

A STUDY OF ACHIEVEMENT IN BIOLOGY USING PEER-REVIEWED STUDENT

JOURNALS TO EXAMINE HUMAN BODY SYSTEMS AND THE IMPACT OF ADVANCES IN BIOTECHNOLOGY

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Rationale

In Florida, students are required to successfully complete an introductory level biology course during their high school years. In order to receive credit for the course, students must pass the course requirements and are being required to pass an end-of-course (EOC) exam. This has been a cause of concern for students and parents but has also increased the amount of content covered while, simultaneously, reducing the actual number of instructional days. Reduction of instructional time is due to the utilization of school days for diagnostic and EOC tests.

At Jupiter High, students enroll in biology in their first year, as freshman. For many students, high school biology is the most challenging course attempted during the first year in high school, particularly as many of the concepts addressed within the course are entirely new to them, having not been covered in elementary or middle school science classes (i.e. biochemistry). Additionally, students often view some curricular topics as not relevant to their lives. The number of new terms contained in the curriculum is especially high, with students continuously having to develop an understanding of vocabulary before they can attain concept knowledge. Cell biology, molecular genetics, and chemistry concepts and terminology are particularly daunting for these 14 and 15 year olds.

At the same time, high school students are captivated by the structure and function of the human body, especially during this time of dramatic maturational change. Students often view study of certain biological concepts as irrelevant while considering the study of human body systems as a worthwhile, relevant pursuit. Often, students themselves, or family members are stricken with devastating diseases which are frightening, and incomprehensible. Within a classroom, there are usually several students who fall into this group. Scientific research utilizes many new and complicated technologies to explore the human body in the pursuit of cures or to prevent disease. These topics are of particular interest to high school students who view this research as directly relevant to their lives.

With the mapping of the human genome, the development of genetic engineering, and research in stem cells by physicians working toward curing devastating diseases, students are bombarded with information that they find exciting, yet difficult to comprehend. In fact, Australian high school students were found to have misconceptions about many biotechnology concepts, confusing terms like cloning with genetic engineering and thinking that human limbs have been cloned (Dawson, 2006). Textbooks have changed significantly in recent years including updates in the fields of genetics and molecular biology, and in improving scientific literacy (Chiapetta and Fillman, 2007). The study of biology is important in high school, and incorporating biotechnology topics in the curriculum is imperative given the advances in modern science. It is clear that teaching students about genetic engineering, cloning, and stem cell research is a critical component of science instruction during the high school years.

To capture student attention and to increase dialogue among students, specific case studies about human diseases are effective. Controversial case studies involving biotechnology have been demonstrated to improve student knowledge as well as higher order thinking skills (Dori, 2002). Further, the achievement gap between high and low performers was narrowed significantly utilizing a biotech module involving case studies (Dori, 2002). Clearly, a focus on medical advances and biotechnology provides the material to not only interest students, but to motivate them. Further, active

learning through lab investigations fosters independent learning and enhanced content knowledge acquisition (Taraban, Box, Myers, Pollard, & Bowen, 2007).

The purpose of this study is to improve student achievement in high school biology by incorporating biotechnology into the study of human body systems and to evaluate the impact of student-created peer-reviewed journals for independent student research.

Students are most often assessed by their teachers but by utilizing a rubric for the peer review process; several positive outcomes are expected. First, students will learn the process of peer review, a key concept addressed by the Florida State Standards related to the nature of science. Although unaccustomed to grading, college students were found to rate their peers in much the same manner as an instructor (Haffner, 2003). Secondly, students often produce higher quality work when they are aware that it will be presented to, and evaluated by their peers. Additionally, students will be providing written feedback to their peers thereby creating a means by which the rubrics may be used as a learning tool, allowing students to improve their performance. Use of a rubric in a peer review situation has been found to be gender neutral (Haffner, 2003). While the writing component of the student created journals may vary with academic ability, the use of the rubric is not related to the academic level of the student and therefore, will provide an authentic means of evaluation (Haffner, 2003). Throughout the peer review process, the teacher will serve as a facilitator and supervisor to ensure that students maintain a level of integrity during the process.

Following peer review, students will divide into groups, presenting their findings in a round table format. The teacher will circulate throughout the discussion period to informally assess student presentations, lab journals, and ongoing discussions.

Action Research intervention:

Over 100 freshmen high school students will be the subjects of this research. At the beginning of the school year, students will be pre-tested for knowledge of biological concepts, ability to identify tools utilized in biological studies, and interest in science as a career option.

In this action research study, high school freshman will explore the structures, function, and diseases of human body systems. Incorporating biotechnology and case study examples, students will examine body systems through independent internet research, learning to distinguish among reputable academic and educational sources. Research of this nature encourages authentic inquiry, allowing students to freely investigate the function of the system and any disease or disorder affecting the system assigned. The research project will require students to address a number of specific requirements designed to increase vocabulary acquisition, graphical interpretation, and writing skills and to present their information in a lab journal.

After initially modeling the research process, students will be assigned a specific human body system and will be required to conduct independent research about the body system. Provided with a rubric and direction regarding the research, students will compile their findings in a lab composition book, to be used throughout the year. All work on the project after initial instruction will be completed outside of school and will supplement classroom instruction.

During the school day, students will be given direct instruction, engage in lab activities, watch video clips, and utilize hands-on and online simulations to enhance understanding of the body system and the biological concepts that relate to its function. Virtual simulations improve acquisition of content knowledge in biology (Kiboss, 2003).

Student research will consist of identifying a disease that impacts the body system, research reputable websites for pertinent information, and write about the disease cause, symptoms, treatment, and prognosis for patients. As part of their research, students will need to include a graph from current medical research relating to the disease and analyze the graph, summarizing its meaning in writing. This analysis of different types of graphs relating to the illness will improve critical thinking and enhance communication skills. At the end of two weeks, journals will be subjected to peer evaluation in the classroom. Student journals will be evaluated by two peers in class, assigned at random. A teacher created rubric will be used for all evaluations. Peer assessment has been found to correlate directly with teacher evaluation, however, any discrepancies will be considered on an individual basis.

Student journals will be analyzed every two weeks through a peer-review process utilizing a teacher-created rubric. Rubrics allow for establishing quantitative levels of performance, varying from low levels to levels of mastery. Found to be useful to teachers and students, rubrics provide a clear depiction of assessment results and are both valid and reliable as an assessment tool (Haffner, 2003). Students in this study will be provided with a rubric prior to beginning their assignment. In this way, students will be able to determine what is necessary to acquire a superior score and will be able to evaluate their own work prior to peer review, providing an opportunity for self-directed learning.

Connections to Bench to Bedside

Biotechnology lab activities and model building kits utilized in the Bench to Bedside summer workshop will be utilized in the classroom. In particular, the following activities will be included:

- Water molecule model building
- Stem cell activity
- Micropipetting by design
- Pompe Disease curriculum
- Nature's Dice
- DNA Chips
- Virtual , webquests, and hands-on simulations

In addition, selected slides from powerpoint lectures will be utilized to enhance instruction about stem cells, viruses, glycogen storage disease, gene therapy, and biotechnology careers. Additional lab activities from the Bench to Bedside Program will also be utilized.

Data Collection and analysis

Data will be collected throughout the school year. Students will be pretested on their knowledge of basic biological concepts and on the structure and function of human body systems. Data will include,

but is not limited to, the results of a district-wide diagnostic test administered to all biology students in our district. This data is collected in September. Students will also be pretested on the tools of science, including those used in genetic engineering and other areas of biotechnology. This pretest, will be administered in August in a rotational lab format. At each lab station, equipment will be numbered and students will move from one station to another individually, and silently record their responses about the equipment.

Following each unit of study, students will take a traditional assessment using multiple choice and short essay questions to assess knowledge acquisition. The assessment of scientific tools will be in a short answer format.

Student-created journals will be assessed every two weeks through a process of peer review utilizing a rubric for assessing performance. As each assignment will involve multiple requirements, each section of the project will be assessed separately. Items from the rubric will be scored with a numeric value ranging from 0 to 5 with 5 being the maximum number of points that could be earned. For each disease they research, students will be required to describe:

- specific vocabulary and terminology (5 points),
- the symptoms (5 points),
- the current treatment (5 points),
- the prognosis (5 points),
- a graph of recent data (5 points),
- interpretation of the graph (5 points),

Budget and Budget Justification

Biotech labs and models will be purchased for this project.

1. Biotech labs provided without cost by the CPET Bench to Bedside Program will be utilized.
2. \$200 provided by Bench to Bedside Program will be allow purchase of additional materials for lab activities and human body systems materials.

Literature cited

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Permissions

Permission slips to engage in science labs and to ensure lab safety are required of all students. No additional permission slips are necessary within the framework of this study.