60% of the time of individual atoms</p>	<p>Students would be able to look at a periodic table and figure out how many electrons are in each atom's outer ring.</p>
	<p>Students did not include any charges and are unable to draw the bonding.</p>	<p>Student confuses the charges of ions.</p>	<p>Students would be able to write the correct charges of the ions form</p>

APPENDIX J

## TREATMENT UNIT 1 STUDENT RESEARCH ASSIGNMENT

This assignment is based on the properties of ionic compound. Examine the following data and look for common characteristics in the properties of the ionic solids that are listed.

Ionic Solid	State at Room Temperature	Melting Point (°C)	Electrical Conductivity when testing the solid	Electrical Conductivity when testing the compound in the liquid phase	Electrical Conductivity of a solution of the ionic compound dissolved in water.
Sodium Chloride	solid	801	does not conduct	Conducts	conducts
Magnesium oxide	solid	2852	does not conduct	Conducts	conducts
Potassium Nitrate	solid	334	does not conduct	Conducts	conducts
Lithium Fluoride	solid	845	does not conduct	Conducts	conducts
Strontium nitrate	solid	570	does not conduct	Conducts	conducts

Answer these questions by using the rubric provided to guide you.

1. Of what type of elements are ionic solids composed?
2. What state are the ionic solids in at room temperature?
3. How would you describe the melting points of the ionic solids?
4. Describe the electrical conductivity of the ionic solids in the solid state.
5. Describe the electrical conductivity of the ionic compounds in the liquid state.
6. Predict the properties of another ionic compound, silver chloride. Tell what state silver chloride is in at room temperature and describe its melting point, and electrical conductivity of the solid and the liquid.
7. Silver chloride does not dissolve in water. Predict whether the mixture made with silver chloride and water will conduct electricity. Support your answer by telling why you say what you do.
8. Will the melting point of an ionic compound be higher or lower when the ionic bond is stronger?

## TREATMENT UNIT 1 ASSIGNMENT RUBRIC

The following rubric will be use to grade the questions in students assignment

Questions	Poor 1	Fair 2	Good 3	High 4
describe the melting points of the ionic solids	Students provide some information on why ionic bonds have high melting point. The information provided is very week and far from complete.	Students provide some information on why ionic bonds have high melting point. Some of the information provided is incomplete.	Students explain why ionic bonds have high melting point; include information about the strength of the bonds. The level of information provided is good.	Students explain why ionic bonds have high melting point; include information about the strength of the bonds. The level of information provided is strong and detail.
electrical conductivity of the ionic solids	Students provide some information on why ionic compounds can conduct electricity in a molten state but not solid state. The information provided is very week and far from complete	Students explain why ionic compounds can conduct electricity in a molten state but not solid state. The explanation is not strong and no mention is made about movement of ions. Some of the information provided is incomplete.	Students explain why ionic compounds can conduct electricity in a molten state but not solid state. Explains in very good details the movements on ions. The level of information provided is good but can be improve.	Students explain why ionic compounds can conduct electricity in a molten state but not solid state. Explains in very good details the movements on ions. The level of information provided is strong and detail.
Predict the properties of another ionic compound, silver chloride	Includes little evidence of understanding both physical and chemical properties, and level of information provided is weak, and is far from complete.	includes some evidence of understanding both physical and chemical properties, and the level of information provided is stronger, yet is far from complete.	Students include evidence of understanding both physical and chemical properties, and the level of information provided is strong, and includes enough detail to be complete.	Student includes evidence of deep understanding both physical and chemical properties of ionic compound. The level of information provided is very strong, and is detailed and complete
Predict whether the mixture made with silver chloride and water will conduct electricity	Students provide some information on why ionic compounds can conduct electricity in a molten state but not solid state. The information provided is very week and far from complete	Students explain why ionic compounds can conduct electricity in a molten state but not solid state. The explanation is not strong and no mention is made about movement of ions	Students explain why ionic compounds can conduct electricity in a molten state but not solid state. The explanation is not strong and no mention is made about movement of ions.	Students explain why ionic compounds can conduct electricity in a molten state but not solid state. Explains in very good details the movements on ions. The level of information provided is strong and detail.

APPENDIX K

## TREATMENT UNIT 2 ASSIGNMENT 1 COVALENT BOND

Answer ALL questions.

1. Define the following terms.

- (a) Covalent bond                      (c) Intramolecular forces      (d) Giant covalent structure  
 (b) Intermolecular forces      (d) allotropes                      (e) Simple covalent structure

2. Compare the physical properties of diamond and graphite.

Property	Graphite	Diamond
Appearance		
Electrical Conductivity		
Hardness		

3. Draw diagrams to represent the bonding in each of the following covalent compound. Explain how the bonding occurs in each of following.

- (a) Hydrogen chloride (HCl)  
 (b) Oxygen (O<sub>2</sub>)  
 (c) Tetrachloromethane (CCl<sub>4</sub>)  
 (d) Carbon dioxide (CO<sub>2</sub>)

4. Explain the following

- (a) Covalent bonding exists in both diamond and sulphur, but the melting point of diamond is much higher than that of sulphur.  
 (b) Diamond and graphite are both pure forms of carbon, but graphite conducts electricity and diamond does not.

## COVALENT BONDING RUBRIC

Use the following rubric to help you draw your Covalent bonding diagram.

**Rubric for drawing Covalent Bonds**

1. Find the total number of valence electrons by adding up group numbers of the elements. For anions, add the appropriate number of electrons, and for cations, subtract the appropriate number of electrons. Divide by 2 to get the number of electron pairs.
2. Determine which is the central atom—in situations where the central atom has a group of other atoms bonded to it, the central atom is usually written first. For example, in  $\text{CCl}_4$ , the carbon atom is the central atom. You should also note that the central atom is usually less electronegative than the ones that surround it, so you can use this fact to determine, which is the central atom in cases that seem more unclear.
3. Place one pair of electrons between each pair of bonded atoms and subtract the number of electrons used for each bond (2) from your total.
4. Place lone pairs about each terminal atom (except H, which can only have two electrons) to satisfy the octet rule. Leftover pairs should be assigned to the central atom. If the central atom is from the third or higher period, it can accommodate more than four electron pairs .
5. If the central atom is not yet surrounded by four electron pairs, convert one or more terminal atom lone pairs to double bonds. Remember that not all elements form double bonds: only C, N, O, P, and S!

## COVALENT BONDING ASSESSMENT RUBRIC

<b>Covalent Bond</b>	<b>Poor 1</b>	<b>Fair 2</b>	<b>Good 3</b>
A covalent bond forms when two isolated atoms merge their ions into a combined bonding orbital and in this bond the electrons are shared.	Student knows the basic concept that an ion is in the outer ring of an atom and has some knowledge of the bonding concept, but would have difficulty drawing an electron dot diagram of an atom let alone an covalent bond of two atoms.	Student understands that the ions in an atom's outer ring will bond with other atoms.	Student has a very good understanding of the ion structures in the outer rings of atoms; would be able to look at a periodic table and figure out how many electrons are in each atom's outer ring;
	Student would be confused at times with the difference between ionic and covalent bonds	The student probably could draw correct electron dot diagrams 60% of the time of individual atoms	Students would be capable of drawing electron dot diagrams and illustrate a covalent bond between two atoms.
		Student might confuse a covalent bond for an ionic bond and would struggle on drawing bonding of two atoms by electron dot diagram.	

APPENDIX L

## TREATMENT UNIT 2 STUDENT RESEARCH ASSIGNMENT

substances	Electrical conductivity when solid.	Electrical conductivity when molten.	Soluble in water?	Melting point ( $^{\circ}\text{C}$ )
R	Poor	Good	Yes	700
S	Poor	Poor	No	-65
T	Good	Good	No	2000
U	Poor	Poor	No	-120
V	Poor	Poor	No	1750

1. Select from the Table.

- Two substances that are solid at room temperature.
- A metal
- A molecular substance
- An ionic compound
- A giant molecular substance.

2. Explain the following;

- The melting point of water is much lower than the melting point sodium chloride.
- The differences between a giant and simple covalent structure.
- A molecule of chlorine is non-polar but a molecule of hydrogen chloride is polar.
- Diamond is one of the hardest substances known.
- Graphite is a good lubricating agent.
- Graphite can conduct electricity but diamond cannot

## COVALENT BOND ASSESSMENT RUBRIC

The following rubric was used to grade student's research assignment questions.

Questions	Poor 1	Fair 2	Good 3	High 4
The melting point of water is much lower than the melting point sodium chloride	Students provide little information on why ionic bonds have high melting point. The information provided is very weak and far from complete	Students provide some of the info why ionic bonds have high melting point bonds have low boiling point. Did not include much information about the strength of the bonds. The level of information provided is incomplete.	Students explain why ionic bonds have high melting point bonds have low boiling point. Include information about the strength of the bonds. The level of information provided is good and detail	Students explain why ionic bonds have high melting point bonds have low boiling point. Include information about the strength of the bonds. The level of information provided is strong and detail.
The differences between a giant and simple covalent structure	Students provide little information on simple and giant structure. The information provided is very weak and far from complete	Students provide little information on simple and giant structure. The information provided is very weak and far from complete	Students include information about giant and simple structure. The level of information provided is good and detail.	Students explain why ionic bonds have high melting point bonds have low boiling point. Include information about the strength of the bonds. The level of information provided is strong and detail.
A molecule of chlorine is non-polar but a molecule of hydrogen chloride is polar.	Students provide little information on the difference between non-polar and polar bond. The information provided is very weak and far from complete	Students provide little information on the difference between non-polar and polar bond. The information provided is very weak and far from complete	Students explain well the difference between non-polar and polar bond. The level of information provided is good and detail.	Students explain well the difference between non-polar and polar bond. Include information about the strength of the bonds. The level of information provided is strong and detail.
Graphite is a good lubricating agent.	Students provide little information. The information provided is very weak and far from complete	Students provide little information on why graphite is a good lubricating agent. The information provided is very weak and far from complete	Students explain why graphite is a good lubricating agent. Include information about the movement of electrons. The level of information provided is good and detail.	Students explain graphite is a good lubricating agent. Include information about the strength of the bonds. The level of information provided is strong and detail.

APPENDIX M

## STUDENT SURVEY

Answer the following questions by circling the number that represents how you feel. Please explain why you chose that category when asked

1 – Not at all      2 - Sometimes      3 – most of the time      4 - Always

- 
- |  |   |   |   |   |
|--|---|---|---|---|
| 1. I enjoyed taking chemistry.                               | 1 | 2 | 3 | 4 |
| 2. I learned a great deal by doing test.                     | 1 | 2 | 3 | 4 |
| 3. I can remember what I learn in chemistry.                 | 1 | 2 | 3 | 4 |
| 7. This test was challenging for me.                         | 1 | 2 | 3 | 4 |
| 8. I enjoyed taking the rubric-based formative assessment.   | 1 | 2 | 3 | 4 |
| 9. I successfully completed these assessments.               | 1 | 2 | 3 | 4 |
| 10. I learned a great deal by doing this type of assessment. | 1 | 2 | 3 | 4 |
| 11. The assessments made learning fun for me.                | 1 | 2 | 3 | 4 |
| 12. I enjoy grading my own work                              | 1 | 2 | 3 | 4 |
| 14. I enjoy using concept maps.                              | 1 | 2 | 3 | 4 |
| 15. Concept maps gauge my knowledge of concepts              | 1 | 2 | 3 | 4 |
| 17. Rubrics are helpful.                                     | 1 | 2 | 3 | 4 |
| 18. Rubric helps me do better on my test.                    | 1 | 2 | 3 | 4 |
21. Which method, tests, concept maps or rubric-based assignments, gauge your learning best?
- Explain.
22. What do you like about rubric-based formative assessment?
23. Explain how rubric- based assessment help you to learn?.
25. Do rubric-based formative assessments motivate you to learn the material being taught?
26. Do you think you receive adequate feedback from rubric-based assessment?
27. Did the feedback you receive on assignment clarify any confusion you had about the topic?

APPENDIX N

## INTERVIEW QUESTIONS

**Unit 1: Atoms, Ions and Isotopes ( Nontreatment)**

1. What are the particles found in an atom and what are the charges of these particles?
2. What is an element? Explain why the isotopes of carbon are the same.
3. Explain why an atom is considered electrically neutral?
4. What are ions? What types of ions and form when an atom loses and gains electrons?
5. Why is it necessary to exercise caution when using radioactive isotopes?
6. What is the octal rule?
7. What do you understand by the valency of an atom?

**Unit 2: Ionic bonding and properties. (Treatment unit 1)**

1. Why do elements form chemical bonds?
2. What types of elements are involved in ionic bonding?
3. What is a crystal lattice?
4. Why do ionic compounds usually have a high melting point?
5. Explain why some ionic compounds conduct electricity when molten but not in a solid.
6. Using the periodic table on the board write the ionic formula for the following compounds. Explain your answer.
  - (i) Copper (I) oxide
  - (ii) Zinc phosphate
  - (iii) Lead bromide
7. Atoms of elements X, Y, and Z have 16, 17, and 19 electrons, respectively. Atoms of Argon have 18 electrons. Determine the formula of the compounds formed by the combination of the atoms of the elements: Explain how you arrive at your answer.
  - (i) X and Z
  - (ii) Y and Z
  - (iii) X with itself

**Unit 3: Introduction Covalent bonding (Treatment Unit 2)**

1. What is a covalent bond?
2. How are covalent bonds formed?
3. What are two differences between covalent and ionic bonds?
4. Why do covalent compounds not conduct electricity?
5. What are simple and giant covalent structures?
6. What is an allotrope?
7. Explain why graphite can conduct electricity but diamond cannot?
8. Draw diagrams to represent the bonding in each of the following covalent compounds? Explain how the bonding occurs.
  - (i) H<sub>2</sub>O
  - (ii) CO<sub>2</sub>

(iii) N2

**Attitude and Motivation questions asked during interview**

1. Do your emotions get in the way when taking tests? Yes or No and Why?
2. Which method, tests or concept maps, gauge your learning best? Explain.
3. Do you think that a project with a rubric can help gauge what you learned? Explain.
4. What do you like best about chemistry class? Explain.
5. Would you like to use rubric-based assignments in the future? Why?
6. Did you receive sufficient feedback of all rubric-based assessments?
7. How useful was the feedback you receive from assignments?
8. Are there any areas you are still confused about?

APPENDIX O

## NONTREATMENT LAB EXERCISE

## MODEL OF ATOMIC STRUCTURE

**Apparatus:** Construction paper (2 different colored sheets, A4 size) Scissors, glue, ruler, 1 cent coin, pencil.

**Method**

1. Take one piece of the construction paper and fold in half then in quarter as shown in the diagram 1.
2. Using a pencil and ruler measure and mark out from the center corner fold an X as shown in diagram 2.
3. Mark 2 more X spots as shown in the diagram 3 and draw an arc line to link all 3 X spots.
4. Measure out a 4 cm arc as shown in diagram 4, in the same manner as the previous arc.
5. Continue to measure and draw a 5 cm, 7 cm, 8 cm and 10 cm arc on the same paper.
6. Cut along all arc lines that you have drawn and unfold each section after cutting.
7. On a piece of plane provided glue the middle circle and the two thicker rings you have cut out in step 6.
8. Take the second piece of construction paper and draw 8 circles using the 1 cent coin to draw around.
9. Cut out each circle you have drawn in step 8.
10. Place two of these circles opposite each other, on top the ring nearest to the middle circle and glue in place.
11. Place 4 circles evenly space on top the outer ring and glue in place.
12. Add the remaining two circles to form pairs with a circle already present in the outer ring and glue in place.
13. Draw a line on your model dividing the middle circle in half.
14. In the right side of the middle circle draw 8 equal sized circles and inside each write p+.
15. In the left side of the middle circle draw 8 equal sized circles and inside each write N.
16. Place your name on the paper and turn in your work.

APPENDIX P

## TREATMENT UNIT 1 STUDENT LAB EXERCISE

## Lab: Properties of Ionic Compounds

**Introduction:**

Ionic compounds (or salts) are formed when metals transfer electrons to nonmetals. The loss of electrons by the metal atom transforms it into a positive ion, or *cation*. The gain of electrons by the nonmetal atom transforms it into a negative ion, or *anion*. The cation and anion are attracted to each other because of their opposite charges. A salt is really a network of cations and anions that are stacked in a specific crystalline structure due to their mutual attractions.

In a covalent compound, atoms share electrons. Covalent bonds are usually formed between nonmetal atoms, which have more valence electrons than they are energetically capable of losing. Nonmetal atoms have reasonably high ionization energies, so it's hard to get an electron from one. When two nonmetal atoms meet they do not tend to completely transfer electrons (as a metal would do to a nonmetal); instead, they tend to share. One pair of electrons makes a covalent bond, and since both atoms "want" that pair of electrons, they stick together as long as the pair is shared.

Both types of chemical bonds exist because of atoms trying to satisfy the octet rule. The octet rule says that atoms gain, lose, or share electrons in an attempt to achieve the same electron configuration as one of the noble gases (which usually have 8 valence electrons – hence the word "octet"). Noble gases have the most stable arrangements of electrons; this explains why they so seldom participate in chemical reactions.

In today's experiment, you will determine some properties of ionic and covalent bonds. You will compare their melting temperatures and electrical conductivity in solutions. You will use the observed properties to make conclusions regarding some unknown compounds.

**Materials:**

Aluminum foil

Ring stand

Iron ring

Bunsen burner

Matches

9-Volt battery

Wire with alligator clips

Christmas light with stripped ends

Chemicals:

Sodium chloride, NaCl

Table sugar, C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>

Unknown Compound #1

Unknown Compound #2

Unknown Compound #3

Unknown Compound #4

Safety Considerations:

ALWAYS exercise caution when using Bunsen burners.

The aluminum foil will be very hot after the first part of this experiment. Be extremely careful.

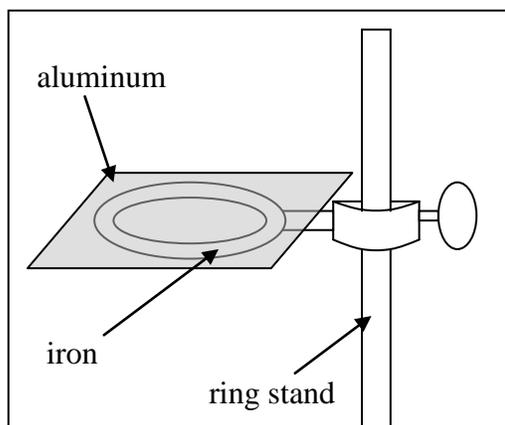
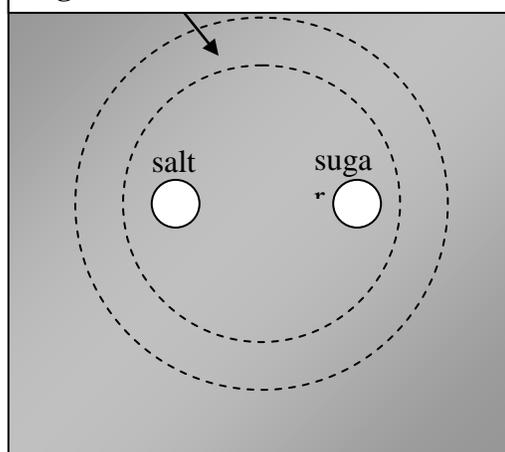
Waste Disposal:

All compounds used in today's experiment can be flushed down the sink with running water.

Procedure:

## PART ONE: Relative Melting Point Determination

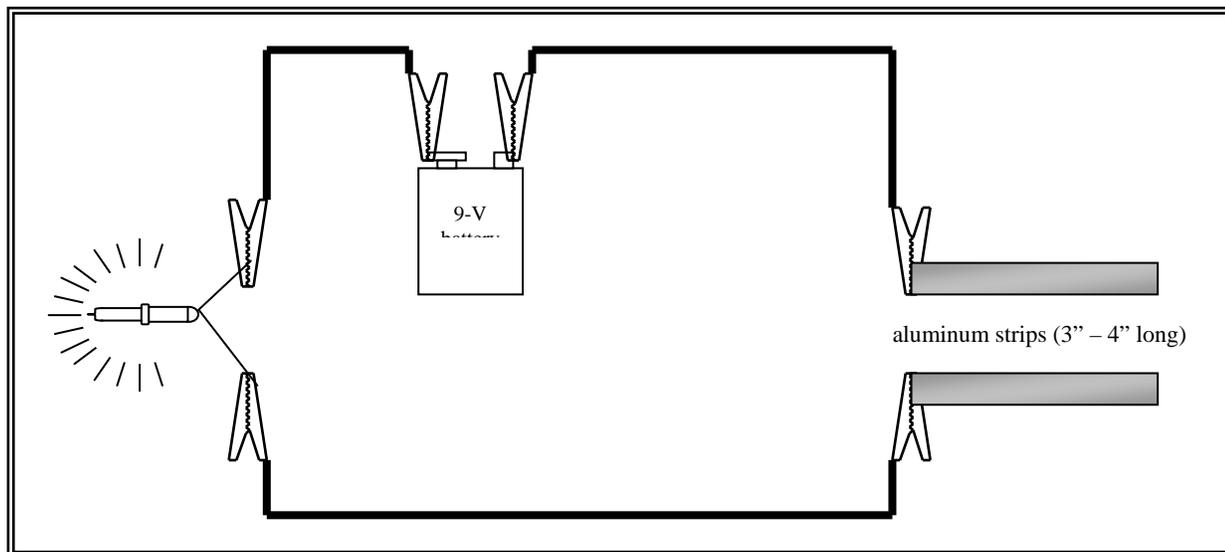
1. Cut a square of aluminum foil that is about 5" by 5". It does not need to be perfect.
2. Set up a ring stand with an iron ring attached. Place the aluminum square on the iron ring, as shown at right in Figure 1.
3. Obtain a small pea-sized sample of NaCl. Place the sample on the aluminum foil, about 1 inch from the center of the square.
4. Obtain a small pea-sized sample of table sugar. Place the sample on the aluminum foil, about 1 inch from the center of the square, but in the opposite direction from the salt.
5. Your square of aluminum foil should look like Figure 2.

**Figure 1.****Figure 2.**

6. Light the Bunsen burner and adjust the flame height so that the tip of the flame is just an inch or so below the height of the aluminum foil. Raise or lower the iron ring if you need to (before you put the burner under it, of course).
7. Move the Bunsen burner so that the flame is directly below the center of the aluminum square. Observe as the two compounds heat up. If one of the samples begins to burn, do not panic. A small sample should burn out quickly.
8. Which compound melts first? Record your observations in the Observations section.
9. Make predictions regarding the relative melting points of covalent and ionic compounds in your Conclusions section.
10. Set up another sheet of aluminum foil and determine the relative melting points (low vs. high) of the four unknowns. Record your results in the Data Section table.

#### PART TWO: Conductivity in Solution

11. Use the following schematic to construct a device capable of testing substances for electrical conductivity.



- 12.** To test for electrical conductivity, insert both aluminum strips into a material. If the light comes on, that material is capable of conducting electricity. If the light does not come on, the material is a non-conductor.
- 13.** Dissolve a spoonful of NaCl in water. Test the resulting solution for conductivity. Record your observations.
- 14.** Dissolve a spoonful of table sugar in water. Test the resulting solution for conductivity. Record your observations.
- 15.** Do ionic compounds conduct an electric current when dissolved? Do covalent compounds? Record your conclusions in the appropriate section.
- 16.** Dissolve a small amount of the four unknowns in four different beakers. Use the conductivity tester to establish whether each unknown conducts a current when dissolved. Record your findings in the Data Section.

Data Section:

Did the table salt or table sugar melt first?

Did the table salt or table sugar conduct a current when dissolved?

Record the properties you observed for the four unknowns in the table below:

Unknown Number	Relative Melting Point (Low/High)	Conducts Electricity When Dissolved (yes/no)
1		
2		
3		
4		

Conclusions:

The formula for table salt is NaCl. Is table salt ionic or covalent?

The formula for table sugar is C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>. Is table sugar ionic or covalent?

Based on your tests with salt and sugar, compare the melting points of ionic compounds with those of covalent compounds.

Based on your tests with salt and sugar, compare the ability to conduct electricity in solution of ionic and covalent compounds.

A compound that conducts electricity when dissolved is called an electrolyte. Write a short statement that identifies ionic and covalent compounds as electrolytes or non-electrolytes.

Identify each of the unknown solids as ionic or covalent, based on your observations:

Unknown 1: \_\_\_\_\_

Unknown 2: \_\_\_\_\_

Unknown 3: \_\_\_\_\_

Unknown 4: \_\_\_\_\_

Using the rubric provided write a detail lab report under the following headings as discussed in class. Title, Objective, Materials, Method, Results, Conclusion

Lab adopted from [www.chemfiesta.com](http://www.chemfiesta.com) some changes were made to original document.

#### LAB REPORT GRADING RUBRIC

Criteria	1 Beginning or incomplete	2 Developing	3 Accomplished	4 Exemplary
Title and Date	The lab report have no date and title.	The lab report fails to meet both of the expectations for Title and Date.	The lab report fails to meet one of the two expectations for Title and Date	Title is present and is descriptive of the lab. Date is recorded and accurate
Purpose	No purpose is given.	Purpose is missing, or is only loosely related to the lab being performed	The Purpose addresses the procedural aspects of the lab, but does not accurately summarize the theoretical foundation of the experiment	Purpose accurately describes the theory that is intended to be reinforced by performing the lab.
Procedure	Missing several important experimental details or not written in paragraph format	Written in paragraph format, still missing some important experimental details	Written in paragraph format, important experimental details are covered, some minor details missing	Well-written in paragraph format, all experimental details are covered
Data/Results	Data is not represented or is not accurate	The student has recorded data after completion of the lab, or fails to meet BOTH expectations 2 and 3 of the Data	The lab report fails to meet either expectation 2 or 3 of the Data section.	Data is neatly organized (in tables if appropriate),and is easy to interpret. All data is correct with regard to

		section. .		significant figures and labels
Conclusions	Conclusions missing or missing the important points. Conclusion does not restate the hypothesis	Conclusion restates the hypothesis, but needs to accept or reject the hypothesis. Conclusion is missing, or is in conflict with the student's experimental results	Conclusion restates and accepts or rejects the hypothesis. Conclusion is present, and does not conflict with the student's experimental findings, but fails to address the theoretical basis for the lab.	Conclusion restates and accepts or rejects the hypothesis and is supported by data. It is aligned with a well-written statement of Purpose at the beginning of the lab.
Questions	Post-lab questions are not answer.	Post-lab questions contain more than 3 errors, or some answers have been omitted	Post-lab questions contain 2 to 3 errors.	Post-lab questions contain no more than one error in total.
Neatness and Organization	Frequent grammar and/or spelling errors, writing style is rough and immature.	Occasional grammar/spelling errors, generally readable with some rough spots in writing style.	All sections in order, formatting generally good but could still be improved	All grammar/spelling correct and very well-written. All sections in order, well-formatted, very readable.

APPENDIX Q

## TREATMENT UNIT 2 STUDENT LAB EXERCISE

## Covalent and Ionic Properties

**Purpose:** In this lab you will examine the properties of ionic compounds and covalent compounds. The properties studied will: **volatility, melting point, solubility in water, and electrical conductivity.** You will use these properties to classify substances as ionic or covalent.

**Background Information:** Compounds have either covalent or ionic bonds depending upon the nature of the forces that hold them together. In ionic compounds, the force of attraction is between oppositely charged ions. This attraction is called an ionic bond. Compounds with ionic bonds form crystals with a regular pattern of positive and negative ions held together by the electrical force of attraction. In covalent compounds, the atoms are held together by an interaction between adjacent nuclei and shared electrons called covalent bonds. Covalent compounds exist in the form of distinct particles called molecules. The molecules of covalent compounds are held together in clusters by weak forces generally referred to as intermolecular forces. Intermolecular forces are much weaker forces than the covalent bonds that hold the elements together within the molecules or ionic bonds that hold the positive and negative ions together in crystals. These different forces account for the many properties of ionic and covalent compounds such as solubility, melting point, the degree of volatility, and ability to conduct an electric current.

Melting -- In order to melt an ionic compound, it is necessary to break ionic bonds. Therefore, ionic compounds usually have high melting points. To melt a covalent compound, it isn't necessary to break bonds. It is only necessary to overcome the much weaker intermolecular forces that hold the particles together.

Volatility -- The particles in a volatile compound must be held together by weaker forces so that some can break away and travel through the air to our noses.

Solubility – Ionic compounds tend to be soluble (or dissolve in) water because water is a polar compound that can exert enough force to overcome the ionic bond and cause the ions to go into solution. In general covalent compounds are less soluble in water. The tendency of compounds to dissociate or ionize in water tells a great deal about the way in which bonds hold the compound itself together.

Conductivity – One way to assess the dissociation tendency of a compound in water is to test for the solutions ability to conduct electricity. If an aqueous solution of the compound does not conduct, it is called a non-electrolyte. If there is conduction in an aqueous solution, the compound is called an electrolyte. Charged particles must be present and free to move in order for an electric current to flow. The amount of conduction by the solution gives an indication of the compound's ionic character. Indeed, conduction or non-conduction by the solution gives an indication of the bond type that exists in the compound.

**Procedure (Part I):**

**Chemicals to be tested :** Sodium chloride, PDB, Potassium chloride, shortening.

**Materials:** Aluminum boats , test tubes, DI water, Shortening , hot plate, test tube rack, stirring rod

1. Volatility – Carefully smell each compound. If you can detect an odor, assume that the compound has a high volatility. Record as high or low volatility.
2. Melting Point – Place a small amount of each substance. Heat the sample on a hot plate and record the time it takes for it to dissolve. The PDB will be heated on a hotplate under the fume hood. The longer it takes the compound to melt, the higher the melting point. Record the time it takes to melt, and whether or not it is considered to be a high or low melting point. If the compound hasn't melted in 3 minutes consider that the compound has a high melting point.
3. Solubility in Water – Put a micro-spatula of each material into a separate test tube. Stir each with a stirring rod (rinsed between each sample) and record how likely the substance is to dissolve in water. Record high or low solubility.

### **Procedure (Part II):**

#### ***Chemicals to be tested***

Sodium chloride solution  
 Potassium chloride solution  
 3M HCl  
 alcohol  
 paint thinner  
 salad oil  
 sugar solution  
 tap water  
 distilled water

#### ***Materials***

spot plate  
 conductivity testers  
 wash bottle of DI water  
 berel pipettes

1. Add one berel pipettes' worth of each of the 9 materials listed to separate wells of a spot plate.
2. Place the two probes into a well. Record the results as conductive or not conductive
3. Rinse probes w/ DI water before putting them into the next sample. Wipe the probes with a paper towel after testing the oil and then rinse with DI water.
4. Test each substance and record results.

### **Conclusion Questions:**

1. Explain why the type of bond could determine the volatility of a substance?
2. Does the strength of the bond have anything to do with the melting point? Explain why.
3. Water molecules are polar which means one side of the molecule is positively charged and the other side of the molecule is negatively charged. Which substances tend to dissolve easier in water, ionic or covalent? Why?
4. What kinds of elements are in the formulas for the ionic compounds?
5. What kinds of elements are in the formulas for the covalent compounds?
6. Explain the difference in conductivity of tap water and distilled water.
7. List the physical properties that indicate ionic bonding exists in a compound.
8. List the physical properties that indicate covalent bonding exists in a compound

Lab adopted from [www.chemfiesta.com](http://www.chemfiesta.com) some changes were made to original document.

## LAB REPORT GRADING RUBRIC

<b>Criteria</b>	<b>1 Beginning or incomplete</b>	<b>2 Developing</b>	<b>3 Accomplished</b>	<b>4 Exemplary</b>
Title and Date	The lab report have no date and title.	The lab report fails to meet both of the expectations for Title and Date.	The lab report fails to meet one of the two expectations for Title and Date	Title is present and is descriptive of the lab. Date is recorded and accurate
Purpose	No purpose is given.	Purpose is missing, or is only loosely related to the lab being performed	The Purpose addresses the procedural aspects of the lab, but does not accurately summarize the theoretical foundation of the experiment	Purpose accurately describes the theory that is intended to be reinforced by performing the lab.
Procedure	Missing several important experimental details or not written in paragraph format	Written in paragraph format, still missing some important experimental details	Written in paragraph format, important experimental details are covered, some minor details missing	Well-written in paragraph format, all experimental details are covered
Data/Results	Data is not represented or is not accurate	The student has recorded data after completion of the lab, or fails to meet BOTH expectations 2 and 3 of the Data section.	The lab report fails to meet either expectation 2 or 3 of the Data section.	Data is neatly organized (in tables if appropriate),and is easy to interpret. All data is correct with regard to significant figures and labels
Conclusions	Conclusions missing or missing the important points. Conclusion does not restate the hypothesis	Conclusion restates the hypothesis, but needs to accept or reject the hypothesis. Conclusion is missing, or is in conflict with the student's experimental results	Conclusion restates and accepts or rejects the hypothesis. Conclusion is present, and does not conflict with the student's experimental findings, but fails to address the theoretical basis for the lab.	Conclusion restates and accepts or rejects the hypothesis and is supported by data. It is aligned with a well-written statement of Purpose at the beginning of the lab.
Questions	Post-lab questions	Post-lab questions	Post-lab questions	Post-lab questions

	are not answer.	contain more than 3 errors, or some answers have been omitted	contain 2 to 3 errors.	contain no more than one error in total.
Neatness and Organization	Frequent grammar and/or spelling errors, writing style is rough and immature.	Occasional grammar/spelling errors, generally readable with some rough spots in writing style.	All sections in order, formatting generally good but could still be improved	All grammar/spelling correct and very well-written. All sections in order, well-formatted, very readable.

### STUDENT SELF-ASSESSMENT RUBRIC

Answer the following questions. This rubric will not be used as a grade. It will be used to determine your understanding of ionic and covalent compound.

<b>Category</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
Questions	All the questions were easy for me to understand after performing the lab	Most of the questions were easy for me to understand after performing the lab	Some of the questions were easy to answer but I needed help	I needed help for most of the questions by either reading back over the lab, used notes, or asked group or teacher
I did my part equally in performing the lab	I was on task at all times	I was on task most of the time	I was on task sometimes	No, I was not on task
I followed the directions and paid attention	All the time	Most of the time	Sometimes	No, I did not follow directions
This activity helped me understand the properties of ionic and covalent compound.	Yes, Explain	Mostly, Explain:	Somewhat, Explain:	No, Explain

APPENDIX R

## IONIC BONDING POSTER PROJECT TREATMENT UNIT 1

The aim of this assignment is to create an informational poster that describes the unique properties of ionic compounds.

Include the following components:

- Select two ionic compounds.
- Give the general properties of the compounds( state of matter, appearance, forms)
- Show the bonding in the compounds
- List uses and importance of these compounds
- Use colorful pictures and drawings where appropriate

## POSTER RUBRIC

Use the following rubric to help you construct your poster.

CATEGORY	4	3	2	1
<b>Part 1 questions ionic compounds</b>	List 3 ionic compound	List only 2 compounds	List only 1 compound.	Did not list any compound.
<b>Properties of ionic compound</b>	Accurately list five properties of ionic compounds	List four properties of ionic compounds.	List two properties of ionic compound.	Only list one property.
<b>Show bonding in compounds</b>	Accurate show the bonding in all compounds selected.	Show bonding in compounds some of the one two bonding is accurate.	Some bonding are incomplete	Did not answer bonding questions.
<b>Importance of compounds</b>	Accurately explain more than five importance of compounds.	Explain three uses and importance of these compounds.	Explain two uses of ionic compounds.	Only explain one importance of compound.
<b>Posters facts.</b>	All facts in the brochure are accurate.	99-90% of the facts in the brochure are accurate.	89-80% of the facts in the brochure are accurate.	Fewer than 80% of the facts in the brochure are accurate.
<b>Spelling &amp; Proofreading</b>	No spelling errors remain after proofreading brochure and report	No more than 1 spelling error remains after proofreading brochure and report	No more than 3 spelling errors remain after proofreading brochure and report	More than 4 spelling errors
<b>Poster - Attractiveness &amp; Organization</b>	exceptionally attractive and well-organized	Moderately attractive and well-organized	Messy but organized	Messy and not organized
<b>Sources</b>	All sources accurately cited	Most sources accurately cited	Some of the sources are accurately cited	Sources not cited

APPENDIX S

## COVALENT BONDING POSTER PROJECT TREATMENT UNIT 2

The aim of this assignment is to create an informational poster that describes the unique properties of covalent compounds.

Include the following components:

- Select three covalent compounds.
  
- Give the general properties of the compounds( state of matter, appearance, forms)
  
- Show the bonding in the compounds
  
- List uses and importance of these compounds
  
- Use colorful pictures and drawings where appropriate.

## POSTER RUBRIC

Use the following rubric to help you construct your poster.

CATEGORY	4	3	2	1
<b>Part 1 questions ionic compounds</b>	List 3 covalent compound	List only 2 compounds	List only 1 compound.	Did not list any compound.
<b>Properties of covalent compound</b>	Accurately list five properties of covalent compounds	List four properties of ionic compounds.	List two properties of ionic compound.	Only list one property.
<b>Show bonding in compounds</b>	Accurate show the bonding in all compounds selected.	Show bonding in compounds some of the one two bonding is accurate.	Some bonding are incomplete	Did not answer bonding questions.
<b>Importance of compounds</b>	Accurately explain more than five importance of compounds.	Explain three uses and importance of these compounds.	Explain two uses of ionic compounds.	Only explain one importance of compound.
<b>Posters facts.</b>	All facts in the brochure are accurate.	99-90% of the facts in the brochure are accurate.	89-80% of the facts in the brochure are accurate.	Fewer than 80% of the facts in the brochure are accurate.
<b>Spelling &amp; Proofreading</b>	No spelling errors remain after proofreading brochure and report	No more than 1 spelling error remains after proofreading brochure and report	No more than 3 spelling errors remain after proofreading brochure and report	More than 4 spelling errors
<b>Brochure - Attractiveness &amp; Organization</b>	exceptionally attractive and well-organized	Moderately attractive and well-organized	Messy but organized	Messy and not organized
<b>Sources</b>	All sources accurately cited	Most sources accurately cited	Some of the sources are accurately cited	Sources not cited

APPENDIX T

## REFLECTIVE JOURNALING PROMPTS

**Teacher**

1. What was something positive today? Explain.
2. What was something negative today? What could I have done to improve it? What could I do better next time?
3. Do I think my students learned today? Explain.
  
4. What assessment techniques worked the best and worst? Why?
  
5. Did the lesson today and students motivate me to teach?
6. Did I effectively close the feedback loop?
7. Do I think students respond well to the rubric?
8. Did I provide students with adequate feedback?
9. How did I feel about teaching today? (What fired me up, what made me feel concerned or worried? etc).
10. Anything else you want to add?

APPENDIX U

## LESSON PLAN TIMELINE

**Nontreatment Unit.**

January 11<sup>th</sup>: Begin nontreatment unit on atoms and isotopes.

- Students took nontreatment preunit assessment, concept map, and interview.

January 13<sup>th</sup>: Continue with nontreatment topic (atoms and isotopes)

- Students took nontreatment in- class assignment in this period.
- Students were given a nontreatment take home research assignment; this assignment was collected on Tuesday Jan 18<sup>th</sup>.

January 14<sup>th</sup>: Continue with nontreatment topic (atoms and isotopes)

- Students were given a performance base activity, constructing a model of an atom.

January 18<sup>th</sup>: Students took nontreatment test covering all aspect of the unit.

January 20<sup>th</sup>: Students took nontreatment postassessment concept map and interview.

**Treatment Unit 1**

January 20<sup>th</sup>: Students began treatment topic (Ionic bonding and compounds)

- Students took preunit assessment, interview and concept map.

January 25<sup>th</sup>: Continue with treatment topic.

- Students took in-class worksheet on ionic bonding.

January 27<sup>th</sup>: Continue with treatment topic.

- Students were given an in-class assignment on properties of ionic compounds.

January 28<sup>th</sup>: Students were given a performance assessment lab on ionic compounds.

- Students completed additional questions on ionic bonding.
- Students were given instruction for poster project.

February 1<sup>st</sup>: Students made presentation of their poster.

February 3<sup>rd</sup>: Students continued with poster presentations.

February 4<sup>th</sup>: students took treatment unit test.

February 7<sup>th</sup>: students began treatment postunit concept map, interview and survey.

February 10<sup>th</sup>: Continue with treatment postunit concept map, interview and survey.

February 15<sup>th</sup> : Students began nontreatment delayed assessments of concept map, unit test and interview.

February 17<sup>th</sup>: Students continued with nontreatment delayed assessment and interview.

## **Treatment Unit 2**

February 18<sup>th</sup>: Students began treatment unit 2 topic (covalent bonding and compound)

- Students took preunit assessment, interview and concept map

February 22<sup>nd</sup>: Continue treatment unit topic.

- Students complete in-class work sheet on covalent bonding.

February 23<sup>rd</sup>: Continue with treatment topic.

- Students were given a research assignment on covalent compound.

February 24: Students complete performance base lab on covalent and ionic compounds.

- Students completed additional questions on covalent bonding and answered questions relating to the lab.
- Students were given guideline for poster project.

March 1<sup>st</sup>: Students presented poster project.

March 2<sup>nd</sup>: Students concluded poster presentation.

March 4<sup>th</sup>: Students completed post treatment unit test.

- Students began post treatment interview, concept map and survey.

March 8<sup>th</sup>: Students concluded post treatment interview and survey.

March 10<sup>th</sup>: Students began treatment unit 1 delayed assessments, interview, concept map, survey and test.

March 11<sup>th</sup>: Students concluded treatment unit 1 delayed assessment, interviews and survey.

March 22<sup>nd</sup>: Students concluded all delayed assessment for treatment unit 2.