Exploring the Effects of Biotechnology Laboratory Applications on Student Interest and Future Enrollment in Upper Level Science Course Selection by High School Biology Students

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Abstract: With the current national emphasis on STEM education and careers, it is important that as high school science educators, we are preparing our students to exist in this world of emergent biotechnology. It is expected that biology students' interest in science and enrollment in upper level science courses will increase as they are exposed to biotechnology content and laboratory activities. As Marek and Cavallo (1997) quote from *Science for All Americans*, “The life-enhancing potential of science and technology cannot be realized unless the public comes to understand science, mathematics, and technology and to acquire scientific habits of mind.” If we fail to engage and prepare students at the secondary level, we have no hope of producing a science literate society.

Rationale: As a high school science teacher at Tenoroc High School, I am often disappointed to hear students’ opinions about science. Tenoroc is the newest high school in Polk County and opened its doors in 2008. Our current SES is 68% and after a year of operation we were designated Title I. We are located in an area that is still fairly rural and many of past graduates have reported no plans to further their education post-graduation.

Due to lack of interest, we have few upper level science courses offered; as of 2011-2012 we only had one section each of AP Environmental Science, Physics Honors and Anatomy & Physiology Honors. Every year there is an attempt to schedule AP Biology and AP Chemistry along with additional units of Physics and Anatomy & Physiology (both regular and honors level), however, due to lack of student interest these attempts have been unsuccessful. This is a difficult reality for me to accept, particularly in light of the fact that Tenoroc was built as a state of the art facility with lots of available technology and two well-equipped science laboratories.

In two years, I have had a combined total of 21 students enrolled in AP Environmental Science. Many of my biology students report a former interest in science, however as they enter high school, the interest seems to wane. Frequently, negative comments are made such as, “I hate science,” “I’m not good at science” or “why do I have to learn this?” After teaching several different high school science courses ranging from regular to Advanced Placement science courses, I have found the negative attitude towards the subject of science and in enrolling in upper level science courses is consistent throughout.

Every year, I hope to influence students in a positive way regarding their interest in science, their ability to learn science concepts and to encourage their participation in upper level science courses. After participating in Bench to Bedside and engaging in the many biotechnology activities presented, I felt that incorporating these activities into the existing biology curriculum would enhance it in such a way that student engagement would increase. As Hanegan & Bigler (2009) summarize, biotechnology is an imperative educational issue and it is vital that it be addressed in high school biology courses to satisfy the National Science Education Standards (NSES) and to benefit society.
Presumably, as student engagement increases with the aid of biotechnology laboratory activities, so will student achievement, thus resulting in increased interest in science and greater enrollment into upper level science courses by biology students at Tenoroc. “With the recent advent of the Human Genome Project (HGP), the Tree of Life Project, Genetically Modified Organisms, and stem cell research, biotechnology has become integrated into personal decisions, politics, and industry. Biotechnology careers are essential to agricultural services, drug manufacturing, and health services, which are expected to grow” (Hanegan & Bigler, 2009, pg. 393-394). Hopefully, as exposure to a biotechnology-infused biology curriculum increases and students begin to take more upper level science courses, they will be more likely to have a post-secondary interest into STEM education and careers. As a science educator it is my responsibility to prepare “informed citizens to participate and work in modern society” through “scaffolding and maintaining national interest in innovative science and technology” (Gardner, 2009, pg. 6).

Per Gardner (2009), public opposition to some emergent technologies is in part due to the lack of personal knowledge. As a result of this uncertainty, the greater impact of this innovation on society is unknown. In order to navigate the complexities of developing technologies, students (future citizenry) need a certain level of science literacy (Gardner, 2009). Mueller (2009) suggests that curricula that includes active-learning (such as the biotechnology laboratory activities) may be effective in promotion of student knowledge and positive views of their learning experiences. It is my hope that the more positive perceptions to their biological learning experiences will inspire more students to participate in more advanced science courses which should affect science literacy. The purpose of this action research is to explore the effects of biotechnology laboratory applications on student interest and future enrollment in upper level science course selection by high school biology students at Tenoroc High School.

**Action Research Intervention:** In order to increase student interest in science and enrollment in upper level science courses, I will integrate the biotechnology laboratory activities I was exposed to during Bench to Bedside into the biology curriculum. I will be studying a single class of biology students. This class will be comprised of mainly 10th graders but may also include some retained 9th graders and 11th and 12th graders who are repeating the course for credit.

In addition to infusing this content and skills into the classroom curriculum, I will also schedule a fieldtrip with my students to the University of Florida (UF) to complete additional biotechnology laboratory activities. Prior to these interventions, students’ current science interest and plans to enroll in subsequent upper level science courses will need to be assessed. I will accomplish this by creating a Likert-scale questionnaire which will be given to students at the onset of the biology course. In addition to measuring student interest, the questionnaire will be design to evaluate the likelihood that the student will take science courses beyond the required three courses.

I will also collect data via student interviews (formal and informal) and teacher journal. Additionally, after performing each biotechnology laboratory activity, students will be
asked to rate their experience through subsequent surveys and reflective journaling. Besides incorporating the Bench to Bedside resources, I also intend to supplement the biology curriculum with additional lessons and activities that I have begun to accumulate from internet resources and other sources.

**Connections to Bench to Bedside Summer Institute:** Attending the Bench to Bedside Summer Institute has expanded my knowledge base and bolstered my interest in biotechnology. It will be the modified PowerPoint presentations and laboratory activities of Bench to Bedside that I will be exposing my biology students to with the hope that just as my interest was piqued so theirs will be also. At this time, I am anticipating using the Bench to Bedside resources in the following units:

- Unit 1 – Introduction to Biology
- Unit 2 – Biochemical Molecules
- Unit 6 – Nucleic Acids and Gene Expression
- Unit 7 – Genes and Heredity
- Unit 11 – Human Body

As our 2012-2013 curriculum maps are finalized, I will look to incorporate more of the resources in other units as well.

**Data collection and analysis:** I will be using a mixed method of collecting both qualitative and quantitative data. Participating students will complete a Likert-scale questionnaire which will be used to measure student interest and plans to enroll in future science courses at the beginning of school and then for a second time at the end of the school year just prior to students registering for classes for the following school year. After each exposure to a biotechnology-infused lesson, students will be given a prompt for reflective journaling. As the teacher, I will also conduct student interviews and maintain a journal of student observations.

After data is collected, it will be processed (edited, coded, etc.), mapped (charts, tables, etc.), and interpreted as major findings are revealed (Brown, 1999). The analysis of data will answer the question of the effects of biotechnology laboratory applications on student interest and future enrollment in upper level science course selection by high school biology students.

**Literature Cited**


*Journal of Science Education and Technology, 18*(5), 393-401. Retrieved from 
http://www.citeulike.org/user/nikkihanegan/article/4175542

Mueller, Ashley L. (2009). *The effects of the apple genomics project active-learning Lessons on high school students' knowledge, motivation and perceptions of learning experiences and teachers' perceptions of teaching experiences* (Masters thesis). Retrieved from ProQuest Dissertations and Theses Database 

**Budget and Budget Justification:** All are tentative and subject to change.
1. Miscellaneous lab materials – TBD as biotechnology materials and activities not included in CPET equipment lockers are determined.
2. Transportation – A bus will be chartered to transport students to UF to participate in additional biotechnology activities.

**Permissions:** Polk County Science Safety Contracts will be signed by all students and parents granting permission for participation in all lab activities. Permission will be secured from Tenoroc High School to schedule a fieldtrip to University of Florida. Parents will also need to grant permission for students to attend the fieldtrip.