We Want You: The Impact of Educational Technology and Cooperative Learning on Student Attitudes, Learning Gains, and Interest in STEM-related Careers in a High School Biology Classroom

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Abstract: This action research project will study the impact technology use and cooperative learning will have on student attitudes towards science, student learning gains, and interest in STEM-related careers in a high school biology classroom. Focusing on a sample of tenth-graders, students will participate in a series of virtual simulations and hands-on lab activities during a unit on biotechnology. Student attitudes towards science and interest in STEM-related careers will be measured both prior to and following the biotechnology unit through the use of surveys and questionnaires. Additionally, students will be given a pre-and post-test to measure any learning gains over the course of instruction.

Rationale: In the United States, there has been a renewed interest in the fields of science, technology, engineering, and mathematics (STEM) as of late. Despite the encouragement of individuals to pursue careers in these areas, there is still a growing concern in the availability of STEM workers in this country. Although there are nearly 14 million unemployed people in the United States, many companies are having difficulty finding workers that possess the necessary skills to fill the estimated 3 million STEM-related job vacancies (Price, 2012). This information is a bit alarming when one considers the U.S. Department of Commerce reported that “about 1 out of every 10 STEM workers has a high school diploma or less (Langdon, Mckittrick, Beede, Khan & Doms, 2011).” So what can be done to motivate and prepare individuals to become part of the STEM workforce? How can this void be filled? Most people agree that the solution is to create student interest in STEM and to provide better STEM education. And that’s where I come in.

I hate science! Though the phrase is equivalent to nails going across a chalkboard, it’s a statement I hear from numerous students at the beginning of the school year. There’s a variety of reasons why students feel this way – I didn’t like my teacher. I don’t know why I need to know this material. It’s boring. I just don’t like it. Whatever the case may be, these are the attitudes I encounter when students enter my course and it’s my goal to change that mindset before they leave. Couple my desire to alter student perceptions with the nation’s STEM agenda, and the question I ask myself subconsciously is this: How do you stimulate an interest in STEM? Thinking about my experiences in the classroom, as both a student and an educator, I feel the solution to this query involves modeling what happens in the real world through the use of technology and cooperative work.

There has been an extensive amount of research performed looking at the use of cooperative learning in biology teaching. Lord’s review of the literature showed that cooperative learning led to the enhancement of science thinking, attitudes, instruction, evaluation, values, the learning environment, practical skills, and social skills, in addition to upgrading the student’s reading and writing skills, modeling real life, and supporting learning in women as well as men (2001). Looking at the influence cooperative learning has in the learning environment, I know I sometimes question why more educators don’t employ the technique in the classroom. I do understand that incorporating the strategy can be a logistical nightmare, but it’s definitely worth the try when you consider the end-result. In my classroom, I’ve seen students become active participants in their education as they work on a task in a small group setting. The continuous encouragement of students leads to a level of empowerment that is not attainable in competitive, teacher-centered classes (Lord, 2001). And ultimately, isn’t it all about the students?
In my opinion, STEM education should involve technology – it’s even in the acronym! In the world of scientific and engineering professionals, industry relies increasingly on technology and computers, both in production settings and in experimental research and development (Scalise, Timms, Moorjani, Clark, Holtermann, & Irvin, 2011). And though it is the 21st century and the use of technology is prevalent in today’s society, there’s still hesitation on the part of schools to employ instructional technology. The merits of technology as an instructional tool mainly depend on how it is being implemented in the classroom. But when properly implemented, computer technology has had a significant effect on student achievement, as measured by test scores across subject areas and with students at all levels (Protheroe, 2005). And in relation to STEM education, the use of technology simulations change student attitudes toward science over time which ultimately has a significant impact on the awareness of STEM-related careers and filling the nation’s void (Chen & Howard, 2010).

Therefore, the purpose of this study is to determine the impact of employing instructional technology and cooperative learning in the biotechnology curriculum on attitudes towards science, student learning gains, and interest in STEM-related careers in a high school biology classroom.

**Action research intervention:** For my research, I will be looking at tenth grade biology students enrolled in my Biology I courses. Specifically, I will be selecting low-performing students so that it will be easier to make note of any learning gains at the throughout the study. I will be studying student progress and interactions as we complete a unit on biotechnology, which is an identified portion of the curriculum as indicated by the Martin County School District’s scope and sequence.

In addition to the guided lectures students will have in class pertaining to biotechnology, I will be using the following interventions:

1. I will be incorporating a variety of virtual simulations into the biotechnology curriculum. Students will be able to model the work of individuals in STEM fields as they create their own stem cell lines. Additionally, students will be given the opportunity to practice the skills necessary to perform PCR or gel electrophoresis prior to actually completing the hands-on activity in class.
2. I will also be implementing a series of labs and activities that make use of cooperative learning. This includes students performing a lab in which they determine how stem cells are used and another in which students will have to perform a genetic screening.
3. I intend students work cooperatively to create presentations for a mock biotechnology career showcase. Students will need to make use of their technological skills to explore the aspects of STEM-related careers and demonstrate their acquired knowledge to their peers.

**Connections to Bench to Bedside Summer Institute:** Many of the activities being used in this biotechnology curriculum are based on those from the Bench to Bedside summer institute. The materials needed to perform these labs will be provided to me by the Bench to Bedside program. In addition, the biotechnology career showcase is an idea that was provided by Viral Quest, a narrative biotechnology curriculum introduced during the 2012 Bench to Bedside institute.
**Data Collection and Analysis:** I will be collecting both quantitative and qualitative data for this study. At the beginning of the school year, students will be given a pre- and post- Likert scale survey to assess changes in attitudes toward science. Students will also be given a questionnaire both prior and after instruction to determine if there is an increased interest in STEM-related careers. To assess student learning gains, a pre- and post-test will be given to assess student knowledge of biotechnology. Throughout the unit, a collection of formal assessments (quizzes, tests) will be given as well.

Seeing as teaching and science are both very reflective, journaling will be completed by teacher and students throughout the biotechnology unit. Teacher reflection will include classroom observations while students will reflect on the lessons in which they took part. At the completion of the unit, students will reflect on the unit as a whole and whether the interventions used had any effect on attitudes, learning, or their interest in STEM. Additionally, the biotechnology career showcase can also serve as an indicator of student interest in STEM-relate careers.

**Literature Cited:**


**Budget and Budget Justification:**

- **Biotechnology Labs – Free of Cost**
  - As a participant in the Bench to Bedside summer institute, I would be able to use the equipment lockers containing all the materials for the

- **Food coloring (Pipetting by Design) - $5/box**
  - Because the Bench to Bedside program cannot ship liquids, it will be necessary to buy food coloring for this lab.

- **Miscellaneous lab materials – TBD**
  - There are a collection of supplies that can be used to perform many of the techniques used in a biotechnology lab. However, as the new kid on the block, I need to do an inventory of what supplies are available among the teachers in the science department.

- **Student Handouts – Part of copy allowance**
  - If given enough time, the school district takes care of any reproductions that need to be made. I can also use my on-site copy allowance if I need be.

- **Art Supplies - $40-$100**
  - For the biotechnology career showcase, students would need to create a visual display board to attract potential applicants. Considering the economic status of many of my students, it would be beneficial if my students did not have to bear the cost of these supplies.

*Estimated total cost: $45-$150, depending on the availability of miscellaneous lab materials*

**Permissions:** In order to complete some of the activities for this biotechnology unit, I will need to reserve one of the school computer labs with my school media specialist. Though I have student computers in the classroom, it might be advantageous to set aside time in the computer lab so I know that all of my students have computer access to complete the virtual simulations. Additionally, I would need approval of the school activity director, principal, and plant operator in order to hold the biotechnology career showcase. And since I feel all students need to be made aware of the STEM-related career opportunities, I would need teacher approval for those students that attend the showcase.