The Effect of Applying Biotechnology Skills Through Case-Study Learning on Increasing Biology Student's Knowledge, Attitudes and Interest Related to Biotechnology Fields

Jody Bertram

Biology Teacher
J.W. Mitchell High School
2323 Little Road
Trinity, Fl 34655
Jbertram@pasco.k12.fl.us

Abstract:
The purpose of this research is to examine the role case studies play in increasing student interest in the field of Biotechnology. Biotechnology skills will be applied to real-world problems to allow students to make connections to realistic situations with the intention of increasing their interest toward biotechnology careers and science in general. The study introduces each unit with a case study, solved as the students learn more about the subject. Each unit then culminates with a spotlight on a career. Data collection involves an initial and final interest and awareness survey as well as several formative and summative assessments to measure the effectiveness of the curriculum, change in attitude and awareness of career pathways. The majority of the research and collection of data will be done during the Classic Genetics and Cell Reproduction & Protein Synthesis Units of Biology.

Rationale:

I have chosen this area of research because I have realized from my own educational experience and my experience as a teacher that the knowledge of biotechnology careers is minimal. I majored in Biology in college, but even after finishing my degree, I wasn't aware of all of the avenues that could be pursued. Because guidance counselors and even many science teachers are unaware of the pathways, an interest in science and biotechnology careers is not cultured at the high school level. I have chosen to encourage student interest through the use of case studies so students can apply the knowledge they gain to real-world situations. The biotechnology skills we have learned during Bench to Bedside fit most appropriately within the Genetics and Gene Expression curriculum, but I intend to incorporate case studies and biotechnology skills within all of the curriculum standards.

Even as a ten-year veteran teacher, I was not comfortable using some of the technology (such as gel electrophoresis and PCRs) in my classroom. Nor was I completely aware of all of the opportunities that are available at all levels of education from high school to post doctoral work. In a study gauging high school and university students' knowledge and attitudes toward biotechnology, 682 students were studied and a statistically significant correlation was observed between knowledge of biotechnology skills and positive attitudes toward the field (Usak et al, 2009). Another study supported the importance of career guidance on influencing future science careers (Boone et al, 2005). Another study also saw a correlation between the impact of preparation and awareness on choosing science-related careers in the future (Basl et al, 2011).

I have decided to meet the above goals within a framework of case studies. As reliance on technology increases at an exponential rate, it becomes difficult for teachers to keep up with the amount of new information available. Science teachers take on the responsibility of informing students of these changes and how they relate to social, political and scientific issues (Bergland et al, 2006). The case-study format has been proven to be a successful avenue for teaching students since they tie biological issues to real-world situations through simulation and laboratories (Bergland).

Because case-based learning is highly reliant on higher level thinking skills, students will actually learn how to think, not just memorize information. Because the world's knowledge base is increasing so rapidly, most scientists believe that some biotechnology information taught to a high school freshman may possibly be obsolete by the time they are seniors (Boone et al, 2005). It is therefore imperative that teachers give their students experiences that teach them how and when to use particular strategies for learning and problem solving so they can apply those metacognitive skills to many situations.

The purpose of this study is to gauge the impact that providing authentic science learning in a case-study format has toward increasing the interest and awareness of how science is actually applied. Curing diseases through gene therapy, producing drugs and developing products that make life easier are the real applications of science. If knowledge and awareness are increased, hopefully interest will be sparked, attitudes toward biotechnology will become more positive and consequently, students will explore biotechnology careers further.

Action Research Intervention

The action plan has been used in all four of my Biology Honors sections. I introduced each Biology unit with a case study. These cases have been chosen to fit the standards under each unit and are in various formats (lab, debate, etc). The majority of them have been downloaded from the National Center for Case Studies in Science while others were found in the Pearson Biology textbook. While learning concepts in each unit, the students have worked through the problems, ultimately solving each problem and tying it to a biotechnology career pathway. Most of the Bench to Bedside skills and equipment locker materials were used during the Molecular Genetics Unit. The most significant connection to Bench to Bedside equipment was the gel electrophoresis materials and micropipettes for the Gatorbait Myslexia Lab (part 1 only), but I also used the virtual gel electrophoresis simulation, the viral microarray, Dr. Weinstein's Glycogen Storage Disease website, Anthony Atala's TED talk, parts of the Viral Quest curriculum and the stem cell and diabetes takeaway labs throughout the year. The learning objectives varied throughout each unit but the main objective tied to the research plan was to learn how biotechnology impacts the individual, society and the environment.

Connections to Bench to Bedside summer institute:

The most significant connection to Bench to Bedside equipment was the gel electrophoresis materials and micropipettes for the Gatorbait Myslexia Lab (part 1 only), but I also used the virtual PCR simulation, the viral microarray, Dr. Weinstein's Glycogen Storage Disease website, Anthony Atala's TED talk, parts of the Viral Quest curriculum and the stem cell and diabetes takeaway labs throughout the year.

Data Collection and Analysis:

The first piece of data that was collected was a formative assessment on polleverywhere. I had already used a viral array that I made based on Dr.

Lawrence's design so the students had some exposure to biotechnology techniques. The survey asked about student interest in science as a class and a career. They were also asked to list any biotechnology jobs they were aware of. The initial data showed that although 65% of the students found science class interesting, only 6% of them indicated that they would definitely pursue a science-related career. Promisingly, 55% of the students indicated that a science career could be an option but not a definite pathway.

I opened the Molecular Genetics Unit with the Gatorbait Myslexia case study. Students completed an activating strategy online to introduce themselves to the techniques of gel electrophoresis and PCR. Then students completed a gene splicing activity and the virtual gel electrophoresis and were asked to create a graphic organizer that summarized the techniques we had learned about thus far. Finally, we came back to the case study and the students performed the laboratory. They were assessed on their completion of the lab, ability to interpret the gel, completion of the pedigree and a paragraph describing the purpose and applications of gel electrophoresis. All students were able to complete the tasks, although some needed individual support to complete the paragraph. Each unit also began with a short pretest and ended with a posttest. Although they were also given a unit test, the pre and posttests were a snapshot indicator that tested only the standards that will be tested on the Biology End-of-Course Test in May. All units saw an increase in scores but the change in the Molecular Genetics tests was the most significant. The scores went from a 2.4 average to a 3.9 average. After completing the lab, we added biomedical and genetic engineers to our list of biotechnology jobs we had created throughout the year. After finishing the next two units, the students completed the interest survey again. I wanted to wait to see if the activities they completed, the jobs we discussed and the case-study format had made an impact on their interest and attitudes toward biotechnology. Student interest in science class only increased 6% to 71%, but the number of students interested in science careers increased from 6% to 17% and the number of students not interested in science careers decreased from 38% to 20%. Although the "maybe" group was still the largest by far (63%), many students changed their attitudes after learning some of the options for science majors. They were also asked to make comments concerning the case studies we did this year; several students made comments that showed a significant change in their view of what a science career involves. One student wrote: "I knew I wanted to help people for my job, but I didn't know that I could do that with a science career unless I was a doctor. I now know that there are many options."

Literature Cited

Basl, J. (2011). Effect of school on interest in natural sciences: a comparison of the Czech Republic, Germany, Finland, and Norway. *International Journal of Science Education*, 33:1, 145-157.

Bergland, M. & Lundeberg, M. (2006). Exploring biotechnology using case-based multimedia. *The American Biology Teacher*, 68(2):81-86.

Boone, H., Boone, D., & Gartin, A (2005). Are you feeding or challenging your students: feeding them knowledge or challenging them to think? *Agricultural Education Magazine*, 77(4), 25-28.

Usak, M. & Erdogan, M. (2009). High school and university students' knowledge and attitudes regarding biotechnology. *Biochemistry and Molecular Biology Education*. 37(2):123–130.

Budget: $200 for purchasing 96-well plates, materials to recreate the stem cell and diabetes science take-out kits, UV paint and pen lights.

Permissions: None