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Title

The Impact of Interactive Science Notebooks on Chemistry Students' use of Evidence-Based Reasoning in a Biotechnology Laboratory Experience.

Abstract

The purpose of this action research will be to examine the impact of interactive science notebooks on students' use of evidence-based reasoning in a high school chemistry course. Lab activities garnered from my participation in the University of Florida's Bench to Bedside Institute will be used during a unit focused on chemical bonding. The students will be given the Epistemological Beliefs Assessment in Physical Sciences (EBAPS) at the outset of the unit and once again upon unit completion. Students will also evaluate their own use of EBR as well as the EBR of their peers using a rubric measuring the effectiveness of persuasive essays. I will also complete the rubric. The final piece of data collection is examples of students work from their interactive notebook. These data will be analyzed using appropriate quantitative and qualitative statistical techniques.

Rationale

The goal of science instruction is to develop students that can effectively participate in the practice of scientific investigation. Included in the practice of scientific investigation is the process of science. The National Science Education Standards (National Research Council [NRC], 1996) identify certain unifying concepts in science education. The concepts are meant to connect the various scientific disciplines. Through this unification the student will be provided with a method to better understand the natural world. One of the identified unifying concepts is the use of evidence and models to justify explanations for natural phenomena.

An important aspect of scientific investigation is the ability to develop scientific claims that can be supported using evidence-based reasoning (EBR). This standard is similar to the Toulmin model of argumentation. Toulmin's (1958) model for argumentation is focused on three primary aspects of argument construction. The three aspects central to Toulmin's model were claim, evidence, and justification. These aspects of argumentation were adapted for inclusion in a review of literature in 2004. These adaptations turned the model for argumentation into behaviors that could be monitored in a classroom (Erduran, S., Simon, S., & Osborne, J., 2004).

Erduran et al (2004) identified three behaviors based on the Toulmin model. The first is making sense of information. This is essentially the ability to analyze information. The second aspect of argumentation is the ability to communicate the results of the analysis of information. Finally, the analysis and communication must be used to persuade using a claim, evidence, justification framework. The behavioral framework was combined with Toulmin's model by Berland and Reiser (2007) with minor modifications in order to make the terms more student and curriculum friendly. Toumlin's initial three areas of argumentation were rewritten by Berland and Reiser (2007) as making sense, articulation, and justification.

The use of biotechnology and biomedical concepts in high school science education is supported by the National Science Education Standards (NRC 1996). The National Science

Education Standards state that a guiding principle that drove the development of science standards was that, "school science reflects the intellectual and cultural traditions that characterize the practice of contemporary science." Biomedical research is at the cutting edge of contemporary science and therefore lends well to increasing the relevance of science content in line with the guiding principles of the NRC.

The purpose of this study is to investigate the impact of interactive science notebooks on chemistry students' use of evidence-based reasoning in a series of biotechnology laboratory experiences. One of the secondary reasons for this action research was the research that showed students have difficulty in explaining and justifying their claims (Sadler, T. D., 2004).

Action Research Intervention

The interactive science notebook will be used to facilitate the explicit instruction of argumentation. The explicit instruction of argumentation is significant because research has demonstrated that the difficulties students displayed in construction sound arguments come not only from a lack of content knowledge but also from a lack of knowing how to construct a strong argument. The Interactive Science Notebook will be used as a background for the explicit instruction of evidence-based reasoning. Research shows students need not only to be shown models of EBR but need to be taught EBR and argumentation must be explicitly taught (McNeill, K. L., Lizotte, D. J., Krajcik, J., & Marx, R. W., 2006). Ultimately, I want to make my students better consumers of information through a better understanding of the evaluation of the claim, evidence, justification framework.

Students will use their Interactive Science Notebook to record their ideas. The first step of the activity will be focused on the content-area question. Students will record the question into their Science Notebooks and will be prompted to answer the question using what they already know. The answer will be supported by my emphasis on the fact that these are first ideas and there is no right or wrong answer. The students will then presented with the follow-up question, "How do you know?" The students will then develop and organize their evidence and their ideas will be shared with the class using individual whiteboards.

Connection to Bench to Bedside summer institute

The Bench to Bedside Lab activities will be used to enhance student understanding of chemical bonding. The study will utilize the Water Kit and the Amino Acids Kit to develop student understanding of chemical bonding. More importantly, these investigation will serve as the con tent focus during the explicit instruction of the use of evidence-based reasoning to develop sound arguments built on observation. The materials for the Amino Acid Lab will be provided by the Bench to Bedside program through the use of their equipment locker.

Data Collection and Analysis

On the first day of school students will be given the Epistemological Beliefs Assessment for Physical Science (EBAPS) (Elby, A., Frederiksen, J., Schwarz, C., and White, B., 2001). The EBAP will be used in order to evaluate the sophistication of students' understanding of scientific reasoning. Upon completion of the bonding unit the EBAP will once again be administered in order to ascertain changes in the sophistication of students' perception of epistemology in chemistry.

During the unit students will evaluate themselves and peers using the persuasion rubric as modified from the Rubistar scale for assessing a persuasive essay. I will also use the rubric to

assess student arguments. The results of this assessment will be used as one measure of student growth related to the understanding of the use of evidence to support an argument. The anticipated result is an alignment of the student, peer, and teacher evaluation of evidence-based reasoning as it relates to argument strength.

In addition to the EBAPS and Persuasion rubric relevant student work as demonstrated in the interactive science notebook will be examined in order to show the development of ideas that includes a greater support of claims through the use of higher quality and quantity of evidence to support student claims.

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Budget
Water Kit
Amino Acid Kit
Miscellaneous Lab Materials
Lab Copies

Estimated Cost 200$

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