WE CAN DO WHAT? : A Study of The Effect of Conducting a Stem Cell Biotechnology Lab on High School Anatomy and Physiology Students Development of an Interest in Biomedical Science Careers

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Abstract
Most high school Anatomy and Physiology students are considering careers in the medical field, yet have not had the opportunity to interact with the new curricular direction of most medical schools, specifically biomedical sciences and biotechnology. Medicine has evolved from a single doctor treating a patient by himself to a multidisciplinary career practiced by a team of doctors and other health care professionals in different fields working together starting with clinical research and continuing at the patient’s “bedside.”

This action research will present the results of conducting a stem cell biotechnology lab in a high school anatomy class and the development of interest in pursuing careers in the biotechnology and biomedical fields. The lab will be implemented during the first semester of the 2012-2013 academic year, and measured by using self-reporting surveys, given before and after the biotechnology lab, as well as other assessments to measure acquisition of biotechnology skills and interest in pursuing careers in biotechnology or biomedical science. Answers given by students who have engaged in the stem cell biotechnology lab will be compared to answers of students who do not participate in the lab.

Introduction/ Rationale

“Action research is a form of collective self-reflective inquiry that participants engage in to improve their own practice” (Herbert, 2002). Action Research is useful to reflect on pedagogical practices and effect changes in instruction to benefit students in either behavioral or cognitive ways.

Attending the Bench to Bedside Workshop at the University of Florida (UF) during the summer of 2012 has caused me to reflect on the methods that I use to teach my anatomy and physiology students and to consider ways in which I can improve my teaching methods to give students the type of instruction which will most effectively elicit their interest in the biomedical field and develop biotechnology laboratory skills while following the instructional plan that the county has set up for teachers of anatomy and physiology honors.

My classroom atmosphere is relaxed, yet with high expectations of the students. My instruction includes lectures, video clips, sketching anatomy structures and memorizing names and functions of anatomical structures, organs, and organ systems both from the textbook and from their observations of the cat dissection, group study, virtual and real labs, case studies, reading of the book Stiff, by Mary Roach, discussions on the online classroom website, projects, research papers, and reviews. Because most of my students are juniors and seniors, I sometimes struggle with thinking that some of the more “fun” activities may be inappropriate for their age or for the rigor of the class; so I opt out of some of them. I am the only honors anatomy and physiology teacher in my school, and unless I discuss with other teachers in the county, I have to come up
with my own teaching ideas. The Bench to Bedside workshop has been instrumental in liberating me from the faulty thinking that everything has to be “hard” in order to be “academic”.

I have intelligent students who are already highly motivated and self-disciplined and deserve the opportunity to experience practices that will afford them a deeper understanding of physiology concepts and the understanding of their application in the medical field. Rote memorization of anatomical structures and their functions is taxing yet necessary, even worthwhile, yet of its own involves no application of research. Though the students memorize quite well, I want more for them and for me, as their teacher. I want to excite them and challenge them to make the connections between what they learn and the application to biomedical science, particularly to stem cells and all the new research in this field. According to JJ. Finkelstein, managing principal of RegenRx Biopharmaceuticals Inc, young people are not interested in the areas of study that help his industry. (Chea, 2001). Nevertheless, High School is a crucial time to help students realize the changing nature of medicine and the important role of the integration of biotechnology and biomedical science.

I can integrate anatomy and physiology with biotechnology by providing labs that focus on anatomy and physiology topics, for example, the use of stem cells for healing structures that are being addressed in anatomy class. Observing the virtual labs involving stem cells at the Bench to Bedside workshop was fun and educational. I was not aware that these labs were available until they were shown to me at the Bench to Bedside workshop. My students can use them to further their own understanding of body structures, disease and healing in an enjoyable format. The Bench to Bedside workshop will also allow me to bring my students to the university to participate in biotechnology labs and visit the biomedical science facility. Both of these activities will enhance my students’ interest and skills in biotechnology and the biomedical sciences.

Teaching in a manner that utilizes group learning and biotechnology applications will be challenging for me with the anatomy and physiology students because not only has education changed much since I began teaching; it is now also drastically different from what teaching was when I was a student. As a matter of fact, many teachers that have been teaching for an average of 17 years confess that they have no experience with biotechnology education (Porter, 2007) There is so much more to learn than when I went to school because there have been many advances in the field of physiology and also because there is so much technology available to the students that the delivery of education is changing. “The significance of integrating technology use in higher education instruction is undeniable. The benefits include those related to access to instruction by underserved populations, adequately preparing students for future careers, capitalizing on best instructional practices, developing higher order thinking activities, and engaging students whose relationships with technology are increasingly native, among others” (Ezarka, 2012).

Action research will be the vehicle by which I strive to bridge the gap in my own education and modern instructional delivery methods for the purpose of finding a
correlation between conducting a stem cell biotechnology lab in a high school anatomy class and the development of biotechnology skills and the interest in pursuing careers in the biotechnology and biomedical fields. The purpose of this study is to investigate the effect of integrating a biotechnology unit on stem cells in an honors anatomy class on the development of interest in biomedical careers.

**Action Research Intervention**

Though I plan to use many biotechnology activities during the year, this action research plan will focus on the use of a few lessons presented at the Bench to Bedside workshop and various instructional strategies. As required by the state of Florida, the activities and instructional strategies will help students meet the following new Generation Sunshine Standards: 1. The students will evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues. (SC.912.L.16.10)  2. The students will explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health. (SC.912.L.14.6)  3. Classify and state the defining characteristics of epithelial tissue, connective tissue, muscle tissue, and nervous tissue. (SC.912.L.14.11) The following outlines the interventions and methodologies that will be used to teach a unit on stem cells to my 11th and 12th grade anatomy and physiology honors students.

I plan to use materials presented at the Bench to Bedside Workshop to instruct and discuss topics such as the changing nature of medicine, including career opportunities, instruction on the theory of stem cells—followed by execution of the virtual online lesson, which will in turn be followed by the simulation lab, “Create a Stem Cell Line”. After the classroom instruction and stem cell labs, students will perform other biotechnology labs—as directed—when they visit the biomedical science lab during the field trip to UF.

My plan is to first hook the students into wanting to learn by giving them a reason to learn. On the very first week of school, I will show a short clip from the movie “Extreme Measures” that shows a father desperate to find a cure for his children with Pompe disease. I will then explain that in order for medicines and treatment to be designed, all the biological processes that occur at the cellular and molecular levels need to be understood by researchers who design medication and/or treatment for diseases. Doctors cannot administer the medication or give the treatment to patients that need it unless the research has been done and medication or treatment has been developed. In order to work on research or medicine, these processes need to be studied. It is my hope that the students will understand the importance of learning the difficult concepts that they will encounter over the year.

Students will participate in 3 pretests/surveys,” What do you know about careers in biotechnology?” “What do you know about stem cells?” and “What do you think about stem cell research?” to find how much they know about stem cells, and careers in biotechnology and biomedical sciences. After the pretests/surveys are completed I will begins a short lesson dealing with careers and requirements for careers in biotechnology. To make the students aware of the important need for people in
many careers available in the biotechnology field, I will create a short power point lesson on careers available in the biotechnology and biomedical field using the information that was shared by Tammy Mandell at Center for Excellence in Regenerative Health Biotechnology (CERHB).

During our study of tissues, I will integrate a unit on stem cells during which I will use several activities. First I will give a brief introduction to stem cells using a power point instructional lesson created by the Bench to Bedside institute followed by a crossword puzzle that will assess the concepts learned. After the crossword puzzle, students will participate in the stem cell virtual lesson created by the University of Utah called the “Nature of Stem Cells” found at http://learn.genetics.utah.edu/content/tech/stemcells/scintro/ . As students are participating in the virtual lesson, they will be directed to answer questions provided by the University of Utah in the same website. The virtual lesson will be reinforced by a short dry lab created by the University of Rochester through which students will learn about adult and embryonic stem cells and how they can be used to treat disease. After the first stem cell lab, students will use the information learned to infer and predict what type of tissue will be generated when starting with various stem cells using the lab, Create a Stem Cell Line—an EdHead lab -- created by the Center for Regenerative Medicine and part of the material provided by the Bench to Bedside Workshop.

The last learning activity will hopefully be a trip to the Biomedical Sciences Department at the University of Florida, where the students will conduct other labs related to stem cells and receive instruction from lab researchers from the Bench to Bedside workshop.

Upon their return to our campus, the students will engage in a final assessment, a multimedia project created by the University of Utah and provided through the website where the online lesson was found, Learn Genetics. The project involves a “public service announcement, advertisement, documentary, newscast, newspaper article, movie, or another teacher approved format created on PowerPoint, video tape, poster board or other teacher-approved media” http://teach.genetics.utah.edu/content/tech/stemcells/scmultimedia. After students have completed all these activities, they will participate in the same survey/ now a posttest to ascertain the effect of exposure to lessons and labs about careers and biotechnology labs dealing with stem cells.

**Connections to Bench to Bedside Summer Institute**

The stem cell labs and lectures are either based on, or provided on their entirety by the bench to Bedside Summer Institute. Some may be purchased by me with the grant money received by the Bench to Bedside Institute after having been introduced to them at the workshop.

**Data Collection and Analysis**

In order to discern the effectiveness of performing a stem cell lab on developing students interest in the biotechnology field and skills, I will be collecting qualitative and
quantitative data from my anatomy classes. Students will be given a pretest before engaging in the lessons, labs and field trips --followed by a post test using questions related to the same, at the end of the biotechnology lessons, labs, and field trip. The pretest will consist of survey questions related to performance of the lab skill, accompanied with a performance assessment to evaluate acquisition of biotechnology skills. (Breslow, 2007)

The surveys will be tallied using NCR scantrons, machine-readable papers where students “bubble in” answers to multiple-choice questions, to determine what percent of students are interested, knowledgeable on content, and skilled on stem cells and laboratory procedures in biotechnology before and after they are exposed to interventions or lessons as delineated in the intervention section. Answers to questions in Postests related to interest in careers in biomedicine and knowledge of uses of stem cell as well as bioethical issues will be compared to the answers given previously to the same questions in the Pretests. Comparisons will be analyzed to measure increased or decreased changes in interest and/or knowledge of the topic.

Literature Cited

Chea, Terence. (2001). A New Stage in Biotechnology; Plays Encourage Students to Study Field, Consider Ethical Dilemmas: *The Washington Post*
Ezarka, S. (2012). Technology Use in Higher Education Instruction, *Claremont Graduate University*
Herbert, A. (2002). The concept of action research, *The Learning Organization*

Budget and Budget Justification

- Stem cell lab kits-- will borrow from equipment locker
- Trip to UF Biomedical Sciences Department—1000 on charter bus company
- $250 for lab conducted at UF.

Permission

Parents and Principal will be asked to give permission for field trips and participation in surveys.