The Effect of Hands-On Biotechnology Activities and Video Games on the Attitudes, Knowledge, and Career Awareness of Students in a High School Medical Academy

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Abstract: The purpose of this paper is to share the results of a study that focused on the effects of hands-on biotechnology activities and video games on the knowledge, attitudes, and career awareness of a group of medical academy students. Biotechnology careers are not commonly covered in the constructs of a medical career academy. This study will look at how biotechnology may be a viable curriculum choice for this population of students.

Rationale: A Medical Laboratory Assisting program is being started at Park Vista Community High School during the 2010-2011 school year. As part of my action research, I would like to see the feasibility of adding a 9 week biotechnology component to this course. In the past, a biotechnology component was not offered in any of the medical academy courses for the following three reasons: (1) resources to teach this portion of the course were not readily available; (2) teachers on staff were not adequately trained in this field; and (3) opportunities for clinical/real-world applications were not accessible. After attending the “Bench to Bedside” program this summer at University of Florida, I would like to try to incorporate a biotechnology unit into the Medical Laboratory Assisting curriculum. I feel that by attending this program that the 3 barriers that previously existed for delivering this program at my school were removed. I feel that I have obtained valuable resources for my classroom that I can use for my research and the training necessary to teach this subject. In addition, I have the opportunity to provide my students with real-world/clinical applications by providing them with hands-on labs and computer simulations on pipetting techniques, DNA extraction, Polymerase Chain Reaction (PCR), Reverse Transcription (RT) and gel electrophoresis.

It has been determined that teachers have not readily adopted curriculum related to biotechnology into their curriculum (Stotter, 2004). This was definitely the case at my high school as was mentioned above. In response to this finding, Stotter offered a two week unit on biotechnology and agriculture to two classes of high school technology education students. The students from this study demonstrated significant gains in knowledge about agriculture and biotechnology and they also showed a greater level of acceptance of genetically engineered products. In addition, the students in this study also reported that they felt that “learning about biotechnology issues is an important part of their education and that biotechnology is not covered in other classes.” I would like to determine if the same results might be true in my medical academy students.

Hands-on activities as it relates to delivering science curriculum has been widely studied in the literature. Stohr-Hunt (1996) stated that “teachers in hands-on science classrooms should be concerned with actively motivating and involving students in experiences that will in some way extend the students knowledge and understanding of the science context being studied.” Hands-on science is “any educational experience that actively involves students in manipulating objects (Haury & Rillero, 1994).

The effectiveness of various hands-on science activities has been evaluated. Stohr-Hunt (1996) determined that students that engaged in hands-on activities frequently (defined as every day or once a week) scored significantly higher on standardized achievement tests then students that did not use hands-on activities as frequently (defined as once a month, less than once a month, or never). In addition, Mueller, Knobloch, & Orvis (2009) found that a high school program that included hands-on learning (including
computer-based) had higher levels of learning and more positive views on learning about biotechnology then students that did not participate in hands-on learning.

The purpose of this study is to use the Mission Bio-Tech video game and curriculum and various hands-on biotechnology activities to measure changes in attitudes, knowledge, and level of career awareness in high school medical academy students.

**Action Research Intervention:** I plan to implement a 9 week biotechnology curriculum in two of my Medical Lab Assisting 3 classes. I will start this by introducing the concept of biotechnology by watching the movie, “Extraordinary Measures.” By watching the movie, I would like my students to see the impact that biotechnology research can have on patients. We will also discuss what “Bench to Bedside” really means.  (Please see attached lesson plan on this topic) I plan to use the Mission Bio-Tech video game and curriculum to introduce biotechnology concepts and careers to my students.  In addition, I will use a hands-on pipetting lab, two gel electrophoresis labs, a simplified pGlo lab, and a simulated ELISA lab to give my students a hands-on experience of real-life biotechnology techniques.  I anticipate doing this research during the period of August through October 2010.

**Connections to Bench to Bedside Summer Institute:** Mission Bio-tech Video Game and Curriculum, “Extraordinary Measures” Movie, pipetting lab, gel electrophoresis techniques, pGlo lab, and simulated ELISA testing.

**Data Collection and Analysis:** I will be using Dr. Sadler’s evaluation instruments for the Mission Biotech program.  In addition, I plan to use the following evaluation tools:

- journal notes of daily class activities
- skills checklist for the pipetting lab
- small student focus group sessions to discuss attitudes about biotechnology, biotechnology careers and what worked and what didn’t work with the 9 week biotechnology curriculum

**Budget:**

- 96 Well Microtiter Plates-Package of 6-$19384 $30.00 (Fisher Scientific)
- Transformation of E.Coli with a Plasmid Containing the Gene for the Green Fluorescent Protein (GFP) Lab-$68654: $85.00 (Fisher Scientific)
- Microcentrifuge Tubes-Package of 500-$34890-3-$19.50 (Fisher Scientific)
- Cube Racks-Pack of 5-$732104-$44.95 (Carolina)

Total Cost of Items: $179.45 with the remainder of the money going to shipping and handling of the materials for a total budget of $200.00.  These items will be used for the hands-on labs that I will do with my students.
Literature Cited:


Permissions: Mission Biotech Permission Forms, Parent Letter to inform parents about research, Focus group permission form, Photo Release Form
<table>
<thead>
<tr>
<th>Lesson Title</th>
<th>Introduction to Biotechnology Why is it important?</th>
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<td>Grade Span</td>
<td>11-12</td>
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<tr>
<td>Content Emphasis (Mathematics or Science)</td>
<td>Science</td>
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<tr>
<td>Targeted Benchmark(s) – Florida Sunshine State Standards</td>
<td>SC.912.L.16.6: Discuss the mechanisms for regulation of gene expression in prokaryotes and eukaryotes at transcription and translation level. SC.912.L.16.7: Describe how viruses and bacteria transfer genetic material between cells and the role of this process in biotechnology. SC.912.L.16.10: Evaluate the impact of biotechnology on the individual, society, and the environment, including medical and ethical issues.</td>
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<tr>
<td>Author(s)</td>
<td>Allison Moyel</td>
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<tr>
<td>School</td>
<td>Park Vista Community High School</td>
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<td>District</td>
<td>Palm Beach</td>
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### Lesson Preparation

**Learning goals:**

As a result of this lesson, students will become familiar with the impact that biotechnology research has on the development of therapies and potential cures for diseases.

As a result of this lesson, students will understand what biotechnology and genetic engineering are and be able to apply this understanding to real-world uses of this technology including discussions such as ethics, clinical trials, and regulatory body control of biotechnology.

As a result of this lesson, students will become familiar with career opportunities in the field of biotechnology.

**Estimated time:** This lesson will require approximately 2 1/2 90 minute block periods or 4 50 minute class periods to complete.

**Materials/Resources:**

"Extraordinary Measures" DVD & Student Study Guide

Clip of Dr. Barry Byrne-chief researcher for Pompe Disease:
http://news.medinfo.ufl.edu/articles/top-stories/byrne-is-no-stranger-to-extraordinary-measures-it-comes-to-pompe-disease/

Movie clip of a boy who has Pompe Disease:
http://phoenixfox.net/index.html

Biotechnology Careers PowerPoint:

Biotechnology and Genetic Engineering PowerPoint:
microvet.arizona.edu/courses/mic205/10geneng/geneticengineering.ppt
Extraordinary Measures Study Guide

Name____________________________________________________________

1. What unusual physical characteristics do you notice about the little girl (Meagan) and her brother (Patrick) at the beginning of the movie? List at least 3 of these characteristics.

1. What disease do these 2 children have? __________________________
   What is the average lifespan for a person with this disease? ____________

1. What do patients with this disease suffer from? (i.e. what symptoms do they have?)

   Is there currently a drug to treat this disease? Yes or No

1. What happened to Meagan when she was hospitalized?

1. Where did John go after Megan had her first episode in the hospital?

1. According to Dr. Stonehill, what causes this disease? What is his theory for a cure?

1. It takes many years of research before a drug/therapy can be even sent to clinical trials. How long had Dr. Stonehill been working on his research?
1. How much are the medical costs for the Crowley’s two kids per month?

1. What does Meagan give to Dr. Stonehill when he visits?

1. What does Mrs. Crowley mean by her statement, “Do we just accept our fate and do what the well meaning doctors say and wait for the worst to happen, or do we fight it?” What do you think you would do if you were in this position?

1. What difference did the Crowley’s notice with Patrick when he was feeding the ducks? How is this related to the progression of his disease?
   
   Why did the invest in the clinical trials with this drug therapy in a reasonable timeframe? Don’t you think this area is a real time frame? Why or why not?

1. Explain what Dr. Stonehill meant by the following comment: “I don’t care about the money, I am a scientist.”

1. What do you think the term “orphan drug” means?

1. Describe your feelings after the Temple family told/shared their story about their two girls at the fundraiser event.
1. How old was Lauren when she passed away?

1. Decisions have to made as to who can participate in clinical trials. Imagine that you had a child who could be potentially cured from a horrible disease by participating in a clinical trial. However, your child does not qualify for the clinical trial. What would you do? Explain your answer.

1. What is a sibling clinical trial?

1. Why was John Crowley’s job in the biotech company a conflict of interest?

1. At the end of the movie, how did Dr. Stonehill know that the therapy worked on Meagan and Patrick?
**Extraordinary Measures Study Guide (Key)**

Name____________________________________________________________

1. What unusual physical characteristics do you notice about the little girl (Meagan) and her brother (Patrick) at the beginning of the movie? List at least 3 of these characteristics.
   *Both are in a wheelchair*
   *Both are on a ventilator*
   *Both have poor head control*

1. What disease do these 2 children have? *Pompe Disease*
   What is the average lifespan for a person with this disease? 9 years

1. What do patients with this disease suffer from? (i.e. what symptoms do they have?) *Muscle deterioration in every part of the body* - *Enlarged heart*

   Is there currently a drug to treat this disease? *No*

1. What happened to Meagan when she was hospitalized?
   *She went into cardiac arrest and almost died*

1. Where did John go after Megan had her first episode in the hospital?
   *Nebraska*

1. According to Dr. Stonehill, what causes this disease? What is his theory for a cure?
   *The enzyme glycogen builds up in the skeletal muscle and the body can’t break it down. The glycogen builds up in the heart and skeletal muscle and the diaphragm fails to work properly. His theory is to make the enzyme nano-6-phosphate and get more of it into the cells so that the cells can break down the glycogen.*
1. It takes many years of research before a drug/therapy can be even sent to clinical trials. How long had Dr. Stonehill been working on his research?

10 years

1. How much are the medical costs for the Crowley’s two kids per month?

$40,000

1. What does Meagan give to Dr. Stonehill when he visits?

An orange goldfish

1. What does Mrs. Crowley mean by her statement, “Do we just accept our fate and do what the well meaning doctors say and wait for the worst to happen, or do we fight it?” What do you think you would do if you were in this position?

Why di…

Answers will vary

1. What difference did the Crowley’s notice with Patrick when he was feeding the ducks? How is this related to the progression of his disease?

He couldn’t throw bread to the ducks; this shows that his disease is progressing.

They wanted the drug therapy in clinical trials within a year because the sooner they could test it, the sooner it could potentially go to market and they could make an investment. Answers will vary for the second question.
1. Explain what Dr. Stonehill meant by the following comment: “I don’t care about the money, I am a scientist.”

_He doesn’t care about the money... he is more interested in seeing his research succeed._

1. What do you think the term “orphan drug” means?

_An orphan drug is a drug used to treat a disease of low incidence._

Describe your feelings after the Temple family told/shared their story about their two girls at the fundraiser event.

_Answers will vary._

1. How old was Lauren when she passed away?

_9 years old_

1. Decisions have to made as to who can participate in clinical trials. Imagine that you had a child who could be potentially cured from a horrible disease by participating in a clinical trial. However, your child does not qualify for the clinical trial. What would you do? Explain your answer.

_Answers will vary_

1. What is a sibling clinical trial?

_Siblings with the same genetic disease participate in a clinical trial together_

1. Why was John Crowley’s job in the biotech company a conflict of interest?

_He was working for the company that was developing a drug to treat a disease that his children had. If they were chosen for a clinical trial, it would be considered a conflict of interest or favoritism._

1. At the end of the movie, how did Dr. Stonehill know that the therapy worked on Meagan and Patrick?

_They were laughing because they were on a sugar high. The glycogen could break down to sugar in their cells._
The Effect of Hands-On Biotechnology Activities and Video Games on the Attitudes, Knowledge, and Career Awareness of Students in a High School Medical Academy

Allison Moyel, MHSE, MT (ASCP)
Health Occupations Teacher
Park Vista Community High School
GOALS/OBJECTIVES

• To determine if a 9-week biotechnology curriculum should be included in the Medical Lab Assisting course in the Medical Academy

• To determine if hands-on activities and video games are useful instructional tools for medical academy students

• To determine if this type of curriculum would change knowledge, attitudes, and career awareness of biotechnology in this population of students
METHODS

Mission Biotech Video Game and Lesson Plans on: Viruses, Lab Equipment, DNA Extraction, PCR, PCR Analysis, & Biotechnology Careers

Hands-on Activities:
- Strawberry DNA Extraction Lab
- Outbreak Electrophoresis Lab
- Pipetting Lab & Competency
- Simulated ELISA Lab

Videos/Simulations:
- Extraordinary Measures Movie with Study Guide
- “Immune Attack” Video
- Bio-Rad PCR Song
- DNA Extraction Simulation
- PCR Simulation
- “A Day in the Life of a Child with Pompe Disease”

Other Instructional Materials:
- “Genetic Engineering” PowerPoint
- “Preparing Students for Careers in Biotechnology” PowerPoint
- Virus PowerPoint Project
- Biotechnology Careers Poster Project
ASSESSMENT METHODS

- Pre- and Post-testing on knowledge, attitudes, and career awareness (3 Mission Biotech Evaluation Instruments)
- Mission Biotech Student and Teacher Feedback
- Student Focus Groups
- Teacher Observation
- Pipetting Competency Checklist
- Project Rubrics (Career Poster & Virus Paper)
- Lab Equipment Quiz
OUTCOMES-PRE/POST-TESTS

Knowledge about Science Related to Biotechnology Scores (20)
  Pre-Test Mean Score: 12.37
  Post-Test Mean Score: 15.10

Mission Biotech Content Scores (20)
  Pre-Test Mean Score: 10.57
  Post-Test Mean Score: 15.63

Attitudes Toward Science and Technology Scores (100)
  Pre-Test Mean Score: 76.80
  Post-Test Mean Score: 74.77
FOCUS GROUP QUESTIONS

1. What was your knowledge of biotechnology prior to this class?
2. How do you think you learn the best? What teaching methods work best for you?
3. What activities did you like best and why?
4. What activities did you like the least and why?
5. What are things you would like to learn more about?
6. What items should be left out of the curriculum?
7. What is your opinion about biotechnology careers? Would you consider a career in biotechnology?
8. Do you think the curriculum should be used next year and why?
9. What knowledge do you feel you gained as result of this curriculum?
10. Is there anything else that you would like to add?
FOCUS GROUPS-
SUMMARY OF OUTCOMES

• Students did not have much prior knowledge about biotechnology
• A majority of students responded that they learn best visually and by doing things “hands-on”
• The students liked the ELISA lab, the DNA Extraction lab, the Outbreak Electrophoresis Lab, the Pipetting Lab, and the Extraordinary Measures movie the best of all of the activities in the curriculum
• The students liked the Mission Biotech video game, the PCR Analysis Lesson, and the Virus Lesson/Research Project the least of all of the activities included in the curriculum
FOCUS GROUPS-
SUMMARY OF OUTCOMES

• Students were interested in learning more about the process of curing diseases, careers in biotechnology, and how biotechnology relates to forensics
• Students indicated that the Mission Biotech Video Game, PCR Analysis, and Virus Lessons should all be left out of the curriculum
• 30% of students (6 of 29) would consider a career in biotechnology
• 86% of students (25 of 29) felt that this curriculum should be used next year
• Students felt the knowledge they gained was in the area of PCR, DNA Extraction, pipetting, and lab equipment
My thoughts…. 

• Students were actively engaged with this curriculum! Hands-on activities work!
• I would definitely like to continue this curriculum with my students for next year!
• I would like to get the Mission Biotech installation/server issues resolved because I think the curriculum would have been enhanced greatly had my students been able to finish playing the game
• I would choose to do this curriculum during the last 9 weeks instead of the first 9 weeks
The Effect of Hands-On Biotechnology Activities and Video Games on the Attitudes, Knowledge, and Career Awareness of Students in a High School Medical Academy

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Abstract: The purpose of this study was to use action research to determine the effects of hands-on biotechnology activities and video games on the knowledge, attitudes, and career awareness of medical academy students. A movie, hands-on labs, and the Mission Biotech curriculum and video game were used during my study. Pre- and post-tests were given to students to assess knowledge and attitudes about science and biotechnology. In addition, focus groups and teacher observation were used to evaluate prior knowledge about biotechnology, perceptions of knowledge gained on the topic of biotechnology, biotechnology career awareness, and preferred learning styles. Results of the study showed gains in knowledge and career awareness and a mixed result of both positive and negative attitudes toward science and biotechnology depending on the instrument used. Based on these results, it was determined that this type of biotechnology curriculum may be a valuable addition to medical career academy courses.

Rationale: A Medical Laboratory Assisting program is being started at Park Vista Community High School during the 2010-2011 school year. As part of my action research, I wanted to see the feasibility of adding a 9 week biotechnology component to this course. In the past, a biotechnology component was not offered in any of the medical academy courses for the following three reasons: (1) resources to teach this portion of the course were not readily available; (2) teachers on staff were not adequately trained in this field; and (3) opportunities for clinical/real-world applications were not accessible. After attending the “Bench to Bedside” program last summer at University of Florida, I wanted to try to incorporate a biotechnology unit into the Medical Laboratory Assisting curriculum. I felt that “Bench to Bedside” helped remove the 3 barriers that previously existed for delivering this program at my school. I obtained valuable resources for my classroom that I could use for my research and the training necessary to teach this subject. In addition, I have the opportunity to provide my students with real-world/clinical applications by providing them with hands-on labs and computer simulations on Pipetting Techniques, DNA Extraction, Polymerase Chain Reaction (PCR), and Gel Electrophoresis.

It has been determined that teachers have not readily adopted curriculum related to biotechnology into their curriculum (Stotter, 2004). This was definitely the case at my high school as was mentioned above. In response to this finding, Stotter offered a two week unit on biotechnology and agriculture to two classes of high school technology education students. The students from this study demonstrated significant gains in knowledge about agriculture and biotechnology and they also showed a greater level of acceptance of genetically engineered products. In addition, the students in this study also reported that they felt that “learning about biotechnology issues is an important part of their education and that biotechnology is not covered in other classes.” I would like to determine if the same results might be true in my medical academy students.

Hands-on activities as it relates to delivering science curriculum has been widely studied in the literature. Stohr-Hunt (1996) stated that “teachers in hands-on science classrooms should be concerned with actively motivating and involving students in experiences that will in some way extend the students knowledge and understanding of the science context being studied.” Hands-on science is “any educational experience that actively involves students in manipulating objects (Haury & Rillero, 1994).
The effectiveness of various hands-on science activities has been evaluated. Stohr-Hunt (1996) determined that students that engaged in hands-on activities frequently (defined as every day or once a week) scored significantly higher on standardized achievement tests then students that did not use hands-on activities as frequently (defined as once a month, less than once a month, or never). In addition, Mueller, Knobloch, & Orvis (2009) found that a high school program that included hands-on learning (including computer-based) had higher levels of learning and more positive views on learning about biotechnology then students that did not participate in hands-on learning.

The purpose of this study is to use the Mission Bio-Tech video game and curriculum and various hands-on biotechnology activities to measure changes in attitudes, knowledge, and level of career awareness in high school medical academy students.

**Action Research Intervention:** I implemented a 9 week biotechnology curriculum in two of my Medical Lab Assisting 3 classes from 8/31/10 to 10/14/10. Each class had 15 Junior Level High School Medical Academy Students.

I started my unit on biotechnology with a lesson that I developed entitled, “Introduction to Biotechnology-Why is it important?” *(Please see Exhibit 1 at the end of the report.)* This lesson used the movie, “Extraordinary Measures” to demonstrate to students the impact that biotechnology research can have on curing diseases. The students were given a study guide to complete while watching the movie and the answers were discussed at the conclusion of the movie. In addition, a short video about an actual child that had Pompe disease and a researcher working on a cure for the disease were shown to students to exhibit a real world example of how biotechnology can help cure diseases. This lesson was concluded with an introduction to what biotechnology and genetic engineering are, how they are currently being used, and careers that are available in this field.

Next, I began the implementation of the Mission Biotech curriculum and video game. I utilized the lesson plans entitled “Viruses”, “Biotechnology Equipment, Hazardous Waste, and Safety”, “DNA Extraction”, Polymerase Chain Reaction, “Real-Time PCR Analysis”, and “Biotechnology Careers” from the Mission Biotech teacher curriculum. In addition, most of my students were able to proceed through Level 1 of the Mission Biotech game. School computer server issues and trouble loading the Mission Biotech software on my student’s computer after many attempts prohibited them from getting the full benefit of experiencing the entire game. The hands-on activities that my students were able to do with the Mission Biotech curriculum included designing the Virus Power Points, the Strawberry DNA Extraction lab and the designing of Biotechnology career posters. *(I have attached some student samples of the Virus Power Points -Exhibit 2, Virus PowerPoint Rubric-Exhibit 3, and pictures of Career Posters-Exhibit 4 at the end of the paper.)*

After the Mission Biotech curriculum and labs, I did an ELISA simulation lab that demonstrated how the technique works and real-world applications for the use of ELISA (i.e. allergy & HIV testing). I finished my unit on biotechnology with a unit on pipetting and gel electrophoresis. I taught my students how to pipet and did a pipetting lab with them to practice their techniques. In addition, the students used their pipetting technique to do the “Outbreak Electrophoresis Lab” This gel electrophoresis lab showed students...
how they could determine the strain of virus that was causing an outbreak at their high school.  (*Please see Exhibits 5 & 6 at the end of this paper to see this lab and a video of the students participating in this lab.*) As a follow-up to the pipetting lab, I gave the students a pipetting competency to demonstrate their mastery of this skill.  (*Please see Exhibit 7 at the end of the paper for the Pipetting Competency Rubric.*)

**Connections to Bench to Bedside Summer Institute:** During my 9-week curriculum intervention, I used the Mission Bio-tech Video Game and Curriculum, “Extraordinary Measures” movie, ELISA 96-well Pipetting Lab, gel electrophoresis techniques, and simulated ELISA testing that I learned at the “Bench to Bedside” Summer Institute.

**Data Collection and Analysis:** Before I started my unit on biotechnology, I gave the students 3 different post-tests that assessed their attitudes towards biotechnology, their knowledge about science related to biotechnology, and their knowledge of content that was going to be specifically addressed in the Mission Biotech curriculum and video game. At the conclusion of the Mission Biotech curriculum and use of the video game, I gave the students the same three tests administered previously as post-tests. Here is what my data showed:

- **Knowledge about Science Related to Biotechnology Scores (High Score-20)**
  - Pre-Test Mean Score: 12.37
  - Post-Test Mean Score: 15.10

- **Mission Biotech Content Scores (High Score-20)**
  - Pre-Test Mean Score: 10.57
  - Post-Test Mean Score: 15.63

- **Attitudes Toward Science and Technology Scores (High Score-100)**
  - Pre-Test Mean Score: 76.80
  - Post-Test Mean Score: 74.77

Students demonstrated an increase in knowledge in both science related to biotechnology and Mission Biotech, but demonstrated a decrease in attitudes towards science and technology. I attribute the problems with the Mission Biotech video game to the decrease in attitudes that were shown in this study. Had the video game worked properly, the scores may have been much different. I believe the increase of knowledge shown was due to the fact that the activities that I did with the kids were interesting to them and effective in allowing them to learn the required concepts.

At the conclusion of the entire 9-week curriculum, I conducted focus groups with both of my classes to assess their views on their learning styles, perceived knowledge gained in the area of biotechnology, attitudes toward biotechnology, and career awareness of biotechnology. I asked a series of 10 questions to all of the student participants. (*See Exhibit 8 at the end of this paper*) The results of the focus group produced the following outcomes:

- Students did not have much prior knowledge about biotechnology
- A majority of students responded that they learn best visually and by doing things “hands-on”
• The students liked the ELISA lab, the DNA Extraction lab, the Outbreak Electrophoresis Lab, the Pipetting Lab, and the Extraordinary Measures movie the best of all of the activities in the curriculum.
• The students liked the Mission Biotech video game, the PCR Analysis Lesson, and the Virus Lesson/Research Project the least of all of the activities included in the curriculum.
• Students were interested in learning more about the process of curing diseases, careers in biotechnology, and how biotechnology relates to forensics.
• Students indicated that the Mission Biotech Video Game, PCR Analysis, and Virus Lessons should all be left out of the curriculum.
• 30% of students (6 of 29) would consider a career in biotechnology.
• 86% of students (25 of 29) felt that this curriculum should be used next year.
• Students felt the knowledge they gained was in the area of PCR, DNA Extraction, pipetting, and lab equipment.

The results of the focus group indicate that hands-on activities are effective with both engaging students in the curriculum and increasing their knowledge of the subject being addressed. Students felt that they had more of an awareness of biotechnology and biotechnology techniques at the conclusion of this curriculum, even though they might not necessarily choose it as a future career. I would attribute the fact that only 30% would choose this as a career because a lot of my students have already chosen a career to pursue. I also encouraged that 86% of this students thought that this curriculum was interesting enough to be used next year.

Budget:
• 96 Well Microtiter Plates-Package of 6-S19384 $30.00 (Fisher Scientific)
• Transformation of E.Coli with a Plasmid Containing the Gene for the Green Fluorescent Protein (GFP) Lab-S68654: $85.00 (Fisher Scientific)
• Microcentrifuge Tubes-Package of 500-S34890-3-$19.50 (Fisher Scientific)
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Total Cost of Items: $179.45 with the remainder of the money going to shipping and handling of the materials for a total budget of $200.00. These items will be used for the hands-on labs that I will do with my students.
Literature Cited:


Permissions: Mission Biotech Permission Forms, Parent Letter to inform parents about action research, Photo Release Form

Modifications from Original Proposal: The modifications that I made from my original proposal were the following: (1) I decided to do my action research with my Medical Lab Assisting classes rather than my Allied Health Assisting classes; and (2) I did not incorporate the pGlo lab in my activities for my action research because I did not have access to an incubator to do the lab.
**Learnings from Action Research:** The hands-on activities associated with the curriculum worked well in increasing awareness and knowledge of biotechnology! The Mission Biotech video game was a huge frustration with this project. I was able to load the software onto the computers at my school, however the district server in my county blocked the ability to be able to save the game where the students left off. Therefore, the students would have to restart the game every class period from the beginning. I also tried to have the students load the game on their home computers and they still had trouble either loading the game or being able to save it. As a result of this problem, my students only really got to experience through Level 1 of the game. It is my hope that these problems can be fixed, so that my next group of students next year can use this resource.

The only thing that I would do differently next time is try any computer programs used ahead of time to make sure that they work properly and that things would go more smoothly. I think a lot of wasted time and frustration could have been prevented if this had been done ahead of time.

I learned a great deal in doing the action research process. I learned that my students are more actively engaged in their work if they are doing hands-on activities or doing something they find interesting. I feel like my students were more actively engaged in their work because they loved what they were doing. This is evident in the pictures that I have attached as part of the video presentation. (Exhibit 6)

**Dissemination:** I have shared the materials from “Bench to Bedside” with several teachers at my school. In addition, I have had my principal visit my classroom to see how actively engaged my students are in this material. He was highly impressed with the technologically advanced techniques that I was able to bring to the classroom. My students were very interested in hearing about the outcomes of my research and I shared it with them in February 2011. In addition, I presented my findings of this research to my “Bench to Bedside” colleagues at a JSEHS in February, 2011. I would be extremely interested in further presenting this research at other conferences and possibly publishing this material in an appropriate forum.