Determining the impact of biosciences-related case studies, lab practical, and cooperative group learning on chemistry students' ability to answer higher order questions in chemistry

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Abstract:

This action research will present the findings of using bioscience case studies, lab practical, and cooperative group learning on chemistry student's ability to answer higher order questions. This study will take place during the first semester of the 2012 – 2013 school year. Biotechnological labs will be introduced into the curriculum during the first and second grading period along with using bioscience related case studies to help facilitate understanding with the difference topics of study. Students will be utilizing biotechnical case studies in the cooperative group atmosphere. On a weekly basis, students will be given ticket out the door questions tying biotechnology and chemistry with higher order questions relating the material of study.

Rationale:

Chemistry is a required class of the First Responders Magnet that I teach at Pinellas Park High School in Pinellas County. Of equal importance, in 2013-2014 all high school freshmen will be required to take Chemistry or Physics prior to graduation.

Students in this course range from sophomores to seniors. After teaching chemistry for 4 years I have noticed that students rarely understand the difficultly they will face throughout the upcoming school year. One of the first questions students ask is "when are we going to blow something up". This question shows what little value they place on the actual understanding of the material that they will be asked to learn. Another comment I hear the first week of school is that how hard chemistry is and how they don't want to fail the class. Students are much more interested in the grades they will earn over actual mastery of the content. From previous years, students seem to struggle with how everything works together in chemistry. In addition to many concepts being highly related to others, and therefore the learning of even relatively simple chemistry concepts being dependent on prerequisite knowledge, conceptual understanding requires the learner to link several modes of representing matter and the interaction that matter undergoes (Gabel, 1997). The students realize that some of the material builds upon prior knowledge, but they still cannot see the big picture. As stated in the journal article by Gillespie (1997), "But this is perhaps not so surprising if we remember that for these students, chemistry consists of a large amount of apparently unrelated, irrelevant, and useless material that they have memorized rather than understood! Their main objective is to pass the course and get on to something they consider more interesting and more useful. They take from the course very little of value in other courses or in later life and little, if any, understanding of what chemistry is really about—merely a conviction that they will never understand it (p.484).

I would like to interest students in chemistry throughout the year by using more diverse activities in the classroom. I can do this by using biotechnical activities that relate the nature of chemistry to everyday scenarios they can understand and utilize. Hopefully, there will be an increase in the ability to

answer higher order questions and ultimately better retention of the material they have learned. If we relate topics of study to students' lives, then we are more likely to draw students into the depth and complexity of a subject (Perrone, 1994). Applying science concepts to real-world problems help students gain deeper understanding of content and fosters the critical-thinking skills needed for them to become productive members of society (Jones, 2012).

A key strategy that will help students with understanding material in chemistry a higher level is cooperative group learning. Cooperative groups include two to six students of different ability, skill, motivation, gender or racial origins who work to achieve a single learning goal (Petty, 1995). Cooperative group learning provides students with the ability to share their ideas and understanding of a topic within a small group of their peers. Cooperative group learning also fosters engagement among the students as their work together on the task at hand. In addition, the more actively engaged the students are, the more they will retain the material they have learned (Vojnovich, 1997).

All of these strategies are being utilized in my class to help students be able to answer higher order questions. By building or learning the ability to answer higher order questions students can improve their critical thinking skills and increase their knowledge. Problem solving, inferring and predicting, and synthesizing are thinking strategies used for scientific inquiry. These strategies help students develop critical-thinking skills, providing opportunities to make observations, inferences, and hypotheses and engage in investigations and data analysis (Jones, 2012).

The purpose of this study is to determine the impact of biosciences-related case studies, lab practical's, and cooperative group learning on chemistry students' ability to answer higher order questions in chemistry.

Action Research Intervention:

In an effort to increase students' ability to answer higher order questions I will be using different educational strategies, biotechnological and real world activities and throughout the school year to give students the skills they need to relate the material learned to answer these types of questions. There is no definite unit that will focus on these goals, but material will be sprinkled throughout many different units through the school year. I will be focusing on one of my chemistry I honors classes.

The first instance of introducing biotechnological science in class will be during the first week of school in the form of a survey pertaining to students' knowledge about biotechnology and its relation to science. Within the second week of school students will write a short essay detailing different biotechnical careers and possible application in the First Responder field. They will be researching the material for their essay in cooperative groups and sharing their essays within these groups prior to submitting the essay to me. Students will also be completing a guided reading on biomedical science and its application to chemistry. The next activity related to biotechnology will be doing the lab "Pipetting By Design" from

the University of Florida science locker. Students will complete this lab in the second month of school, at the conclusion of the dimensional analysis unit. As an assessment, students will be given an individual lab practical using the technique learned in the lab "Pipetting by Design". This lab will prepare students for a trip to the University of Florida campus to complete the crystallization of a protein lab in the following month.

Students will be given a pretest at the beginning of the next unit to assess their knowledge of matter and biomedical science related to science. Students will be provided information that builds upon the material they learned in biology to understand protein through PowerPoint lectures and guided readings. At the end of the unit students will be reassessed using a posttest identical to the pretest given at the beginning of the unit.

One of the final activities the students will complete is utilizing a case study that ties biotechnology, chemistry, and the First Responder field together. This activity is two-fold in that it involves the case study relating to biotechnology and that the students will be working in cooperative group learning to complete the activity. The case study will involve a group of four students; there will be a reader, recorder, timekeeper, and group leader. As we complete more case studies throughout the year the students will all get a turn at each of the assigned duties.

Throughout the semester students will be asked to complete reflective writings at the end of classes where biotechnology was discussed to give me a better understanding if the students are making the connections to the material.

Connection to Bench to Bedside Summer Institute:

Students will use the same techniques that I learned in the lab "Pipetting by Design" at the Bench to Bedside institute in July 2012. I will be designing PowerPoint lecture and class information from the material generously presented by professors at the University of Florida during the summer institute. When students come to the University of Florida during the fall field trip they will be completing the lab "Crystallization of a Protein" that was shared by Dr. McKenna, performed by Angela McCall, during the Bench to Bedside institute. The field trip to the University of Florida would not have been possible without the opportunity presented during the Bench to Bedside Summer Institute.

Data Collection and Analysis:

Students will be administered a pre and post-test during the third unit of the year. I will compare student responses on the pre/post test to see if there was an improvement in student understanding of higher order questions. The following are three questions the students will be asked to answer in the pre and post tests:

- State the law of conservation of mass. Then apply the law to this question: What would be the total mass of the products of a reaction in which 10 grams of water decomposes into the elements hydrogen and oxygen?
- What is the difference between a solution and a heterogeneous mixture? Give an example of each.

- Define *element* and *compound.* Explain the difference between an element and a compound.

Students who attend the field trip to the University of Florida will be asked to share their experiences with students in their class and other classes. They will be asked to complete a series of higher order questions related to the material that was covered during the field trip. This assignment will be counted as an opportunity for extra credit during that grading period. After the students share their experiences from the field trip, fellow classmates will be given a ticket out the door survey with the following specific questions:

- What was one new idea you learned about biotechnology that you didn't know before your classmates shared their experience
- Think about all the material we have learned up until this point; how can you relate one thing in chemistry to the new knowledge you gained from your classmates shared experience?

Students will be asked to complete reflective journaling periodically through the semester. Some of the reflective journaling students will be completing will contain higher order questions so I can assess their knowledge. Students will be posed questions tying biotechnology to the new material that they have learned in the material presented in class. At the end of the semester students will be administered an open ended survey. This survey will assess students' feelings about how well they learned the material and their ability to answer higher order questions. I will compare the results from the pre/post test to see if students were able to get a higher understanding of the material that is being presented in class.

Resources:

Gable, D. (1997). The complexity of chemistry and implications for teaching. In Bruce J. Biddle, Thomas L. Godd, Ivor F. Goodson (Eds.). *International Handbook of Teachers and Teaching.* (pp. 233-249). Hingham, MA: Kluwer Academic Publishers.

Gillespie, R. (May 1997). Reforming the general chemistry textbook. *Journal of chemical education*, 75, pp. 484-485.

Jones, R. A. "What were they thinking? Instructional strategies that encourage critical thinking." *The Science Teacher* 79.3 (2012): 66+. *Popular Magazines*. Web. 25 July 2012. http://go.galegroup.com/ps/i.do?id=GALE%7CA295060744&v=2.1&u=gain40375&it=r&p=PPPM&sw=w

Perrone, V. (1994). How to engage students in learning. *Educational Leadership, 51 (5), pp. 11-13.*

Petty, P. (1997). *Increasing Student Engagement and Retention through the Use of Cooperative Groups and Authentic Assessment*. [S.l.] : Distributed by ERIC Clearinghouse, http://www.eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=ED411058

Vojnovich, C. (1997). *Improving Student Motivation in the Secondary*

Classroom through the Use of Critical Thinking Skills, Cooperative Learning Techniques, and Reflective Journal Writing. Distributed by ERIC Clearinghouse, http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=ED411334

Budget and budget Justification:

- Pipetting Activity for the Bench to Bedside Science Locker
- UF Field Trip: Protein Crystallization Lab; $1000 for chartered bus to UF

Permissions:

- District/Principal approval for field trip to the University of Florida for one day
- Field trip permission from parents of students who are going the University of Florida for the biotechnological lab