

The effect of exposure to current biomedical themed activities related to chemistry on student situational interest, attitudes and self-concept in chemistry.

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Abstract:

The purpose of this study is to use biomedical-themed activities related to chemistry in the beginning of the school year to measure the changes on student situational interest, attitudes and self-concept in chemistry. This study will examine how creating a positive affect towards chemistry early on in the school year influences the success of students throughout the course.

Rationale:

Chemistry Honors is a required science course for all students on the college preparatory track in Hillsborough County. Students in the course are sophomores and juniors. In my experience, most students entering the course do not have an intrinsic interest in chemistry nor do they understand what studying chemistry means. In a class wide informal survey at the beginning of last school year students were asked to share their expectations for the chemistry course. The three most common answers were that chemistry was hard and scary, they want to earn good grades for college, and they want to see things explode. These common answers show that most of my students enter the class with a preconceived notion of how they will progress in chemistry, care about earning good grades to later progress onto higher education, and also have a limited scope of what they will learn in chemistry class. These preconceived notions of chemistry have effects on student confidence and success in the classroom.

I would like to improve student affect towards chemistry in the very beginning of the year by incorporating applied chemistry. By weaving biomedical themed activities into the nature of science unit I hope to see an improved understanding of chemistry content, a greater interest in the course, and increased self-confidence of students.

Research has shown that when students feel they are successful in chemistry they will enhance their understanding of the science content (Nieswandt, 2007). Students' chemistry-specific self-concept is how students perceive themselves succeeding or not in the chemistry classroom (Nieswandt, 2007). A large body of work as quoted by Nieswandt suggests that students with good self-concepts begin to practice behaviors that increase their success in the chemistry classroom. Behaviors include:

1. Challenging themselves academically
2. Trying longer on hard tasks
3. Experiencing less anxiety in achievement situations
4. Enjoying the learning process (Nieswandt, 2007).

All of these behaviors are traits of some of the most successful chemistry students, and if students are successful in chemistry this may translate into higher self-esteem when approaching other difficult classes or career path options. By implementing this intervention early on in the school year I hope to change some negative connotations they may have about the course or themselves in science, thus increasing their self-concept and leading to greater student success.

It is critical to not only raise students' chemistry-specific self-concept, but also to peak their interest in chemistry. Student interest in a topic has been shown to influence their affective response (Nieswandt, 2007). A more positive affective response then leads to a stronger self-concept and more meaningful learning. Furthermore, the more engaged students are with their science studies, the more likely they are to continue pursuing sciences as a career choice (Aschbacher, Li & Roth, 2009). A study on why students pursue or leave the sciences showed that science self-concept and a future interest in the science they have been exposed to influenced their educational and career decisions (Aschbacher, Li & Roth, 2009). All of the chemistry honors students are on the college bound track and are at a point where they are beginning to decide what they want to do in the future. As the National Research Council stated, "the...field of chemistry...has an exciting story to tell, with intellectual excitement and practical applications that are critical to modern civilization." (Evans, Leinhardt, Karabinos & Yaron, 2006). If

scientists and educators want to influence the future of America's science industry it is imperative we interest the youth and show them the potential they have in the science field.

Sophomores and juniors are at a critical juncture in the scientific pipeline. Studies show this is where they begin to decide if science is a career option for them or not (Aschbacher, Li & Roth, 2010). In Aschbacher, Li, and Roth's study of why students stay or leave the sciences they noted that not a single student in a study of 1,247 participants not a single student developed a new strong interest in science after their sophomore year (Aschbacher, Li & Roth, 2010). The majority of my students are sophomores and a handful of juniors. How they perceive science while studying chemistry in my classroom could be a turning point in their interest for science. Another study states that student's views of science become less positive as students get older (Neff, Retsek, Berber-Jimenez, Barver, Coles, Fintikakis & Huigens, 2010). With this knowledge in mind, it is even more crucial that students have a positive self-concept in the sciences and an interest and appreciation for the field.

The timing of this intervention is also crucial to the goals of increasing chemistry-specific self-concept and situational interest. The plan is that students experience this during the second week of school. As Nieswandt found in her study on student affect in chemistry, "Even if situational interest is not perfectly sustained through the school year, early situational subject interest may generate ongoing positive self-concept." (Nieswandt, 2007). Essentially, a strong start may be the push students need to continue developing a strong, positive self-concept in chemistry. By exposing students early on to a hands-on biotechnology lab I hope to have students gain confidence in their ability to perform "real" science.

	Monday 8/29/2011	Tuesday 8/30/2011	Wednesday 8/31/2011	Thursday 9/1/2011	Friday 9/2/2011	Monday 9/5/2011	Tuesday 9/6/2011
Essential Question	What rules must be obeyed to safely conduct an experiment?		What are the components of a good scientific experiment?			NO SCHOOL Labor Day	What are the components of a good scientific experiment?
Class Work	<ul style="list-style-type: none"> Lab Equipment Stations Graphic Organizer <ul style="list-style-type: none"> Station 1: Mix it! Station 2: Bubbles Station 3: Design Station 4: Bunsen Burner 	<ul style="list-style-type: none"> Lab Safety Review Station 5: Pipetting By Design 	<ul style="list-style-type: none"> Lab Safety Quiz Discuss Drug Reading How to Set Up and Write a Lab Report 	<ul style="list-style-type: none"> Prepare and Discuss UF: Protein Crystallization Lab (use to model for students how to set up and write a lab report) 	<ul style="list-style-type: none"> UF: Protein Crystallization Lab with Dr. Houda Darwiche 	○	<ul style="list-style-type: none"> Finished UF: Protein Crystallization Lab ...observed crystal growth Reflection on Crystallization Lab Number Line Activity Scientific vs. Standard Notation
Home Work		<ul style="list-style-type: none"> Guided Reading: Science Without the Boring Bits "How to Heal the Sick" 	<ul style="list-style-type: none"> Pre-lab Assignment 	Textbook Scavenger Hunt			<ul style="list-style-type: none"> Finish lab report questions

The purpose of this study was to use biomedical-themed activities related to chemistry in the beginning of the school year to measure the changes on student situational interest, attitudes and self-concept in chemistry.

Action Research Intervention:

In an effort to improve student situational interest, attitudes and self-concept in chemistry I incorporated biomedical themed activities into our first unit about the nature of science. These activities took place the second week of the school year. By raising student affect towards chemistry I hoped to see an improved understanding of the chemistry field, a greater interest in the course, and increased self-confidence of students in the sciences.

Biomedical-themed activities specifically related to biochemistry included: learning pipetting skills, a guided reading on personalized medicine followed by a class discussion and all of this culminating in performing a protein crystallization lab. Below is a copy of the class lesson plan for the second week of school showing the incorporation of the biomedical-themed activities while studying the nature of science unit. The essential questions from the curriculum have been included to show which aspects of the activities will be emphasized.

Connections to Bench to Beside Summer Institute:

- Students will learn pipetting skills with an activity similar to “Pipetting by Design” presented to participants on July 11, 2011.
- Throughout the discussion of the articles, information will be drawn from all the cutting edge technology I’ve been exposed to throughout my two weeks at the University of Florida’s Bench to Bedside summer institute.
- The protein crystallization technique used in this study will be nearly identical to that developed by Dr. Robert McKenna for the Bench-to-Bedside summer institute for teachers through CPET at University of Florida. We will utilize the technology made available by the CPET staff to conduct the experiments and study the applications presented in Dr. McKenna’s PowerPoint lecture on July 14, 2011.
- Dr. Houda Darwiche will visit the classroom and conduct the lab with the students. As well as answer their questions and speak with students about UF’s current research.

Data Collection and Analysis:

- Likert Survey
 - This was used to measure the students’ situational interest, attitudes and self-concept in chemistry.
 - Administration:
 - It was administered on the first day of school before students have even been given a syllabus or explanation of what will be studied this school year.
 - It was administered again after the first unit of study.
 - This Likert survey came from Martina Nieswandt study, “Student Affect and Conceptual Understanding in Learning Chemistry.”
- Findings
 - Based on analysis of the Likert Survey, attitudes and situational interest in chemistry did not change a significant amount.
 - However, there was a significant positive change in chemistry-specific self concept. In the Likert Survey students marked significantly more positive responses for the following statements:
 - Understand the content of my chemistry class

- Can use the content of my chemistry class
- I evaluation my achievements in my chemistry class
- I expect my achievement in chemistry class in the future to be...

Literature Cited:

- Aschbacher, PR., Li, E., & Roth, EJ. (2010). Is science me? high school students' identities, participation and aspiration in science, engineering, and medicine. *Journal of Research in Science Teaching*, 47(5), 564-582.
- Evans, KL., Leinhardt, G., Karabinos, M., & Yaron, D. (2006). Chemistry in the field and chemistry in the classroom: a cognitive disconnect?. *Journal of Chemical Education*, 83(4), 655-661.
- Neff, GA., Retsek, J., Berber-Jimenez, L., Barber, N., Coles, M., Fintikakis, C., & Huigens, B. (2010). Bend it, stretch it, hammer it, break it: materials chemistry applied. *Science Education*, 19(2), 48-55.
- Nieswandt, M. (2007). Student affect and conceptual understanding in learning chemistry. *Journal of Research in Science Teaching*, 44(7), 908-937.

Budget:

- Pipetting Activity Supplies
 - Pipette Locker
 - Pipette Tips
 - Well Plates
 - Design Instructions
 - Food coloring
- Protein Crystallization Lab Supplies
 - Copies of the “Crystallization Hand on, Lysozyme crystallization” lab instructions.
 - Micropipettes and tips (P-1000,P-200 and P-20)
 - 64 well dishes
 - 24-well Limbro plate
 - Forceps
 - Plastic micro-bridges for use in Limbro plates – 12 per student group
 - 22 mm Round cover slips for covering wells
 - Vacuum grease and tooth picks for sealing cover slips on trays
 - Lysozyme at 50 mg / ml – on ice
 - ddH₂O
 - 4M NaCl
 - 0.5M Sodium Acetate
 - 1M Tris-HCl
 - Dissecting microscopes
- Any leftover funds will go towards general classroom consumables

Permissions:

- Student/Parent consent forms for releases of pictures, data, etc.

Learnings from your Action Research:

I feel my action research was highly successful in helping students improve their chemistry-specific self concept. The activities and lessons included were related to their everyday lives, hands on and everyone had the ability to be successful. I would absolutely include this group of lessons next year. I feel it started the school year on a more intellectually rigorous level, but a rigor which each student could attain. I feel my grades and student’s academic behavior has been better this year, in part to the improve self-concept.

My action research did not prove any significant changes in attitudes or interest in chemistry. I noticed that student responses to the Likert Survey were quite polarized in these categories. Students had an opinion (good or bad) coming in which didn’t waver too frequently by the end of these activities.

I'm not completely sure what I can do to alter these opinions, but have consistently interesting and rigorous lessons all year. I would be very interested in doing this same type of study in a biology classroom. Are they losing interest in chemistry? Or earlier?

I gained a great deal from the research process. I was able to develop and implement amazing new lessons for my students. I also learned how to collect data and how overwhelming that data is! I really enjoyed going through the data, though as a teacher, I don't always have time to do so. So this really forced me to collect and analyze hard data. I also found amazing new resources through this project. The other teachers I have met, the faculty at the University of Florida and the literature I read through helped me hone and develop my teaching skills.

Dissemination:

- I have highly recommended the Summer Institute to all of my colleagues. I co-plan frequently with another chemistry teacher. So she was very excited by all the information and ideas I brought back and was able to share with her. We used many of the same reading guides and activities. In addition to having my students participate in activities from the Summer Institute, I was very proud to share my experience in the institute with my students. They enjoyed the activities and the special visit by Dr. Darwiche. Many are interested in going to the University of Florida and parents are alumni so they were thrilled with the involvement. Furthermore, they respected that I was trying to make the classroom better for them and contributing the science education community.
- Yes, I would certainly be interested in writing an article or sharing this information at another conference.

Teacher-Created Documents (Attached Below):

- General Chemistry Likert Survey
- "How Prescription Drugs are Produced" Article and Guided Reading Questions
- Protein Crystallization Lab Procedure

General Chemistry Survey

Part I:

Question	Strongly Agree	Agree	Disagree	Strongly Disagree
1. When I learn something new in chemistry, I am willing to spend my free time on it.				
2. I would like to have more class periods in chemistry.				
3. I am looking forward to chemistry class.				
4. I think it is fun for me to work at a chemistry problem.				
5. My chemistry class is the most important class for me.				
6. When I am working at a chemical problem it can happen that I do not realize how time flies.				
7. It is personally meaningful for me to be a good chemist.				
8. It is important for me to know a lot in my chemistry class.				
9. It is important for me to remember the content learned in chemistry class.				

Part II:

Question	Very Well	Well	Fair	Some-what	Not at All
1. I understand/comprehend the content of my chemistry class.					
2. I can use the content of my chemistry class in my mind...					
3. I participate in my chemistry class...					
4. I think my classmates believe that I am doing... in my chemistry class.					
5. I evaluate my achievement in my chemistry class as...					
6. I think my chemistry teacher evaluates my achievement in chemistry class as...					
7. I expect my achievement in the chemistry class to be ...in the future.					

Part III:

Question	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Chemistry is one of the most important disciplines.				
2. I think chemistry is an unnecessary discipline.				
3. We should not spend so much money for research in chemistry.				
4. Chemistry plays an important role in my life because I use many products of the chemical industry.				
5. I think we would live healthier without chemistry.				
6. Chemistry yields more advantages than disadvantages.				
7. I think chemical products are very important.				
8. Today's life would be unthinkable without the results of chemical research.				
9. We could do without the products of chemical industry.				

Part IV:

1. What do you think you will learn in this class?

2. What is something you are interested in learning about chemistry?

3. What kind of academic behaviors will help you succeed in chemistry?

Real-World Reading Guide:

“How Prescription Drugs are Produced”

DIRECTIONS: Skim the article first, then go back answer all questions in complete sentences.

- **Before Reading**

1. What personal connections do you think you can make with this article?

- **Approach**

2. What is the main idea of this paragraph?

3. What are the different stages of making prescription drugs?

4. Why do so many drugs fail to ever be produced and sold?

- **Research and Development**

5. How do scientists start to develop a drug?

6. How do you feel about testing medicines on animals?

- **Production Process**

7. What is the last step after a drug has passed clinical trials?

8. What are the goals when manufacturing prescription drugs? Why are these goals important for pharmaceutical companies?

How Prescription Drugs are Produced

By Jacquelyn Jeanty, eHow Contributor How Prescription Drugs Are Produced



1. Approach

The fact that prescription drugs will ultimately alter the physical chemistry of people requires that a comprehensive system of product development be put in place. To meet this requirement, the actual production process doesn't begin until extensive research, and development and testing trials are completed. The hard work is done at the very onset where researchers must "discover" a new drug treatment for a current illness, or disease.

After a series of laboratory trials, animal testing is done to verify the drug's effectiveness and safety. Clinical trials done on humans are then carried out to pinpoint specific drug effects. The next step requires a whole new series of testing which is carried out by the Food & Drug Administration. The entire process is lengthy and costly, where only 1 out of every 5,000 to 10,000 drugs actually make it out into the marketplace.

2. Research and Development

The process of developing a new prescription drug begins by creating a compound that is targeted for a specific use. As scientists work towards a better understanding of how the body works, new avenues for drug development arise. New discoveries provide a starting point for research and development specialists to better match a chemical's effects with the body's responses. New compounds are put through a screening process in which samples are observed within a culture preparation to see if the anticipated effects occur. Compounds are then administered on laboratory animals who display characteristics of the illness that the compound is meant to cure. If no therapeutic benefits are seen at this point, the screenings end. Otherwise, further testing will occur with human subjects using placebo, or healthy, group samples to determine baseline dosage levels and side effect risks. The final group of test subjects will be carefully selected according to health conditions which most resemble the target treatment range for the compound.

3. Production Process

Once a drug passes the clinical testing trials, manufacturers then submit it for approval to the U.S. Food & Drug Administration -- Center for Drug Evaluation and Research. The drug is retested on human patients to evaluate its safety and effectiveness. Drugs which make it past this point, finally come to the production phase, where the actual manufacturing of the drug can begin. Careful consideration is made as to what production methods will be used, as well as the cost-effectiveness of the process. The overall goal is to be able to manufacture the drug on a mass production scale, in the most cost effective way possible. Tools used in the manufacturing process are typically automated, and designed to mill, pulverize and mix chemical compounds into specified dosage amounts, according to formula. Packaging tasks are also automated where the finished compound is put into capsule, tablet or liquid form.

Resources

- [Pharmaceutical Online -- Sourcing for Pharmaceutical Manufacturing](#)
- [Pharmaceutical and Medicine Manufacturing](#)

Protein Crystallization

Chemistry Honors
Adapted from Drs. McKenna, UF
By Stephanie Quintero

Background Information

Proteins consist of long macromolecule chains made up from hundreds of residues. Every chemical reaction essential to life depends on the function of proteins. It may serve as a structural material (e.g. keratin), as enzymes, as transporters (e.g. hemoglobin), as antibodies, or as regulators of gene expression. A protein can be made of several hundred amino acids and fold into a 3-dimensional structure.

The protein crystallization technique allows scientists to understand the 3-D structure of a protein. The structure of the protein is used to better understand the studies of medicine, agriculture, the environment and other biosciences.

Proteins can be prompted to form crystals when placed in the appropriate conditions. In order to crystallize a protein, the purified protein undergoes slow drying from a water-based solution. As the water is evaporated, individual protein molecules arrange themselves in a repeating pattern (this is called a lattice). Then scientists can use X-rays to study the crystals. By studying the crystals scientists can then determine the structure of the proteins.

The goal of crystallization is to produce crystals that are large enough and uniform enough to provide useful structural information upon analysis. Several conditions come into factor if a protein sample will crystallize or not. Some of these factors include protein purity, pH, concentration, temperature, and precipitants. In this lab you will determine which concentration of the solution will make the best protein crystals.

Purpose

The purpose of the experiment is to determine which concentration will make the best crystals for further studies.

Procedure:

1. Add the following microliters of ddH₂O, buffer and NaCl to each specific well. ***Be sure to change pipette tips between each solution!***

	A1	A2	A3	A4	A5
Water	725	675	625	575	375
Buffer	100	100	100	100	100
NaCl	175	225	275	575	525

2. Apply a thin layer of oil around the rim of each well (reservoir) in the limbro plate.

Pre-Lab Questions

1. Restate the purpose in your own words.
2. Why is protein structure so important to study?
3. What are the characteristics of a good crystal to study?
4. What factors affect how well a crystal will be made?
5. Which factor will you be testing in this lab? (NOTE: This is your independent variable).
6. Review the procedures. How many different conditions will the independent variable be tested?
7. List at least 5 variables we are keeping controlled (not changing) in this experiment?
8. Why is it important to keep these variables the same?

Analysis Questions

1. Quantitative data is when you collect numbers, qualitative data is when you collect and analyze observations. What type of data did you collect in this lab?
2. Which concentration of NaCl did you find gave you the best crystals? Explain your answer.

Materials

3. Use forceps to pick up the cover slips. Air blow to remove dust if required. Lay out the coverslips on top of the scintillation vials. Slightly off-set them from the center for easier pick up. ***Don't touch with bare fingers—this will leave grease.***
4. Pipette 5 microliters of lysozyme stock onto the center of each cover slip. Using a fresh tip, add 5 microliters of the solution from the first well (**A1**) to the first drop. Gently pipette up and down to stir the mixture.
5. Pick up the cover slip with forceps or fingers and flip upside down, without loosing the drop, over the first well. The oil will form a seal between the slip and top of well.
6. Repeat steps 5 and 6 for wells **A2 to A5**.
7. When done, place wells under dissecting microscope and make observations about the crystals you formed. Organize your observations in a table.

Micropipettes and tips (P-1000,P-100 and P-10)
 Well plates
 24- well Limbro plate
 Forceps
 Plastic micro-bridges
 22 mm Round cover slips
 Immersion oil and applicator
 Scintillation vials
 Lysozyme at 50 mg / ml – on ice
 ddH₂O
 4M NaCl
 0.5M Sodium Acetate
 1M Tris-HCl
 Dissecting microscopes

Figure A: Shows the concentration of each solution you have made in Step 1.

#1 #2 #3 #4 #5

Row A

NaCl Concentration (Molarity)				
0.7	0.9	1.1	1.3	1.5

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