Action Research Proposal

Biotechnology Explorations: Bench to Bedside

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Position: **High School Science Instructor, Trenton High School, Gilchrist County**

Title: **Application of Interactive Biotechnology Lessons in a Rural School to Assess Student Achievement and Attitudes**

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Abstract:

This action research project will explore the outcomes of the introduction of interactive biotechnology lessons into the rural high school, focused on 9th and 10th grade Biology I students. The focus of this intervention is to introduce concepts and hands on application of topics that have previously been considered non-core concepts to a population that is generally disinterested in science. My action research will measure not only if student achievement on complex concepts improves with direct hands on activities, but also if the general attitude towards science will be changed as well.

Rationale:

I have observed a general disinterest in science amongst high school students in the rural communities. I hypothesis this attitude is related to two preconceived notions: the first is general misconception that "science is boring." This general feeling of boredom could be related to Altiparmak and Nakiboglutezer's idea that to the student "classroom learning is inadequate:

> *Many students have heard the term biotechnology or recombinant DNA, but most of them probably could not explain the difference between the concepts. Students also have trouble in visualizing the structure of DNA, replication, central dogma, protein synthesis, and the techniques of DNA cloning. Instruction-based lecture with no other pedagogical applications yields unsatisfactory results. Students lack a motive to learn the subject as they find classroom learning inadequate.*
> (Altiparmak & Nakiboglutezer, 2009)

The authors go on to explain that as modern teachers we must view students as "active participants of the learning process" which is the ultimate goal in my classroom; a goal that I will be measuring through my biotechnology based action research. Ebenezer and Zoller (1993) observed while studying 10th grade students that their "enjoyment" of science directly related their comprehension of the subject material. I propose that an active learning driven instructional unit will enhance student comprehension and therefore their enjoyment of the material. This idea is supported by Stohr-Hunt's 1996 study on hands-on experience and science achievement:

> *…it was concluded that significant differences existed across the hands-on frequency variable with respect to science achievement. Specifically, students who engaged in hands-on activities every day or once a week scored significantly higher on a standardized test of science achievement than students who engaged in hands-on activities once a month, less than once a month, or never* (page 101).

The second general observation I have made about the attitudes of rural students regarding science is they are generally uneducated about the broad spectrum of biotechnology related careers available. By applying a synergistic biotechnology unit I believe that students will not only be able to understand difficult science concepts, as measured by various assessments, after participating in innovative and interactive hands on practices, they will also be exposed to the vast career possibilities at all education levels available in the world of biotechnology and applied sciences. The purpose of this study is to investigate the efficacy of interactive biotechnology application in the classroom on the attitudes related to science and

careers in the biotechnology field, and achievement on various assessments in rural high school students.

Action Research Intervention:

My research will be performed with Biology I students, who are primarily freshmen and sophomores, in a rural and socio-economically disadvantaged region. This intervention will occur after the central dogma and genetics units. The intervention will consist of a 2 week long unit with multiple teamwork projects. The focus of the project will be on molecular genetics and will being with a genetic screening activity while exploring enzyme function through restriction digest analysis. Each team will then perform a BLAST Analysis search on the National Center for Biotechnology Information website to find out which disorder they screened via the restriction digest. Finally students will create a model of the protein causing the disorder the found using the BLAST tool, with the assistance of the RCSB Protein Data Bank. Students will also perform biotechnology career research throughout this unit and report via their class blogs. Please see the attached lesson plan and budget break down for further details.

Funding is provided by CPET's Biotechnology Explorations: Bench to Bedside Program and additional funding sources through the GCSD. I have already obtained the media releases required for this action research project through my district and with my students.

Bench to Bedside Connection:

This action research project will not only introduce rural students to advanced biotechnology practices, it will link them to a world of research that is creating medial therapies and protocols from the roots of classic bench top science and developing new technology inspired by disorders in at the bedside. By introducing this unit after the study of Medellin genetics my students will see the connections between classical biology and new biotechnology advancements. One of my goals embedded within this action research project is to teach my students about the vast career opportunities available within the biotechnology field and I hope that after exposure to the exciting new technology that is driving biotechnology explorations from the bench to the bedside, some of them will be motivated to join the medical research industry.

Data Collection and Analysis:

The types of data collection I will use are both quantitative and qualitative. The quantitative methods will include, but are not limited to: traditional pre and post tests and/or quizzes; rubric graded student projects and concept map construction; as well as surveying using a Likert scale. My qualitative assessments will include, but are not limited to: online "blogging" journal entries and video journaling. I will perform statistical analysis as are appropriate upon the completion of my quantitative data collection. To assess the qualitative responses I will look for general trends with a focus on students who report a change in attitude in regards to science and biotechnology careers.

Works Cited:

ALTIPARMAK, Melek, and Mahmure NAKIBOGLU TEZER. "Hands on Group Work Paper Model for Teaching DNA Structure, Central Dogma and Recombinant DNA." *US China Education Review* 50th ser. 6.1 (2009): 19-23.

Ebenezer, J. V., and Zoller, U . “Grade 10 students’ perceptions of and attitudes toward science teaching and school science.” *Journal of Research in Science Teaching* 30 (1993): 175–186.

Stohr-Hunt, Patricia M. "An Analysis of Frequency of Hands-On Experience and Science Achievement." *Journal of Research in Science Teaching* 33.1 (1996): 101-09.

Bench to Bedside Lesson Plan

Theme: Using Biotechnology for Genetic Analysis

Lesson Title	Man, that Family is Wack!
Grade Span	9-11th (mixed section)
Content Emphasis (Mathematics or Science)	Biology I
Targeted Benchmark(s)	**SC.912.L.16.10***DNA Biotechnology and Impact on Human Society, Medical and Ethical Issues, **SC.912.L.16.2***Discuss Inheritance Patterns with Dominant, Recessive, Codominance, Sex-Linked, Polygenic and Multiple Alleles**, HE.912.C.1.4***Analyze Heredity & Family History
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District	Gilchrist

Lesson Preparation

Learning goals: What will students be able to do as the result of this lesson?

Upon competition of this unit lesson students will be able to analyze an enzyme digest of a gene segment to construct a family pedigree tracking a single gene disorder, use the BLAST tool to determine the cause of the disorder and then reference the PDB to construct a model of the protein related to the genetic disorder. Students will also be able to see the practical application of biotechnology and find information about careers in the biotechnology fields.

Estimated time: Please indicate whether this is a stand-alone lesson or a series of lessons.

This project will consist of multiple lessons and activities that will span approximately 2 weeks of class time.

Materials/Resources: Please list any materials or resources related to this lesson.

Carolina Scientific: Nature's Dice- A Genetic Screening Simulation Kit (Item # 211018): $279*
Classroom Set of Micropipettes and tips: On loan from the program
96 well plates for pipetting practice-THS storage room
Styrofoam balls, modeling foam and clay for protein modeling-THS storage room

*****Additional funding will be provided by the THS Science Department

Teacher Preparation: What do you need to do to prepare for this lesson?

In addition to purchasing the Carolina Scientific kits: Nature's Dice-A Genetic Screening Simulation Kit for the restriction enzyme digest I need to look up the nucleotide sequences for my students to complete the BLAST search and have materials available for them to construct protein models, based on the information on the PDB.

Lesson Procedure and Evaluation

Introduction: Describe how you will make connections to prior knowledge and experiences and how you will uncover misconceptions.

In this lesson I plan to connect student's previous knowledge of basic Medellin genetics and human pedigrees with the application of genetic screening and the tracking of genetic disorders throughout family histories.

Through the student analysis of the DNA fragments I will be able to determine how well they understand both the concepts of restriction enzyme sites on the DNA in addition to the process of human genetics and heredity.

Exploration: **Describe in detail the activity or investigation the students will be engaged in and how you will facilitate the inquiry process to lead to student-developed conclusions.**

Upon completing of the "Nature's Dice" Genetic Screening kit (see product description at the end of this document) students will be provided with a nucleotide sequence to perform a BLAST search on. They will have to determine from the information in the data base which disorder their sequence is related too. Students will be provided with a "normal" nucleotide sequence so they can connect the concept of mutations driving genetic disorders. Students will also model the protein related to their disorder, which will enforce how point mutations can cause misfolding of proteins and thus change/inhibit the protein's function.

Application: **Describe how students will be able to apply what they have learned to other situations.**

Students will be better able to visualize how DNA is translated and transcribed after seeing how the restriction enzymes cleave the DNA into fragments. This lesson will also give students an hands on opportunity to experience working with biotechnology and possibly inspire them to pursue careers in medical research and biotechnology.

Assessment: **Describe how student knowledge is being assessed at the appropriate cognitive level for the targeted benchmarks.**

The students will be assessed at each step of the unit, including a complete lab report for the restriction enzyme digest, a BLAST report (rubric graded), and a protein model (rubric graded). Students will report on their progress via their blogs (rubric graded) and the entire unit will be traditionally assessed with a pre/post test.

<u>Teacher Self-Reflection:</u> Record your thoughts on the lesson and describe any modifications you would recommend based on the outcomes.

This will be completed at the end of the unit.

From the Carolina Scientific Website: *Students receive a 24-member family tree and DNA samples presumably taken from each family member. They determine the genotype of each of the relatives by cutting the DNA samples with a restriction enzyme and separating the fragments by gel electrophoresis. The genotypes revealed by the class are used to determine the pattern of inheritance of the "gene" being analyzed and to predict each person's phenotype. In this simulation, the teacher and students choose a fictitious phenotype to link to the gene, although the principles and issues raised would apply to real situations.*