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WHAT HAPPENS TO STUDENT ENGAGEMENT AND UNDERSTANDING OF CHEMISTRY WHEN CROSS-CURRICULAR ACTIVITIES AND ASSIGNMENTS ARE USED IN AN HONORS CHEMISTRY CLASS?

By
Heather L. Keller

A Thesis

Submitted in partial fulfillment of the requirements of the
Master of Science in Teaching Degree
of
The Graduate School
at
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Approved By _____
Dr. Yvonne E. González Rodríguez

Date Approved June 25, 2009

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ABSTRACT

Heather L. Keller

WHAT HAPPENS TO STUDENT ENGAGEMENT AND UNDERSTANDING OF CHEMISTRY WHEN CROSS-CURRICULAR ACTIVITIES AND ASSIGNMENTS ARE USED IN AN HONORS CHEMISTRY CLASS?

2008/09

Dr. Yvonne E. González Rodríguez
Master of Science in Teaching

The focus of this action research study was to determine if cross-curricular learning strategies could be used in a chemistry class to increase both student engagement and understanding of chemistry content. Two strategies were implemented in an honors chemistry course of sophomores and juniors. Participants were chosen on a voluntary basis, those students who chose not to participate still needed to complete the activities, however, their grades and responses were not included in the data. Participating students were required to complete a consent form and obtain parental permission. Students completed a creative writing activity and a kinesthetic activity in which they demonstrated their understanding of the content. The students showed an increase in engagement and understanding of chemical concepts that were a part of this research study. Thus, the conclusion of this research study suggests that implementing cross-curricular learn strategies increases student engagement and understanding of chemistry.

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CHAPTER I

INTRODUCTION

Statement of the Problem

Statement of the Problem

A number of students in my class were having trouble connecting to the material when it was presented to them in a traditional lecture style of teaching. I began to see that when using unconventional methods to emphasize the point, the content became more memorable and easier for the students to later recall.

This problem is persistent across the grades. Middle school teachers as well as college professors are struggling to try to make the material more personal to students (Albers, 2000, Etkina, 2000). This can be done by showing students that science can be creative and fun. This can pique their interest and cause them to become more interested in the topics that are being taught. In some cases, students viewed science as nothing more than a mechanical exercise with little creative expression (Alber, 2001). If a personal connection can be made to the content then the chances of remembering the key concepts increases.

Story behind the Research

Eisenkraft, Heltzel, Johnson, & Radcliffe (2006), found in their research that science is sometimes viewed as a cold subject where all you do is regurgitate facts and figures. The goal of good chemistry and science teachers alike is to make the content meaningful to the student (Eisenkraft et al., 2006). I believe that if a student can make a

connection, they will become more engaged in the class; therefore, try harder and perform better when it comes time to take the test or the quiz.

I started using pneumonic devices, rhymes, demonstrations and analogies to help the students understand the topics. I noticed that some of my students were struggling to pay attention, I asked my cooperating teachers for some advice. They suggested that I make that lesson memorable. For example, in a previous unit, before my strategies were implemented, I observed my cooperating teacher teach a lesson on the movement of molecules in different states of matter. She was moving and dancing all around the room. I saw that the students were positively responding to her and that was when I had my 'aha moment'.

When I incorporated movement with my explanation or a pneumonic device to help the students remember a concept, I saw that the students began to pay more attention to the lesson. As a student teacher, I struggled to find ways to get the content across to the students as well as make it interesting. I understood that for some, science is not fun and that they would rather have a study hall. This became apparent to me when I heard the comments of the students and saw the general lack of enthusiasm when engaging in a conversation about the topics of the day.

Significance of the Study

As a student teacher, I noticed that students today are more concerned with what they need to know to get a good grade on a test or quiz. In some cases, the students were not concerned with learning the material. They wanted to know, 'is this going to be on the test?' They also wanted step by step instructions on how to answer the questions in a way that would earn them the most points on a test or quiz. That was a bit of a shock to

me. When I was in school, I was concerned with how the content related to my life, I found it interesting that students in this class did not feel the same way.

I also think that finding new ways to present science content can be beneficial to both the students and the teacher. Effective teachers try to hold the students' attention from bell to bell. Holding the students' attention for the entire class period is the major battle that every teacher must face; when a teacher can do this, she feels like she succeeded and that her students were engaged in learning something new during that time they spent together.

Questions

While observing my cooperating teachers and my students, I started to wonder about incorporating creative activities into my lessons. My research question then became, what happens to student engagement and understanding of chemistry when cross-curricular activities and assignments are used in my sophomore/junior honors chemistry class? Which activities increase student learning, those that are more kinesthetic or those that are more writing based?

Integrated Action and Purpose

I presented the students with two different ways to make the material more meaningful. One strategy I used allowed the students to exercise their skills in creative writing. As a result of expressing their creativity, I expected that they would be more apt to remember the content because they internalized it. They had to analyze and then synthesize new ideas as a part of the creative aspect of the assignment. They had to take a scientific concept and express it in a way that made sense in the story, song or poem they chose to create. The second strategy allowed the students to take a description of a

structure and build a three-dimensional model. I hoped a hands-on activity would make the subtle differences among the structures clearer to the students.

Assumptions and Limitations

I had several assumptions when I chose to use my honors class for the purposes of this study. First, I assumed that the students had a basic understanding of the topic before they engaged in the activities that were planned. They needed to have enough background knowledge in the content before they could complete the activities. I assumed they knew the purpose behind the activity.

Secondly, I assumed that being an honors level class, the students had enough self-motivation to complete the activities in a self-directed fashion. I wanted to see what the students produced when they were able to be creative. I wanted the material to be original and not a recitation of an idea that I gave them.

Thirdly, I assumed that the participants had a preference for one strategy over another. I assumed that the participants would provide better quality work if the strategy is one they liked. By allowing the students to have the opportunity to participate in both types of activities, I hoped to alleviate complications from this assumption.

Limitations of this study include its validity. The assumptions, procedures, activities and results are only valid for the class, district and school in which the study occurred.

The extent to which meaningful responses were obtained from students was also a limiting factor of this research study. When responding to a writing prompt it is up to the student to provide the information. As a result, the study is limited by the participants' responses, my interpretation of participants "feelings" and opinions from my

observations and the grades they earn in order to get a complete picture of the success or failure of the strategies.

Definitions

Teacher Researcher: a teacher that conducts action research within his/her classroom to improve his/her teaching practice for the benefit of the students (Hubbard & Power, 2003).

Action Research: any systematic inquiry conducted by teacher researchers, principals, school counselors, or other stakeholders in the teaching/learning environment to gather information about how their particular schools operate, how they teach and, how well their students learn (Mills, 2007).

Modality: one of the main avenues of sensation (Merriam-Webster, 2009)

CHAPTER II

LITERATURE REVIEW

When students are asked to think about chemistry class there might be a fair amount of moans and groans. Students can find science difficult and unappealing, because they are not mathematically inclined, or they find the language, concepts, and people of science abstract (Alber, 2001). These students view science as nothing more than a mechanical exercise with little creative expression (Alber, 2001). There are, however, students who are comfortable with mathematics and skilled at manipulating symbols and are able to use abstract reasoning (Alber, 2001). Even those students who find the math and abstract reasoning easy, it can still be hard for them to view science, and chemistry especially, as a creative endeavor (Alber, 2001). Science is viewed as a cold subject where all you do is regurgitate facts and figures (Eisenkraft et al., 2006). The goal of good chemistry and science teachers alike is to make the content meaningful to the student (Eisenkraft et al., 2006).

In searching for literature on student engagement it became apparent that there were multiple ways to incorporate both writing based and kinesthetic based types of learning activities in chemistry that will lead to student success.

Writing Based Strategies

One way to increase student interest in science is to incorporate more writing. High school students in particular, typically associate correct grammar and sentence structure with English class only. They neglect to follow the rules of writing when in another class (Smeltzer, 2000). Incorporating familiar literary genres into the science

classroom gives students new structures in which to express their voices and construct their scientific understanding (Marcum-Dietrich, Byrne & O'Hern, B, 2009). Early College High School programs are looking to incorporate literacy techniques into content area classrooms (Bayerl, 2007). "When students apply literacy strategies, they can access and understand increasingly difficult content in any subject area" (Bayerl, 2007, p.3). One technique that can be used to enhance students' literacy skills in the science classroom is an interactive notebook. Renner has her students take notes and write lab work on one side of the notebook and then reflect on what is written on the adjacent side. The students are writing, drawing, or diagramming to make sense of the content. The students are learning in a way that is most meaningful to them, which makes the content that much more likely to stay with them. The notebook is used consistently and checked frequently. Then Renner is able to assess how the class is doing by looking at what she calls her students' "output." If it seems like the students are not grasping a concept, she is able to see it and then re-teach using a different strategy. Students are held accountable for their learning and are required to demonstrate exactly what it is they have learned (Bayerl, 2007).

Etkina (2000) was looking for a way to assess what her students were learning from her teaching. About fourteen years into her career, she decided to start requiring her students to write weekly reports (similar to the interactive notebooks used by Renner). In those reports the students were to answer three questions that were chosen to demonstrate their understanding of the week's content. Etkina asked her students to think about what they learned and explain it to her. She was forcing them to think about the content in a different way. Throughout the course, she was able to see a change in the way her

students responded to the question prompts. They were giving more in depth answers as they were growing more confident in their knowledge (Etkina, 2000).

Pacovsky, focused on scientific reading and writing. He had his students read scientific articles, and then had them reflect on the articles in a variety of formats. He first guided them through the process by showing his students examples of what their writing should look like. Over time, the students were writing more sophisticated pieces and asked more insightful questions in class because they were constantly exposed to concepts and ideas that were written at a higher level then they were used to. His students were thinking critically about everything they were reading. It was obvious that Pacovsky focused on writing a lot more in his class than the average science teacher would. The success of his methods was evident in his students' consistently high marks on standardized test (Bayerl, 2007).

Another way to incorporate writing into science is to have students complete a research writing assignment. At Derry Area High School in Pennsylvania, teachers found that students typically associate correct grammar and sentence structure with English class only. They neglect to follow the rules of writing when in another class other than English. With this cross curricular emphasis from the English and science departments, students were required to write a research paper that dealt with a topic in science. They received guidance on the content from their science teachers and help with grammar and style from their English teacher (Smeltzer, 2007).

According to Feather, science department chairperson at Derry Area High School, by formally writing about science in a researched based manner, students were forced to "stop and process knowledge, adjusting what they know, forming new thoughts, and

changing their understanding of concepts" (Smeltzer, 2000, p. 17). The students took the time to stop and process what they were reading about and to make connections to other topics that were connected or mentioned in their research paper.

Introducing creative writing is another method that is used to initiate student engagement. Students who have trouble conceptualizing abstract ideas may be able to demonstrate their knowledge in more creative, written medium. "Our idea was to have students use primary texts and laboratory experiences as the basis for writing assignments and in the process gain insight into the nature of scientific discovery and the lives of scientists" (Alber, 2001, p. 478).

Alber began to introduce the idea of creative writing in chemistry class by having the students first write science limericks and other forms of poetry. Alber wanted his students to use primary sources for their works. He wanted his students to get a better idea of who the scientists were and what their work meant. He felt that this could not be studied in depth by simply using the textbook (Alber, 2001). Having the students read the primary sources encouraged them to understand what it was they were reading and then synthesize that material and change it into something creative and unlike much of what they have seen in science classes before this class.

Marcum-Dietrich, Byrne and O'Hern (2009) mention that students can be challenged by writing creatively in science. They had their students write not only poems, but children's books and even write an essay about a scientific topic from reading only an Updike poem. The students had to use their analytical skills to decode the poem and explain the scientific principals that were alluded to in the poem. The students were using

language arts skills as well as their science content knowledge to evaluate and respond to the poem.

Interactive Strategies

Stephens, a middle school science teacher, uses web technology in his classes (Bayerl, 2007). Stephens set up a class web page where all assignments and course content could be accessed by any student from any computer at any time. There was also a discussion forum that was set up for students to log in and respond to prompts. Mr. Stephens found that students who may have been too shy to speak up in class were more willing to respond using the online discussions. One benefit of the online forum for Mr. Stephens was the fact that he could post an assignment and did not have to photocopy it for all students. He could review student work and make corrections at school or at home and not have to carry multiple notebooks filled with student assignments. It is important to note that Mr. Stephens did not solely rely on the "virtual classroom," he used interactive notebooks as he knew all of his students did not have the luxury of computer access at home. He tried to incorporate technology as much as possible so that his students would have a bit of an edge when they enter a four year college/university or the work force (Bayerl, 2007).

Stephens used a RERUN technique when his students were writing about what they did in the laboratory.

> "In the RERUN format (R: recall what you did during the lab, E: explain why you did it, R: reflect on the meaning, U: discuss uncertainty and the reliability of your results, N: generate new questions or ideas). This process requires higher order thinking than many students experience in typical science classes; they have to

connect to prior knowledge, analyze results, conclude whether a hypothesis is supported by data, and generate new questions and ideas" (Bayerl, 2007, p.9).

Stephens found a way to incorporate reading and writing into science in a format that is non-threatening to students. A positive side effect of using technology was that the assignments had become fun for the students.

Moving toward more active strategies, Munn (2007), discusses the use of Quest Guidebooks. A quest is a series of poems that take you on a journey to find a treasure. In the Quest Guidebook strategy, students were grouped into teams of 2 to 4 and were asked to write a Quest for a conservation property they would be visiting. This type of activity is good because it challenges the student to write about science in a different format. The students were creating a treasure hunt for the reader that took the reader throughout the property. The teacher can require that specific requirements such as culture that is associated with the property or a particular aspect of science be addressed in the Quest (Munn, 2007).

The quest works by having the students write a series of different types of clues for the reader in the form of a poem. The students first write a "movement clue," this clue tells the reader to move to a particular location. Once there, the students provided a "teaching clue." The teaching clue, teaches the reader something about the current location. The teaching clue is followed by a movement clue that brings the reader to a new location. This process repeats until the reader has completed the quest and has found the treasure box. To get the reader exactly where the writers wanted them to be, the students had to learn how to write very specifically and deliberately. The teacher can make the guidebooks as complex as the students can handle (Munn, 2007). The Quest

Guidebooks the students wrote were not just for their classmates, the conservation properties (museum or national park which the students wrote about) keep the guidebooks and distribute to visitors. The curators of these properties found the information the students compiled to be of enough educational value and entertainment to want to use them to educate their guests. The students were able to go to these properties and see their work being used by others.

An often overlooked method that can be useful is role playing. Ross, Tronson and Ritchie (2008) suggest role playing to help students construct their own images of what is going on. In some cases, using the more traditional method of lecture then lab, students are not always gaining a conceptual understanding of an abstract idea. Role playing allows students to make macroscopic and microscopic connections that a teacher may not be able to make in a more traditional lecture format (Ross, Tronson & Ritche, 2008). Craft and Miller (2007) used role playing in the chemistry class to trace the evolution of the atomic model. Not only were students required to create a skit, they had to write a newspaper article that summarized the major events in atomic history. The newspaper articles were purposeful in that they forced the students to think about the contributions their individual scientists were making. Students were thinking critically about the consequences of the contributions of their chosen scientist (Craft & Miller, 2007).

As a result of the use of both strategies in the classroom, it is important for a teacher to take into account the different learning styles and strengths of each student. A teacher should design activities and assignments that allow students to express their learning in the way that is most personal and important for them (Sweet, 1998). One particular student of Sweet was named Tim. Tim was a student who was out-casted by his

peers and had difficulty with reading and writing. He desperately wanted to be treated like the other students and refused the help that was provided to him in his individualized education plan. However, Sweet knew Tim would excel with the project if he chose the option to build a model of a nuclear power plant. Tim was a kinesthetic learner and would benefit most from a hands-on demonstration of his understanding. At the end of the assignment and for the rest of the school year, "Tim saw himself as a competent, confident student. He went on to enroll in a local community college" (Sweet, 1998, p51). Tim, like many students, was not engaged in the class until there was an assignment that allowed him to demonstrate what he learned in a way that made sense to him. The purpose of this study was to increase student engagement and understanding, what better way to do that then to design lessons that will be of interest to the students.

I allowed the students to work in groups to complete the activities. The science culture is one that encourages cooperation among peers. According to Lin (2006), using cooperative learning in the science classroom promotes student involvement and engagement. The purpose of this study is to find out which strategy increase student engagement in the chemistry classroom and cooperative learning can be an important aspect of increasing the engagement.

It is important to keep in mind the types of learners that are present in any classroom. There are bound to be students who enjoy writing, some who enjoy building things, some who enjoy working independently and some who enjoy working as a group. It is impossible to target all learners with every lesson. All of the studies indicate creating lessons that incorporate strategies from other classes helped students understand science material better. The studies also showed that student engagement increased in the science

classroom when creative strategies were used. Creating meaningful lessons that target students' interests and abilities increases the chances that they will participate in the learning experience.

CHAPTER III

METHODOLOGY

Context of the Study

School and community

My action research project took place in a 10th and 11th grade honors chemistry classroom. Happy Valley High School (HVHS) (pseudonym was used to maintain the anonymity of the school and participants) serves three communities that have a combined population of approximately 82,500 (New Jersey Department of Labor and Workforce Development, 2007). Not all the students from the largest feeder township go to this one school. There are 3 high schools in the district. HVHS has access to a fair number of resources including, a fully stocked laboratory, computer access, digital projectors in the classroom, and strives to provide an environment in which all students can succeed. The school consists of approximately 70 % Caucasian, 15 % African American, 10 % Latino and 5 % other ethnic descent (New Jersey Department of Education, 2007).

Classroom

The class consisted of twenty-three students, nine males and fourteen females. The classroom contained a separate laboratory area and classroom lecture area. Within the lecture area, the desks were arranged in rows which allowed for little interaction between the students. When working on a lab the students did work well together and they were able to benefit from the help of their peers on a more regular basis. There was a computer in the classroom that was connected to a projector. This allowed the teacher to

use internet animations to help demonstrate a topic. The classroom also contained a television with a VCR and DVD player.

Participants.

The participants in the study were selected on a volunteer basis. All students who volunteered participated in the study. Students who chose not to participate in the study still completed the activities, however, their responses and test/quiz data were not used in the data analysis. Participants were asked to sign a consent form as well as obtain parental permission (see Appendix A). Initials were used in place of proper names to protect the identity of the students. Out of the twenty-three students in the class, 12 chose to participate. The participant students were eager to begin the research process and took the assignments very seriously.

Data Sources

Instrumentation, Observations, and Surveys

Throughout the course of this study, I chose to use four different collection strategies to obtain the necessary data. First I chose to use a Modality Preferences Survey (see Appendix B) to determine the students' preferred learning styles. It was important to find out where the students' interest were in order to plan activities that the students would obtain the optimal learning experience.

Secondly, I chose to use written responses from the students to gather their opinions about each of the activities. After each activity, the students were asked to respond to the prompt, "What did you think of this activity? Did you like it, why or why not?" The students had the option to responded anonymously, this gave them confidence to respond honestly and openly about the experience.

Thirdly, I chose to use student artifacts to help support the claims made by the students in their written responses. Each activity was planned to coincide with a quiz or test. This was done so that the impact of the experience could be measured. Quizzes and tests scores prior to the implementation of the activities were compared to quiz and test scores after implementation of the activity.

Lastly, I chose to take field notes while the students were completing the activities. I noted the demeanor, contribution to the group, and time on task. I took note of the behaviors of students who typically do not engage in the class discussion and those who participate on a regular basis. Field notes were coded by comparing observations to the responses the students provided in their written responses.

Triangulation of the data was used to confirm the validity of the data. I used multiple sources of data to guard the study from becoming biased.

In an effort to acquire valid results, I used Guba's Criteria for Validity of Qualitative Research (1981, as cited in Mills, 2007). Guba states that trustworthiness can be attained if the following four criteria are met: credibility, confirmability, transferability and dependability (Mills, 2007).

Credibility is met when all possible scenarios are taken into account throughout the course of the study. I used triangulation to ensure that all data was credible. I used student artifacts such as responses to prompts, surveys, and work samples to establish referential adequacy to test my analyses against the original data samples (Mills, 2007).

Confirmability refers to the neutrality or objectivity of the data that is collected. I ensured confirmability by using triangulation to ensure that multiple sources of data were used. The sources of data for this action research study included observations, written

responses, surveys and student artifacts. I also practiced reflexivity by making the reader aware of my own bias and reasons for conducting such research (Mills, 2007).

Transferability refers to creating descriptive, context-relevant statements. I created a detailed description of my research context that gave the reader a sense of seeing the environment for themselves. I achieved this by using data from the school report card about the towns from which the students live. I included details about the school community and the role that science class plays in the community as a whole. I also took into account the interests of the students when designing the lessons (Mills, 2007).

Dependability refers to the stability of the data. I established dependability by utilizing overlapping data collection methods to ensure that the weakness of one method is compensated for by another method. In other words, the students' self perception of the experience will either be substantiated or refuted by field observations and grade analysis. When I looked at the level of student engagement with regard to one method, I looked at both my observations and the responses I receive in written student responses (Mills, 2007).

Collecting reliable data is critical to the validity of this action research study. Using multiple sources of data collection that allow for participants to openly provide opinions, provide a picture of what happened through observations, and concrete evidence demonstrated by participants' grades ensured that the data collected is reliable (Mills, 2007).

CHAPTER IV

ANALYSIS, FINDINGS, AND INTERPRETATION

Analysis

Analysis of the data began with categorizing responses to the participant modality preference surveys. Participant "agree" responses within each section of questions (visual, auditory, and kinesthetic) were tallied. The modality with the greatest number of "agree" responses is considered the student's preference. Table 1 shows the breakdown of modality preferences for the group of participant students. The auditory modality was not a strong preference for any of the participants and was not pertinent to this action research study and therefore was omitted from the data.

Student	**Visual Score (V)**	**Kinesthetic Score (K)**	**Preference**
SG	8	8	V/K
JF	5	6	K
BG	8	7	V
MM	5	8	K
JW	7	10	K
MK	9	7	V
SA	6	8	K
CS	9	6	V
TS	8	6	V
VB	8	10	K
DL	5	7	K
AL	4	7	K

Table 1 – Participant Student Modality Preferences.

Participant surveys were coded according to the following procedure. Responses for the written activity from the students (N=12) were recorded into a table. Responses

that stated the student liked the activity or thought it was "fun" was coded as the participant liking the activity. Responses that stated the activity was unhelpful or boring were coded as disliking the activity. For the writing activity, eleven participants turned in a response. Participant responses can be seen in Table 2 below.

Student	Comment	Like (L) or Dislike (D)
SA	Fun, but a bit annoying	L
JW	I think this activity was a lot of fun. It helped me remember the order of the bonds very well.	L
JF	I thought this activity was enjoyable and we learned and reviewed at the same time. I had FON.	L
DL	I really enjoyed this activity. It allowed me to work with my classmates and have fun while learning chemistry. It was FON!	L
MM	I really enjoyed this activity. It was a blast interacting with my classmates and learning from them. This was a great experience and a lot of FON!	L
SG	This activity was extremely beneficial and everybody had a great time performing it for you. IT WAS FON!!!!	L
TS	I think this activity was pretty fun.	L
AL	I thought it was ok. It was not the best of ideas but it was decent.	D
BG	I had fun doing the song and it kind of helped me remember my notes for the quiz.	L
CS	AWESOME! A lot of FON!	L
MK	This activity was pretty fun and interactive. It helped me to learn the material that was originally confusing to me. These activities really do help memorize boring material.	L

Table 2 – Participant Student Comments – Writing Activity. (N=11)

The same data coding procedure was followed for responses to the kinesthetic activity. The participant responses were recorded into a table and were coded following the same criteria listed above. Responses that stated the student liked or thought the activity was "fun" were coded as liking the activity. Responses that stated the student disliked or thought the activity was boring were coded as dislike of the activity. For the kinesthetic activity twelve participants turned in responses. Participant responses can be viewed in Table 3 below.

Student	Comment	Like (L) or Dislike (D)
SA	I liked the marshmallows.	L
AO	Using the marshmallows really helped me to see the shape of the crystal. I also liked eating the marshmallows.	L
JW	I liked building the crystal. I thought it was a fun activity, I especially enjoyed the marshmallows.	L
JF	Yum! This was a cool activity that showed me the shape of the crystal while also being able to eat it after I was finished.	L
DL	I was able to see the solid crystals in a 3D representation that made it easier for me to visualize the arrangement of the molecules. I also loved eating the marshmallows!	L
MM	The marshmallows were delicious. Good idea for showing us the structure of a crystal.	L
SG	I really enjoyed this activity. I liked that I was able to build a crystal and visually see its structure. Now the description makes sense to me. Can we have more activities where we eat marshmallows?	L
TS	This activity made the notes make more sense to me. I never would have gotten it if I only saw a picture.	L
AL	More marshmallow activities.	L
BG	This activity allowed me see the shape of a crystal. I think it will help me when it comes time to take the test.	L
CS	I thought this was a good activity because it allowed me to see the shape of the crystal. I liked eating the marshmallows as well.	L
MK	This was a good activity. I liked being able see a crystal from all angles. I was a little confused when I first started but got it after you explained it to me. I also liked eating the marshmallows!	L

Table 3 – Participant Student Comments – Kinesthetic Activity. (N=12)

Analysis of participant students' grades (see figure 1) was conducted using the following procedure. The quiz grades of all participants prior to implementation of the activities were averaged together. Grades for the quiz following the implementation of the strategy were also averaged. The same procedure was followed for participant test grades. Average quiz and test grades were plotted on the graph illustrated in Figure 1 (shown below).

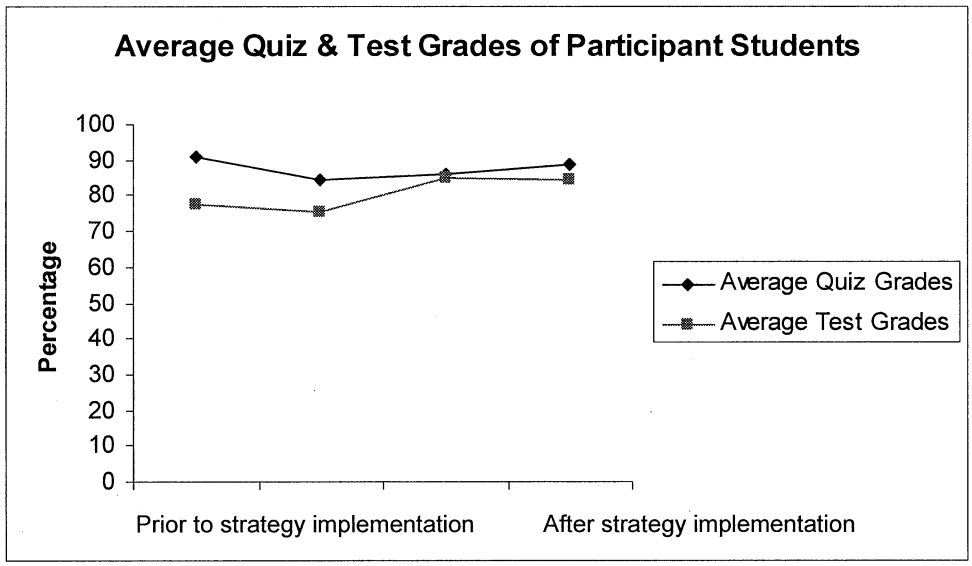


Figure 1 – Participant Student Grades

Field observations were used to support or refute the findings of the participant responses and participant grades.

Findings

In the analysis of the data, attention was paid to make sure the data was triangulated. Multiple sources of data were used to ensure Guba's criteria for validity were met. Data sources included: modality preferences survey, participant written responses, teacher observations while the activity was in progress, and participant student grades prior to the strategies and after.

Analysis of the modality preferences surveys revealed that the participant students were evenly divided into two major preference categories. The participants showed preferences for both visual and kinesthetic modalities. The high presence of these modalities follows expected outcomes of implementing the chosen strategies.

Analyzing participant student responses demonstrated that the majority of the participants found both strategies engaging and helpful. To quote student JF, "I thought this activity was enjoyable and we learned and reviewed at the same time." This was the overwhelming response of the majority of participants. They enjoyed participating in activities and found that they were fun, and served to help them review the material (for additional comments see Table 2).

Analyzing participant responses from the kinesthetic activity revealed that the participants once again enjoyed the activity. They found it useful in that they were able to see a three-dimensional model of a written description. They liked having something to hold and examine. This response was summed up nicely by student DL. "I was able to see the solid crystals in a 3D representation that made it easier for me to visualize the arrangement of the molecules." For more samples of students' comments please see Table 3.

Comparing the average grade of three quizzes prior to implementing the strategies shows that, as a class, the average quiz grade did increase slightly. The data suggested that the students' understanding of the topics which the activities addressed also increased. Looking at the participant students' test grades also demonstrated the same trend. As a class the students' test grades increased slightly. This also demonstrated that overall the students understanding of the concepts addressed also increased.

The main theme that was present in participant observations (see Appendices C & D) of both the written activity and kinesthetic activity was that the students were completely engaged in the activities for the entire length of the class. The students found the activities to have meaning and chose to fully participate in them. Those students who chose not to participate in the study were fully engaged as well. Preliminary analysis suggested that the students' level of engagement was increased as a result of implementing cross-curricular strategies in the chemistry classroom.

This action research study has found that the students enjoyed participating in chemistry class when both the writing based and kinesthetic based strategies were used. The students participated in the activities throughout the duration of the class period. For the written strategy, the students displayed an exceptionally high level of creativity. Each group chose a different way in which to convey the required information. Two groups chose to write lyrics, one modeled after an Irish pub tune. The second group chose to write lyrics that went along with a popular hip-hop song. One of the remaining two groups chose to write a poem and the other chose to write a story using atoms as characters.

The students also gave each other encouragement while completing the activities. They asked questions of other groups and tried their best to answer questions of their classmates. It was also noted that the students did not ask for much guidance from the teacher to ensure they would receive and adequate grade. They were content to work on their own or with their classmates.

It was also helpful asking the students to take a modality preference survey prior to implementing the strategies so the teacher could create an assignment that would

appeal to the students preferences as well as creating an activity that students would find engaging.

Interpretation

Action research that would allow for an improvement in teaching abilities as well as an improvement in student outcomes was the main goal of this research study. The results of this research have shown that by including cross-curricular activities in which the students are able to express creativity does increase engagement and understanding of chemistry.

As a result, it would be suggested to include at least one of the strategies, either creative writing or kinesthetic activity, in each unit of study in chemistry.

CHAPTER V

CONCLUSIONS

Summary

The focus of this action research study was to determine if cross-curricular learning strategies could be used in a chemistry class to increase both student engagement and understanding of chemistry content. Two strategies were implemented in an honors chemistry course of sophomores and juniors. Participants were chosen on a voluntary basis, those students who chose not to participate still needed to complete the activities, however, their grades and responses were not included in the data. Participating students were required to complete a consent form and obtain parental permission.

The first strategy incorporated creative writing and required the students to write a story, poem or song lyrics that described the four types of intermolecular forces. The second strategy required the students to use written descriptions of a three dimensional crystal, mini marshmallows and toothpicks were used to build a model that fit the description. The students worked independently to complete this activity and were able to ask each other questions to clarify placement of molecules (marshmallows).

The participants provided written responses that described their opinion about each of the activities. The students did not address their learning progress due to the time constraint of completing the data collection. They did however, complete a short writing prompt after each of the activities that asked them to explain why the liked or disliked the activity. The participant students' responses were complied and analyzed along with field

observations of each activity and the students' grades before and after the implementation of the activities.

Conclusions and/or New Understandings

In conclusion, with the research that was done for this study, and the particular group of participants, it seems that the incorporation of cross-curricular strategies that allow students to be creative does increase the engagement of students and their understanding of a chemistry concept. This conclusion was reached by performing an analysis of student responses about the experience, field observations and students' quiz/test scores.

Implications

It would follow then as a result of this research study, that including more cross-curricular strategies would increase student engagement and understanding even more. Using any combination of strategies would increase engagement and participation in the class. Increased participation leads to the student working with the material more and should lead to an increased understanding of the material. Putnam & Burke (2005) have suggested that when students work in groups, they find their studies to be more motivating, informative, and instructive. This was the main goal of this action research study. When the participants worked in a group they asked each other questions to clarify their own understanding of the concept. The students had an investment in the activity in that the teacher was merely an observer and the students provided each other with explanations.

Recommendations

Other strategies mentioned in the review of the literature such as quest guidebooks, poetry and skits would also be beneficial to students if utilized by the teacher in the proper manner. If the activity connects with the material then the students will see that is has value and will participate in the activity.

If one were to complete this study again, it is recommended that more than two strategies be utilized. It may even be more effective to use cross-curricular strategies throughout an entire unit of study and not only two or three lessons within the larger unit. Given the time constraints of completing the needed research, it may be more beneficial to the students if they are given more time to complete more activities that challenge them to think creatively with science content. It is suggested then, based on the research presented in this study, that cross-curricular strategies should be implemented throughout the school-year to increase student engagement and understanding in the chemistry classroom.

Though this action research study strived to minimize bias and maximize the benefit to the student, the question arose, what happens if a cross-curricular strategy is used for which the students do not have a modality preference? Are the results the same? Will the students show the same positive attitude toward the activities or will their attitude toward them be more negative? It would be interesting to see the results of a modified version of this study.

New Directions and Questions

In the future, incorporating creative activities that allow the students to demonstrate their understanding of a chemistry concept will be incorporated in unit plans.

Creative writing and kinesthetic activities increased student engagement as well and increasing students' understanding of the chemical concepts.

REFERENCES

Alber, M. (2001, January 1). Creative writing and chemistry. *Journal of Chemical Education*, *78*(4), 478-80. (ERIC Document Reproduction Service No. EJ639941) Retrieved January 23, 2009, from ERIC database.

Bayerl, K., & Jobs for the Future, B. (2007, March 1). Rigor plus support: How science teachers use literacy techniques to get students ready for college. *Jobs for the future*, (ERIC Document Reproduction Service No. ED497816) Retrieved January 23, 2009, from ERIC database.

Craft, J., & Miller, J. (2007, February 1). Unlocking the atom. *Science Teacher*, *74*(2), 24-29. (ERIC Document Reproduction Service No. EJ758686) Retrieved March 11, 2009, from ERIC database.

Eisenkraft, A., Heltzel, C., Johnson, D., & Radcliffe, B. (2006, November 1). Artist as chemist. *Science Teacher*, *73*(8), 33-37. (ERIC Document Reproduction Service No. EJ758670) Retrieved January 23, 2009, from ERIC database.

Etkina, E. (2000, January 1). Weekly Reports: A two-way feedback tool. *Science Education*, *84*(5), 594-605. (ERIC Document Reproduction Service No. EJ613656) Retrieved January 23, 2009, from ERIC database.

Hubbard, R. S., & Power, B. M. (2003). *The art of classroom inquiry: A handbook for teacher-researchers*. Portsmouth, NH: Heinemann.

Marcum-Dietrich, N., Byrne, E., & O'Hern, B. (2009, December 1). Marrying the muse and the thinker: Poetry as scientific writing. *Science Activities: Classroom Projects and Curriculum Ideas*, *45*(4), 14-18. (ERIC Document Reproduction Service No. EJ817944) Retrieved March 11, 2009, from ERIC database.

Mills, G. E. (2007). *Action research: A guide for the teacher researcher*. Upper Saddle River, NJ: Pearson Education.

Modality. (n.d.) In *Merriam-Webster online.* Retrieved May 31, 2009, from http://www www.merriamwebster.com.

Munn, N. (2007, April 1). Quest guidebooks. *Science Teacher*, *74*(4), 38-41. (ERIC Document Reproduction Service No. EJ766698) Retrieved January 23, 2009, from ERIC database.

New Jersey Department of Education. (2007). *School Report Card.* Retrieved January 26, 2009, from http://education.state.nj.us.

New Jersey Department of Labor and Workforce Development. (2007). *Estimates of resident population by municipality: Camden county, 2000-2007.* Retrieved April 1, 2009, from http://lwd.dol.state.nj.us/labor/lpa/dmograph/est/mcd/camest.htm.

O'Neill, D. (2001, January 1). Knowing when you've brought them in: Scientific genre knowledge and communities of practice. *Journal of the Learning Sciences*, *10*(3), 223-64. (ERIC Document Reproduction Service No. EJ635978) Retrieved January 23, 2009, from ERIC database.

Putnam, J., & Burke, J. (2005). *Organizing and managing classroom learning communities.* Boston: McGraw-Hill.

Ross, P., Tronson, D., & Ritchie, R. (2008, March 1). Increasing conceptual understanding of glycolysis & the Krebs cycle using role-play. *American Biology Teacher*, *70*(3), 163-168. (ERIC Document Reproduction Service No. EJ791438) Retrieved February 22, 2009, from ERIC database.

Smeltzer, T. (1999, January 1). Integrating the library into the curriculum: Research, writing and science. *Book Report*, *18*, 16-17. (ERIC Document Reproduction Service No. EJ601812) Retrieved January 23, 2009, from ERIC database.

APPENDICES

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APPENDIX A

Consent Forms

March 9, 2009

Dear Student:

As part of my student teaching I will be introducing some different ways to learn and use chemistry in class. I am asking for your help. I will need to use some information that I gather in class as part of my research data. I will be observing what happens in class as well as looking at the work you produce.

If you choose to participate I want you to know that all information that I gather will be kept confidential. I will not reveal your name in any of my research. If you choose not to participate that is okay. Your grade will not be affected in any way by your decision to participate or not to. Please complete the form below regardless of your decision, have your parents complete the parental consent form and return both to me by Monday, March 16, 2009.

Sincerely,

Ms. Keller

I, _____ agree to participate in Ms. Keller's research study.

I, _____ do not want to participate in Ms. Keller's research study.

_____ _____

Student Signature Date

March 9, 2009

Dear Parent/Guardian:

My name is Ms. Keller and I am a student teacher working with your child this semester. Currently, I am a graduate student in the teacher education department at Rowan University. I will be conducting a research project under the supervision of my professor as part of my master's thesis concerning how student participation in chemistry class can be improved. I will be using two different types of techniques throughout the course of my research. The goal of my research is to see which technique will increase student participation in class the most.

Each student will be invited to participate in my research. There are no extra commitments that will be required by your child if you choose to allow them to participate. The identity of your child will be protected and no identifying characteristics will be used. I will be using samples of the students' work, with names blacked out, to show how student participation has increased.

Your decision whether or not to allow your child to participate in this study will have absolutely no effect on your child's standing in his/her class. At the conclusion of the study a summary of the group results will be made available to all interested parents. If you have any questions or concerns, please contact me at mskellerchem@gmail.com. Please return this form to me by Monday, March 16, 2009. Thank you.

Sincerely,

Heather Keller

Please indicate whether or not you wish to have your child participate in this study by checking the appropriate statement below and returning this letter to your child's teacher by March 16.

I grant permission for my child _____to participate in this study.

I do not grant permission for my child _____to participate in this study.

_____ _____

(Parent/Guardian Signature) (Date)

APPENDIX B

Modality Preferences Survey

Name:_____

The Modality (Sensory) Preferences Survey

This survey will help determine your modality (sensory) preferences. For each item, circle "A" if you agree that the statement describes you most of the time. Circle "D" if you disagree that the statement describes you most of the time. When you are responding to the questions, keep in mind that your sensory preferences are usually evident during extended and complex learning tasks.

1. I prefer reading a story rather than listening to someone tell it.	A D
2. I would rather watch television than listen to the radio.	A D
3. I remember faces better than names	A D
4. I like classrooms with lost of posters and pictures around the room.	A D
5. The appearance of my handwriting is important to me.	A D
6. I think more often in pictures.	A D
7. I am distracted by visual disorder or movement.	A D
8. I have difficulty remembering directions what were told to me.	A D
9. I would rather watch athletic events than participating in them.	A D
10. I tend to organize my thoughts by writing them down.	A D
11. My facial expression is a good indicator of my emotions.	A D
12. I tend to remember names better than faces.	A D
13. I would enjoy taking part in dramatic events like plays.	A D
14. I tend to subvocalize and think in sounds.	A D
15. I am easily distracted by sounds.	A D
16. I easily forget what I read unless I talk about it.	A D
17. I would rather listen to the radio than watch TV.	A D
18. My handwriting is not very good.	A D
19. When faced with a problem, I tend to talk through it.	A D
20. I express my emotions verbally.	A D
21. I would rather be in a group discussion then read about a topic.	A D

22. I prefer talking on the phone rather than writing a letter to someone. A D
23. I would rather participate in athletic events than watch them. A D
24. I prefer going to museums where I can touch exhibits. A D
25. My handwriting deteriorated when the space becomes smaller. A D
26. My mental pictures are usually accompanied with movement. A D
27. I like being outdoors and doing things like biking, camping, swimming, hiking, etc. A D
28. I remember best what was done rather than what was seen or talked about. A D
29. When faced with a problem, I often select the solution involving the greatest activity. A D
30. I like to make models or other hand crafted items. A D
31. I would rather do experiments rather than read about them. A D
32. My body language is a good indicator of my emotions. A D
33. I have difficulty remembering verbal directions if I have not done the activity before. A D

Interpreting Your Score

Total the number of "A" responses in items 1-11	____	VISUAL score
Total the number of "A" responses in items 12-22	____	AUDITORY score
Total the number of "A" responses in items 23-33	____	TACTILE / KINESTHETIC score

If you scored considerably higher in any one area, this indicates that modality is probably your preference for learning situations.

If you scored considerably lower in any one area, this indicates that modality is not likely to be your preference for learning situations.

If you have similar scores in all three areas, this indicates that you can learn things in almost any way they are presented.

APPENDIX C

Field Observation of Creative Writing Activity

April 23, 2009

8:27 – 9:59 am

The students are completing an assignment in which they are to describe the four intermolecular forces (IMFs) of attraction that hold molecules together. They were given the option to create a poem, a skit or come up with new lyrics to a song. They were given an hour to work with their group-mates to complete the assignment. All groups were required to read/perform their assignment. The students were not given detailed instructions, the only requirements were to include the four IMFs and to make it school appropriate.

The students were excited to begin the activity. Some of the groups formed quickly, these were the smaller groups. The largest group is a combination of two smaller groups. I noticed that each of the smaller groups was having trouble coming up with a topic and they kept asking each other questions. They then decided to work together.

Some of the groups are getting very into the assignment. In particular the group with CC, DG, SA, SA, VB and KG are using an iPod to put new words to a song. They are conversing a lot and I can hear them arguing as to what word should go where.

Should be noted that one student in particular chose not to participate in this activity. She did not think she was creative enough, thought the activity was uninteresting and opted to sit out and not participate.

On the other hand, it seems that the students who have previously shown themselves to be creative are really enjoying this activity. They are getting into writing their songs. The largest group is even beginning to do some choreography to go along with the presentation.

All students, with the exception of the one student choosing not to participate, are engaged in the activity. MD is actively participating with his group. This is unusual behavior for MD in the classroom. Typically, MD is disengaged, head down or staring off into space. I can hear that MD is contributing to the skit the group is working on.

During the presentation portion of the activity, all students were actively listening to their peers. They were respectful and praised one another with applause at the completion of a presentation.

Overall, it seems as if this activity was a success. The students seemed to have enjoyed working together and being able to think about that they learned in the previous class. Should be noted that this lesson comes one day before the students are to take a quiz on the types of IMFs; should be interesting to compare the quiz grades of the IMF quiz to the grades of previous quizzes.

APPENDIX D

Field Observation of Kinesthetic Activity

April 28, 2009

9:15 – 9:59 am

For this activity students were building three-dimensional representations of the unit cell structure of crystals within a solid substance. The students were using mini marshmallows and toothpicks to complete this activity. The marshmallows represented each molecule and the toothpicks served to hold the marshmallows in position. The students then used the notes they took that described the structures and built the three-dimensional representations. Then, they sketched what they built into their notebooks so they would have a picture of what the unit cell looked like. The students worked individually to complete this activity. They were allowed to eat the marshmallows once they sketched all three of the possible structures.

The students were concerned with exactly how many marshmallows and toothpicks they needed to complete the activity. Once they had their supplies they returned to their seats or back to lab tables. They each built their own crystals, but they worked together to build the more complex structures.

SG asked for help multiple times throughout this activity. SG was concerned with whether or not the structure was built correctly. SG is very concerned with details and wanted everything to be perfect.

Many students had trouble building the face-centered crystal. They knew the marshmallow was in the center of each face of the cube but they did not know how to hold it there. It took some engineering from them to figure it out. I told them that they were correct and now they needed to figure out how to get it to stay there using a toothpick.

There were at least two different ways in which the students held the face-centered marshmallow in place. Some put half a toothpick in the marshmallow in the corner and the other end in the face-centered. Other students used two half toothpicks with one end of each in marshmallows located in opposite corners and the other end of each holding the face-centered marshmallow in place.

The students seemed to enjoy this activity. Many of them commented on how they understood what the description meant once they could see it and hold it in their hands. The students also seemed to enjoy eating their structures once they finished with the activity.