

The Effects of Adding Biotechnology Simulations and Labs to Traditional
Molecular Genetics Instruction on the Knowledge and Attitudes of AP Biology
Students

Jane Beebe, MT (ASCP)

Honors Biology and AP Biology Teacher
Forest High School
5000 SE Maricamp Road
Ocala, FL 34480

Jane.Beebe@marion.k12.fl.us

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Forest High School

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Abstract

The purpose of my action research was to evaluate the effects of adding biotechnology simulations and labs to traditional molecular genetics instruction on the knowledge and attitudes of AP Biology students.

I used two virtual simulations-Click and Clone and Virtual PCR; one hands-on simulation-Science Take Out Stem Cell Activity; and 2 labs-AP Biology Lab 6 and Alu-PV92 PCR lab. I added these to my traditional method of instruction using lecture and study guides (AP Lab 6 is also traditionally used).

My data clearly shows that the students' knowledge of molecular genetics increased as measured with a pre and post test. Some questions were on material that was covered with the additional activities and some were on material that was covered by lecture and study guides alone. There was also a difference there as the students show more gains on the questions associated with the activities. My AP Biology students had generally positive attitudes both before and after instruction.

In conclusion, using biotechnology simulations and labs increased knowledge over traditional instruction on molecular genetics topics. Attitudes were generally positive both before and after instruction.

Rationale: Molecular genetics is a very difficult topic for many AP Biology students. Many don't remember what they learned (or were not exposed to) in their previous biology class and therefore lack background knowledge to "hook" new ideas on to. I have never been completely satisfied with my normal mode of instruction which is as follows: Students read these chapters and complete teacher-designed study guides. Then I lecture, go over the study guides with them and watch and discuss some animations that come with the textbook that I use. Students also do Lab 6 from the AP Biology lab manual that goes along with this unit. However, there are some topics that are only covered by reading the chapter and doing the study guide, which may not be enough instruction for these concepts. In this study, I used a variety of hands-on and virtual simulations given to me in the Bench to Bedside summer institute. I also added a PCR lab in addition to Lab 6 which is a required lab.

My first goal was to increase student knowledge in biotechnology. Biotechnology has been given fleeting attention in public schools. Public perception of biotechnology had "drifted far from reality" (Braun and Moses 2004). It is clear that both adults and high school students (in traditional science classes) have limited knowledge of biotechnology. I believe that using the simulations (both hands-on and virtual) allowed students to experience biotechnology activities that are not available in the day to day classroom. Using a simulation also allowed students to repeat the experience until they "got it right" (Bergland, et. al., 2006). The simulations actively engaged students. "Computer simulations can provide a bridge between theory and experience when the simulations and hands-on activities are closely coupled" (Richards, Barowy, and Levin 1992).

My second goal was to influence attitudes of biotechnology in my students. In my experience attitude is correlated with knowledge. I used assessments that told me my students' attitudes before and after instruction in biotechnology. Although science and technology have made most peoples' lives better, many are suspicious, even fearful of it (Braun and Moses, 2004). People tend to fear the unknown. The data showed that an increase in knowledge led to more positive attitudes toward biotechnology. Mueller, Knobloch, and Orvis (2009) found that using hands-on activities and simulations led to increased knowledge and more positive views about biotechnology (than students who did not receive this type of instruction).

The purpose of this study was to use simulations and labs to augment the traditional instructional strategies for molecular genetics in AP Biology with the intention of increasing the knowledge and attitudes of AP Biology students.

Action Research Intervention: The molecular genetics unit of the AP Biology curriculum encompasses the structure of DNA, gene to protein and DNA technology and genomics. The activities I used to enhance instruction of the objectives are described below.

According to the AP Biology Topic Outline provided by the College Board (2009), Molecular Genetics includes the instructional objective of “Nucleic acid technology and applications.” This includes: a. current recombinant technologies, b. practical applications of nucleic acid technology, and c. legal and ethical problems that may arise from these applications.

A draft copy of the new curriculum framework for AP Biology for 2012-2013 from College Board (2010) uses the following standards that will include the activities I plan to use:

Essential Knowledge 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.

Learning Objective: The student can justify the claim that humans can manipulate heritable information by identifying at least two commonly used technologies.

Essential Knowledge 3.B.1: Gene regulation results in differential gene expression, leading to cell specialization.

Learning Objective: The student is able to explain how the regulation of gene expression is essential for the processes and structures that support efficient cell function.

Learning Objective: The student can use representations to describe how gene regulation influences cell products and function.

My objectives were to increase knowledge and understanding of these objectives by enhancing my traditional instruction with more biotechnology activities.

In addition to the traditional types of instruction (see first paragraph of rationale) that I normally used, I included two virtual simulations: Click and Clone and virtual PCR. I used the Click and Clone activity to reinforce the students’ knowledge of Somatic Cell Nuclear Transfer, which is a way to clone organisms. The virtual PCR was included so students could practice what they had learned about PCR, before they did the actual lab. General questions on both of these activities were on the pre- and post- tests and the lab write-up for PCR (virtual PCR). I used a hands-on simulation which was the Science Take Out activity on Stem Cells. The purpose of this activity was to reinforce what they had heard in lecture, by simulating real-world situations. Once again, there were questions on the pre- and post- tests on this activity. Lastly, I utilized the assistance of the CPET staff at University of Florida to do a PCR lab called PV92 (this is the field trip mentioned in my budget). Unfortunately no results were obtained

from this lab because the electrophoresis did not work. The students did enjoy the lab and saw the steps of PCR in action, as well as, how the products of PCR are then used to obtain data. I still believe the students' attitudes were positively affected due to the connections established with the knowledgeable presenter from University of Florida. Two classes of AP Biology performed these activities in November 2011 in my classroom and at the university.

Connections to Bench to Bedside Summer Institute: All of the additional activities I used came from my Bench to Bedside experience. I purchased the Stem Cell kits from Science Take Away. The PCR lab was performed with the assistance of the CPET staff at Forest High School.

Data Collection and Analysis:

Attitudes Survey: I have attached the attitudes survey and the graph of the results. I only tabulated the results of the agree/disagree questions on the graph. The results show that the students had positive attitudes both before and after the intervention, but the attitudes were slightly more positive afterwards.

Pre-Test and Post-Test Results: A copy of the test is included with the other documents. Students scored higher on all of the questions except the first one. I believe the "all of the above" response was automatically chosen by many of the students on the pre-test. The incorrect response shows that they were thinking more, but not always remembering all of the examples we discussed on the post-test. Two other graphs are included regarding the pre-test and post-test: Measures of Central Tendency and Breakdown of Question Topics. The Breakdown of Question Topics shows that gains were made for each intervention technique.

Literature Cited:

AP Biology College Board Professional Development Workshop Handbook (2009-2010). Topic Outline. www.collegeboard.com

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Mueller, A., Knobloch, N.A. & Orvis, K.S. (2009). The effects of an active learning biotechnology and genomics unit on high school students' knowledge, motivation, and learning experiences. *American Association for Agricultural Education Research Proceedings*, 272-275.

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Budget: The money was used to purchase a class set of the Stem Cell Kits and to pay for a sub and gas to get the students up to UF for the PCR Lab.

Permission: Students completed permission slips for the field trip to UF. Dr. Houda Darwiche also completed paperwork that permitted her to visit the Forest High School campus.

Modifications from the Original Proposal:

The only modification to my original proposal was that I was going to do a microarray simulation with my students. I was not able to fit that in, but I hope to do this in the future.

Learnings from my Action Research: All of the interventions worked in the sense that they increased my students' knowledge and improved their attitudes regarding biotechnology. Next time, I think I would have them do some of the virtual simulations at home with a questions sheet, so that I could make more time for other activities during class. I learned that it is not too difficult to get real data from the activities I do with my students to assess the effectiveness of those activities.

Dissemination: I meet with a group of teachers for lunch every day in my classroom, and shared my research with them, as well as my principal. Since I am a biology teacher, it has been difficult this year to do much more because of the implementation of the new standards and preparing for the state exam. I may investigate publishing this summer, if I find the process to be easy and straight forward.