Evaluating the Effectiveness of Inquiry Based Biotechnology Lessons on Attitudes and Real-World Application of Information to Multi-Ethnic International Baccalaureate Students

by

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Abstract:

This paper serves as a vehicle to explain the effectiveness of inquiry-based instruction of biotechnology lessons on attitudes and applications of multi-ethnic groups in the IB program. The aim is to study the effects of integrating inquiry-based learning into the curriculum and measuring student retention and receptiveness towards topics subjects across the biotechnology curriculum.

Rationale:

The Middle Years Program of the International Baccalaureate program has been at Atlantic High School since 1995. The MYP is the ninth and tenth grade component that students must successfully complete before they are allowed to enter the IB program. Once students have entered into the IB program they must choose a focus area: arts, science and medicine, or language. Besides the upper level IB requirements, the following factors prohibit serious inquiry-based science curriculum to be implemented in our school, including but not limited to: a.)District-wide budget cuts b.)Lack of interest which led to a decrease in professional development of teachers. c.)A strong focus on state-mandated measures due to our student population and d.) A lack of science lab rooms and laboratory materials. There is a medical program on campus that is not supported although it could serve as a positive vehicle for the connection of biotechnology to the field of medicine. Enter Bench to Bedside! Using the International Baccalaureate “medical track” students as a model, I will attempt to deliver biotechnology curriculum through inquiry and chart the outcomes through a series of assessments. The assessments will range from multiple choice testing, cooperative learning groups and will culminate in a two-part lab-based practical. My participation in the Bench to Bedside program has allowed me access to lab materials that our school normally wouldn’t be able to afford. This will enhance the effectiveness of my lesson delivery and enable me to infuse modern biotechnology practice into my current lessons.

Traditionally, I have graded my midterm and final exams and found that although students obtain a wealth of information throughout the year they did not perform well on these assessments. Consequently, student semester averages drop and their overall GPA is affected. I didn’t take the time to think about why until I came to Bench to Bedside. The possible reasons are based mainly on the following:

a.) They didn’t study (unlikely based on the population of students, with a few exceptions of course)
b.)They never learned the material in the first place, for whatever reason
   c.) I didn’t make the lesson memorable enough for them to establish a point of connection.
      (There I said it!)

This action research plan serves a challenge to myself as an educator, and will help shape my approach to learning differently based on the things I’ve learned and the resources I have
available to me. As stated by Scruggs “When teachers choose to use an inquiry-based approach, they commit to provide rich experiences that provoke students’ thinking and curiosity; and to continuously assess the progress of each student as they work toward their solution or final product” (Scruggs, T.E. 1993, pg 1)

Finally, the reason I’m doing this is because the state of Florida is moving to the Biology End of Course (EOC) exam and students have to be exposed to information from all units, including biotechnology. As our knowledge develops in the areas of biotechnology and research science, educators will be expected and/or required to supplement their curriculum with up to date information, which will greatly increase the possibility of more students matriculating in those areas. There are not nearly enough students entering the field of science as they are into engineering and medicine, although we work closely with others in those fields, there seems to be a declining number in the students, African-American students in particular, that choose research as a career. “It is well known that African-Americans are underrepresented in the sciences and that there are many factors which contribute to the problem. A survey completed on Pearson Learning Company reported the following reasons were given for the low numbers of African- Americans in science: (1) lack of early encouragement and motivation (24.4 percent); (2) lack of financial support and limited opportunities (15.1 percent); (3) limited recruitment (11.2 percent) and institutional racism (11.2 percent); (4) lack of tradition (8.7 percent); and (5) science perceived as too difficult and unrewarding and lack of role models (8.3 percent each).” (Murfin, Brian 1992) Additionally, sociologist Katherine Crumb states that “What is holding minority students back are the educational disadvantages that are cumulative in nature, and that low performance early on in school make it difficult to attain the prerequisites they need to continue,” (Sasso, Anne 2008) As you can see there are several studies that suggest that by enhancing curriculum and educating teachers on current biomedical research we significantly impact the scientific community.

The purpose of this action research plan is to gauge and enhance student interest in biomedical research as well increase the awareness of the advancements being made in the field of contemporary science and medicine. By implementing the Boot Camp model into my curriculum, I will describe the impact of an inquiry-based approach to biotechnology education on the excitement for the future of biotechnology research practices.

**Action Research Intervention:**

The execution of this action research plan will take place at Atlantic High School in Delray Beach, Florida during the 2011-2012 school year. The student population consists mainly of African American and Haitian-American students while the majority of the MYP program population consists of Asian and Caucasian students. The actual implementation will begin January or February 2012 and will target my MYP freshman students. Additionally, I will involve 2 colleagues to pilot the program with me: one regular education science teacher and one that teaches alongside me in the IB program. I will do this to determine the correlation, if any, between my original action research plan and the revised action plan. My original research plan sought to find out which level of multi-ethnic students benefited more from an inquiry-based biotechnology program: Regular education students or International Baccalaureate students.
Although I will review the outcomes of their instruction, it will not be a part of official data recording. Instead, that unofficial data will serve as part of an ongoing portion of my action research plan as a part of a comparative analysis for the 2012-2013 school year. The findings, whether positive or negative, will be reported to Bench to Bedside staff.

**Biotechnology Boot Camp**

I will conduct a 3 week Biotechnology Boot camp which will serve as an introductory component to help students realize the importance of biotechnology applications to modern research science and medicine. Before we begin boot camp, students will be given a basic pre-test on biotechnology to gauge their knowledge and understanding of contemporary research practices. The Boot Camp will be based on a block scheduling where I see students every other day for one hundred minute periods.

Immediately after the pre-test the Biotechnology Boot Camp Instruction will follow this model:

- **Days 1 and 2:** Biotechnology Lecture (History, Practices, Future)
- **Day 3:** Stem Cell Lecture & Creating Stem Cell Line Lab (B2B Locker Program)
- **Day 4:** Diabetes and Glucose Metabolism Lecture & Glucose Lab (B2B Locker Program)
- **Day 5:** Intro to Genetic Engineering, PCR Lecture and Gel Electrophoresis Lecture
- **Day 6:** Begin Gator Myslexia Lab (B2B Locker Program)
- **Day 7:** Complete Gator Myslexia Lab; Discussion of Applications to Science and Law Enforcement
- **Day 8:** ELISA Lecture and ELISA Virus Lab (Charles Lawrence and B2B Locker Program)
- **Day 9:** Biotechnology Rotational Lab Practical (Written Portion based on Lecture Series)
  - Performance Tasks will include: calculating pipetting measurements, aseptic technique, identifying ELISA results, identifying patients with diabetes, etc
- **Day 10:** Dr. Moseley’s: 5 Ways to “Do” Ethics Lecture and Silent Debating Exercise
- **Day 11:** Abortion Debate: Are there certain situations in which abortion should be prohibited?
  - Setup: 3 Groups: For Abortion, Against Abortion, and Government
  - Note: Government will pose questions to each side and allow them to respond to the question. Additionally, they will monitor how each side answers questions fielded by the opposing party.

  **The Government will choose the “winner” of the debate**

  The teacher will assign the grades for students that were a part of the government. Their grade will be based on and how they “kept order”, the level of questions they asked each party, and whether or not they used the rubric appropriately in order choose the winner.

- **Day 12:** Bioethics Discussion: How Framing Sets the Stage for Biased Discussions and Opinions (Dr. Moseley’s Lecture)
  - Students will be placed in teams of 4 to discuss the scenarios that I will provide from Dr. Moseley’s lectures. I will provide rubrics for students to grade their peers. Grades will be based on areas outlined in “Classroom Debate Instructions” (See #4 under
Days 13 and 14: Watch Movie: Outbreak (Identify Ethical Issues and Answer Discussion questions based on Movie)

Day 15: Boot Camp Debate Reflection Paper

Biotechnology Letter to Next Year’s Boot Campers

After the boot camp, I will have my students to write a letter to next year’s students as an alternate form of assessment. The purpose of this letter will function as a platform for the new students as well as a recap for the biotechnology unit. The letter contains specific guidelines for passing the Biotechnology Boot Camp Practical. The letter to next year’s campers must include following:

a. A brief description of the field of biotechnology.
b. The importance of biotechnology to the field of science.
c. Description of a major technique used in the field of biotechnology.
d. What they learned about biotechnology and the field of science as a result of the inquiry-based lesson.
e. Where they see the future of biotechnology in the year 2015.

Biotechnology Poster Contest

Students will work in a group setting to create a poster that consists of things learned in the biotechnology unit. This includes but is not limited to: description and illustrations of biotechnology techniques and or labs, Guidelines on How to “Do” Ethics and Case Studies applications we learned throughout the unit. We will hang the posters in the “science” hallway to showcase our students’ talents and hopefully further increase pride in learning.

Biotechnology Lab Visit

Hopefully, at the end of our biotechnology unit students will be able to visit UF or one of our local labs in order to supplement their lesson. The students will spend a day in the life of a scientist participating in lectures, shadowing activities and performing basic activities at the bench with real scientists.

Bench to Bedside Connection:

The main connection to Bench to Bedside is the ability to evaluate my teaching practice more effectively. I am able to integrate cutting edge technology information into my curriculum and utilize more hands-on activity as a result of the access to the equipment lockers provided by the institute. Although the kids I have are above average they still lack the exposure to modern biomedical research. I plan on using the glucose lab, PCR lab, and the stem cell research labs we used in the institute because I think most students can make a connection to these common diseases. Diabetes has doubled in the U.S. in the past ten years which makes it relevant both locally and globally, as most students know at least one diabetic. As we all know, most diabetics
die as a result of disease complications, therefore it is important for students to realize that their loved ones can possibly be cured or receive an extended life span due to the intervention of biomedical research.

**Data Collection and Analysis:**

Analysis will be based on student performances, through various modes of assessment. It will consist of both qualitative and quantitative measures. These assessments will include but are not limited to:

I. **Content Knowledge and Lab Skills**

**Quantitative Data**

1. Biotechnology Pre-Test
2. Biotechnology Boot Camp Lab Practical (Written and Performance Task Portions)
   a. Can students answer questions based on the lecture series?
   b. Can students perform the tasks asked of them at each lab station?
   c. Based on test results, do they need a review of biotech information or techniques?
3. Boot Camp Post-Test
   a. Were the post-test results better than pre-test results?
   b. Based on results do students have a better general understanding of biotechnology research?

**Qualitative Data**

1. Analysis of Debate Topics Activity: Days 11-14 (rubric based; see #4 under Literature Cited)
   a. How did students grade themselves?
   b. Which areas do they feel could use improvement?
   c. Which accommodations can be made to assist them in their improvement areas?
2. Boot Camp Debate Activity Reflection Paper (rubric based)
   a. Students will grade their group’s ability to debate effectively
   b. Students will grade the opposing team’s (including the government’s) ability to debate effectively based on Dr. Moseley’s “How to Do Ethic’s Lecture”
3. Boot Camp Based Poster Project
   a. Are the posters accurate?
   b. Do they reflect activities and concepts discussed in the boot camp?

4. Boot Camp Letters
   a. Did they answer all the questions accurately?
   b. Does the letter reflect an accurate depiction of what took place in the Boot Camp?
   c. Are students realistically stating a probable future of biotechnology and research?

II. Interest Level

Pre and Post Likert scale surveys

After the Likert Self-Evaluative Session
Depending on the responses, I will modify at least 3 more lesson plans to determine if the lessons were just exciting or if the delivery method had an effect on the learning and assisted with student retention. Additionally, I will take my own extended Likert survey in order to assist in identifying the areas in which improvements are needed.

Literature Cited:

   http://www.inspiredteaching.org/admin/Editor/assets/Inquiry%20Issue%20Brief.pdf

   http://www.africa.upenn.edu/K-12/African_Science.html

   http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2008_05_16/caredit.a0800070

4. Debate Rubrics (under Classroom Debate Instructions)
   http://www.educationworld.com/a_lesson/lesson/lesson304b.shtml

5. Science Poster Project Rubric
Budget and Budget Justification:

B2B Locker Materials $ 0.00
Science Take-Out (Glucose Kit) $ 15.00
Electrophoresis Pack Red Box (2) $ 220.00

Note: Some material costs will be supplemented by Florida Teacher Lead Money

Permissions:

We were appointed a new principal for the 2011-2012 school year. Depending on the principal’s focus and support of the IB program model the action research plan may or may not be completed in its entirety.

Since we are changing administrators I imagine there will be more science support throughout the school as well as an opportunity to develop a biotechnology program at Atlantic High. This will allow teachers to work together with professional development programs to create a more streamlined path into the fields of biomedical science and research for our International Baccalaureate students.
Classroom Debates

Introduction

The classroom debates are exercises designed to allow you to strengthen your skills in the areas of leadership, interpersonal influence, teambuilding, group problem solving, and oral presentation. Debate topics and position statements are outlined below. Groups may sign up on a first come, first served basis, by specifying both the debate topic and the position desired (i.e., Pro or Con). Note that all groups must have signed up for the debate by the date denoted in the class schedule. All group members are expected to participate in the research, development, and presentation of your debate position. Preparation will require substantial library research. Each participating member will receive the same group grade.

Debate Format

6 minute Position Presentation - Pro
6 minute Position Presentation - Con
5 minute Work Period
4 minute Rebuttal - Pro
4 minute Rebuttal - Con
3 minute Work Period
2 minute Response - Pro
2 minute Response - Con
1 minute Work Period

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2 minute Position Summary - Pro or Con

2 minute Position Summary - Pro or Con

5 minute Tallying of Ballots/Announcement of Winner

**Debate Procedure**

The debate will take the form of timed individual and/or group presentations and responses separated by
timed group work periods. The rules applied may deviate from the formal rules of debating. When questions arise, the judgment of the instructor will provide the definitive ruling.

Prior to the beginning of the class period, both teams are to position their desks facing each other at the front of the room. Each team is to write its team name, debate position, and debate position statement on the blackboard behind their desks. Note that absolutely no changes may be made to the position statements presented below. You must argue them exactly as written!

Team members may speak either from their desks or from the podium, as they desire. Audiovisuals may be used at any time, including, but not limited to, handouts, flipcharts, transparencies, slides, audio and videotapes, etc. While a team is not required to use all of the time allocated to each debate component, speakers must stop immediately when the allocated time runs out. Team members are prohibited from speaking to the audience or opposing team except at the times specifically allocated to them. Thus, there can be no immediate, reciprocal interchange of comments between the teams. The sequence of the position summaries will be determined by a random procedure at the conclusion of the final work period. Note that no new information may be introduced during the summary. Doing so may result in disqualification of the offending group. If either team feels that their opponents are introducing new information during the summary, they may challenge them immediately and request a ruling from the instructor.

**Selection of Winner(s) and Allocation of Points**

The instructor reserves the right to allocate fewer than the default or class voted points to a group, if, in his opinion, the quality of preparation and/or presentation was inadequate. Debate "losers" who prepare and present adequately will receive 30 points for their efforts.
Debate "Winners" will be selected in two ways, as follows:

**Audience Vote:** Class members in the audience will vote by secret ballot for a debate winner. Votes are to be based upon presentation quality only, and not upon personal agreement or disagreement with the position espoused. At the conclusion of each component of the debate, class members will be asked to assign a point rating along with explanatory comments to each team for their performance during that component. When the debate is over, the point ratings will be summed. Whichever team has the higher sum will be the winner on that ballot. After all ballots are collected, the number of votes for each team will be announced. Whichever team has more votes will be the winner, and the team will receive 10 bonus points in addition to the 30 for basic preparation. In the event of a tie, the instructor’s vote will decide the winner.

**Instructors' Vote:** The instructor will also evaluate both teams according to the above procedures and criteria, and select his choice for the winner. The team of his choice will receive 10 bonus points. Thus, depending upon the nature of the vote split, the "Winner(s)" may receive 10 or 20 bonus points, for a total of either 40 or 50 points for the debate.

**Review of Ballots**

Each debating team will have the opportunity to take home all of the ballots overnight for review and feedback on their performance. If necessary, the team to take them first will be determined by the flip of a coin. Once both teams have reviewed them, they are to be returned to the instructor.

**Debate Topics**

*Whose Responsibility is Stress?*
**PRO:** Employees who cannot take the stress inherent in a job should be relieved of their current duties (i.e., transferred, demoted, or fired, as appropriate). Stress management should ultimately be the employees' responsibility.

**CON:** Employees with stress problems should be guaranteed not to lose their current positions while the company provides or arranges for special treatment to alleviate their stress related problems. The corporation has an obligation to provide significant assistance to employees in the area of stress management.

*Employee Privacy*

**PRO:** Employees of any organization should be accorded significant privacy rights relating to both their time and behavior on the job, and the use of their personal information. Employee privacy on the job should be respected as much as it is in their homes.

**CON:** By virtue of accepting employment in an organization, employees must relinquish many of the privacy rights that they might enjoy in personal settings, such as their own home. The ability of an organization to function effectively and meet its goals requires this limitation to personal privacy rights.

*Romance in the Workplace*

**PRO:** Workplace romances are private matters between the individuals involved. Organizations should not try to regulate them in any significant way.

**CON:** Workplace romances can impact negatively on morale and productivity, and may result in charges of sexual harassment. Organizations have the right to regulate them as they see fit.

**DEBATE BALLOT**
Debate ______________________________________________  Class _____________

Name of Evaluator ____________________________________  Date _____________

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**PRO**

**CON**

6 Minute Position Presentation

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***** 5 Minute Work Period *****

4 Minute Rebuttal

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***** 3 Minute Work Period *****

2 Minute Response
| Rating = ____ | Comments: | Rating = ____ | Comments: |

***** 1 Minute Work Period *****

2 Minute Position Summary

| Rating = ____ | Comments: | Rating = ____ | Comments: |

[ ] Total Points     [ ] Total Points

Circle Winner Below:
Overview (Review/posting of agenda; Summary of case)

Diagnosis/Analysis (Review of chapter content; Issues/Problems in case)

Quality of Recommendations/Explanations (Reccs for what should be/have been done differently, OR, Expls for why current situation successful)

Summary/Conclusion (Review of major points; Statement of relevance to practice of management)

Process

Quality of Professional Attire/Grooming

Verbal Behavior (clarity/choice of words/voice level)

Nonverbal Behavior (posture; gestures/movement; eye contact; presence; use of notes/reading)

Variety in Style (lecture; discussion; game; activity; skit; role play; quiz)

Audiovisual Support (Transparencies; PowerPoint; blackboard; video)

Level of Audience Involvement (Stimulation/structuring of activity/disc)
1 2 3 4 5  **Timing** (Within limit; coordination; use of time)

1 2 3 4 5  **General Coherence** (Ability to follow points; quality of transitions)

1 2 3 4 5  **Creativity/Psychological Impact**

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**Strengths**

**Weaknesses**
Improvements

General Comments

Signature of Evaluator:

__________________________________

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Bench to Bedside Action Proposal Research Lesson Plan

Title: Back to the Basics (Biotech Boot Camp 101)

Key Question: What is the importance of biotech research to modern medicine and what effect (if any) does hands-on biotechnology instruction have on student attitude when it comes to career choice?

Subject: MYP Biology (part of the International Baccalaureate program)

Overall Time Estimate: The lesson plan will take 3 weeks to complete. It will include pre and post Likert surveys as well pre and post assessments of biotechnology material.

Learning styles: The lesson contains components that cater to diverse learning populations which include tactile, visual, auditory learners.

Lesson Summary: Students will complete hands-on biotechnology lesson modules in “boot camp” style format. The “boot camp” will include a series of pre and post tests, lectures, debates, and lab practical performance tasks in order to gauge the understanding of boot camp participants. Pertinent information on the history, techniques, applications, and future of biotechnology will be covered.

Learning Objectives:

1. SWBAT explain the significance of genetic, environmental, and pathogenic factors to health from the perspectives of both individual and public health. (SC.912.L.14.6)
2. SWBAT evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues. (SC.912.L.16.10)
3. SWBAT discuss the technologies associated with forensic medicine and DNA identification, including restriction fragment length polymorphism (RFLP) analysis. (SC.912.L.16.11)
4. SWBAT describe how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, polymerase chain reaction, ligation, and transformation) is used to construct recombinant DNA molecules (DNA cloning). (SC.912.L.16.12)
Materials:

Essential:
- Glucose Metabolism Lab Kits from Science Take-Out (need 15 kits per class)
- PCR locker from B2B Locker Program (need 1 kit per class)
- ELISA Testing Lab from B2B Locker Program (need 6 kits per class)
- Computer Access to EdHeads Website to Create a Stem Cell Line (need 1 computer per group of 2)
- Copies of “Frankenfoods: The Debate over Genetically Modified Crops” (2 copies per group of 4)
- Debate Rubric (4 rubrics per group of 10 students)

Supplemental:
- DVD Player and the movie “Outbreak”

Procedure:

1. Biotechnology Pre-Test (Time Estimate: 30 minutes)
2. Brief discussion of the history of biotechnology through the use of mindstreaming.
   - Mindstreaming is asking students what they know about a particular topic and jotting it down on the board and erasing incorrect responses as you teach a lesson.
   - (Time Estimate: 5-10 minutes)
3. History of Biotechnology Powerpoint Presentation (Time Estimate: 30 minutes)
4. Have a discussion centered around the following questions:
   a. “Does anyone know someone with diabetes?”
   b. “What cellular mechanism has gone wrong when a person get diabetes?”
   c. “How does that affect a person’s dietary lifestyle?”
   d. “What treatments are available for a person with diabetes?”
   - (Time Estimate: 15 minutes)
5. Introduction to Diabetes Powerpoint (Time Estimate: 20 minutes)
6. Diabetes Lab (Identifying Patients with Diabetes)
   a. Students will be divided into groups of 2.
   b. They will be given a glucose kit with instructions.
   c. They will test each “patient” for high blood sugar levels.
   d. They will determine which patients are afflicted with diabetes based on the blood sugar numbers assigned by the chart in the kit.
   e. Students will answer questions about procedures and their understanding will be checked based on questions on the accompanying worksheet.
   f. Review questions with Instructor
   - (Time Estimate: 1 hour)
7. Overview of Genetic Engineering, PCR and Gel Electrophoresis Lecture  
   **(Time Estimate: 30 minutes)**

8. Begin Gatorbait Myslexia Lab  
   a. Students will centrifuge and label their DNA tubes  
   b. 20 microliters of DNA will be pipette into each of the corresponding tubes  
   c. They will pipette up and down to make sure the DNA is mixed  
   d. Each DNA tube will be centrifuged again  
   e. Tubes will be placed in the thermal cycler at 37 degrees for 30 minutes.  
   f. Students will complete the Biotechnology Puzzle while waiting for the thermocycler to run for 30 minutes  
   g. After 30 minutes students will place tubes on ice until the next class  
   **(Time Estimate: 1 hour)**

9. Complete Gator Bait Myslexia Lab  
   a. Students will remove the samples from ice  
   b. Centrifuge samples  
   c. Prepare gel by plugging the powerbase into the outlet and loading the gel cassette in the base  
   d. Pre-run the gel by pressing either the 25 minute or 30 minute button until the red light turns to green  
   e. The gel will pre-run and the light will turn green again and beep. Shut off the noise.  
   f. Remove the comb from the gel  
   g. Add 20 microliters of distilled water to wells 1-2 and wells 10-12  
   h. Load 20 microliters of the DNA samples into well 3-9(change the pipette tip each time!)  
   i. Add 20 microliters of distilled water to wells 6-12.  
   j. Run the gel for 30 minutes  
   k. Students and Instructor will discuss the possible applications of PCR and Gel Electrophoresis in different fields  
   l. Analyze the gel  
   m. Students will draw the gel in their lab notebook  
   **(Time Estimate: 1 hour)**

10. ELISA Lecture (20 minutes)

11. ELISA Virus Lab (Dr. Charles Lawrence and B2B Locker Program)  
   a. Students will be assigned assays  
   b. They will follow simple protocol on the instruction manual  
   c. They will use a black light to get the ELISA results  
   d. They will record and analyze results  
   e. Discussion: ELISA Applications to Biotechnology and Other Fields  
   **(Time Estimate: 1 hour)**
12. Biotechnology Lab Practical Post Test Assessment Review (Written Portion)
   a. Students will be given a Lab Practical Answer Sheet
   b. 30 stations with 2 essay questions per station are set up
   c. Each student takes a station and circles the number corresponding to the station where they started on their answer sheet
   d. Student has 2 minutes to answer both questions at the station
   e. Students shift clockwise until they complete all 30 stations
      (Time Estimate: 65 minutes)
13. Biotechnology Lab Practical Post Test Assessment Review (Performance Tasks)
   a. Students are given a Lab Practical Answer Sheet
   b. 30 stations are set up with different performance tasks (pipetting different volumes, reading and making graphs, analyzing data, identifying patients inflicted with a disease[ELISA and Diabetes testing, etc...])
   c. Each student takes a station and circles the number corresponding to the station where they started on their answer sheet
   d. Students will be expected to perform each task at the bench and record the answers on their lab practical sheet
   e. Students have 4 minutes at each station to complete each task
   f. Students shift clockwise until they complete all 30 stations
      (Time Estimate: 1 hour, 20 minutes)
14. Biotechnology Post-Test (Time Estimate: 1 hour)
15. Dr. Moseley's How to "DO" Ethics Lecture (Time Estimate: 30 Minutes)
   a. Students will be given a case study called “Frankenfoods: The Debate over Genetically Modified Crops” (this will be used as a prep step)
   b. Students will get into groups of 4 and argue their case for 40 minutes
   c. Each student group will then address the class with their concerns about GM crops (if any) in an environment known as “Silent Debating or Connections”
   d. Silent Debating/Connections is a strategy where you sit people in a circle after they have discussed an issue and allow each member in the class/group to say what they feel about the topic WITHOUT anyone responding to it(there is COMPLETE silence). Each person says something about the topic (if they wish), and no one can speak twice until EVERYONE has spoken OR the room has been silent for at least a minute (to be fair to everyone). This allows everyone to formulate their thoughts on the subject as well as listen to others opinions. Students are allowed to write things down for later questioning.
      (Time Estimate: 15 minutes)
   e. This will be followed with a 10 minute free write about the subject.
      Total Time Estimate: 1 hour, 35 minutes)
16. Abortion Debate: Are there certain situations in which abortion should be prohibited?
   a. Students will be broken down into 3 Groups: For Abortion, Against Abortion, and Government
   b. Students are given numbers (1, 2, or 3) and they report to their corresponding group
c. Group 1 = For Abortion Group 2= Against Abortion  Group 3= Government
d. Each group of students will meet for 30 minutes and discuss arguments based on their
assigned position as well as possible counterarguments for the opposing party. The
government will explore both sides as well as the provide questions for each side to
answer.
e. Setup: Government will begin the debate by posing a question to each side and allowing
them to respond to the question. Additionally, they will monitor how each side answers
questions fielded by the opposing party.
f. **After the debate:** The Government will choose the winner based on the rubric below(See #2
under Literature Cited)
g. The teacher will assign the grades for students that were a part of the government. Their
grade will be based on and how they “kept order”, the level of questions they asked each
party, and whether or not they used the rubric appropriately in order choose the winner.
*(Total Time Estimate: 1 hour, 40 minutes)*

17. Bioethics Discussion: How Framing Sets the Stage for Biased Discussions and Opinions
a. Students will asked “What is framing?” and “Can framing set the stage for a biased answer
on an issue?”
b. I will introduce them to framing by giving them a specific scenario such as “If you have sex
with someone who is unconscious in a hospital, is it rape?” and start an impromptu debate.
c. After a few minutes of debate, I will add “What about if it’s the person’s spouse?”
d. Next I will add “The lady was a known prostitute and a known cocaine and drug abuser and
the guy announced that he was her and her pimp and stated they used to engage in the
behavior all the time after she had a drug high” as well as “Should someone call the cops or
the person’s next of kin”
   **Time Estimate: 30 minutes**
e. Finally, students will be split into groups of 4 and given the following question to debate:
   “Surrogate Parent hood: Does the child belong to the biological mother or the woman that
carried it?”
f. Students will reconvene and grades will be based on areas outlined in the rubric under
   “Classroom Debate Instructions”  (See #2 under Literature Cited )
   *(Total Time Estimate: 1 hour, 30 minutes)*
18. Bioethics Discussion Reflection Session cont...
a. Reflection Session: Students will be asked to reflect on our previous discussion of “How to
Do Ethics” when framing is possibly involved.
b. Students will write a 1 page paper discussing what they learned about ethics and framing.
   *(No assessment just for reflection)*
   *(Time Estimate: 1 hour)*
19. Watch Movie: “Outbreak”
   a. Students are to identify and discuss ethical issues based on the movie.
   b. Possible questions may include: “Should the town be told that they have a cure for Motaba or should the Army protect their biological weapon for warfare?”
   c. “Do agencies designed to protect us always do the right thing; and is it wise to put out lives in the hands of people who might have a different “frame” of mind than we do?”
   d. “Should Dustin Hoffman do his job even though he feels it is wrong OR should he continue as he did in the movie”
   e. “Should the men have dropped the bomb in the ocean or should they incinerate the town as instructed?”
   f. Reflection: Is there a parallel between biomedical research and wartime when it comes to “reasonable casualties of war”? Why are casualties acceptable in biomedical research but not ok in wartime?
   (Time Estimate: 4 hours over a 2 day period)

20. Group Reflection Paper
   a. Students will get into their original groups and grade themselves and their other peer groups based on the rubric below (See #2 under Literature Cited)
   b. Students will also write about what areas they can improve upon when debating and when considering framing.
   (Time Estimate: 45 minutes)

21. Boot Camp Poster Project
   a. Students will be placed in groups of 3-4
   b. Students will create a poster that consists of things learned in the biotechnology unit. They are not limited in their approach and may include debates, lab techniques, applications of biotechnology, etc.
   c. Assessment of the poster will be based on the following question as well as the rubric below (See #3 under Literature Cited)

   1. Does the poster reflect activities and concepts discussed in the boot camp?

   (Time Estimate: 1 hour, 40 minutes)
22. FINAL REFLECTION : Boot Camp Letters
   a. Students will have to write a letter to next year’s campers’ which will function as a platform for the new students as well as a recap for the biotechnology unit.
   b. The letter contains specific guidelines for passing the Biotechnology Boot Camp Practical.
   c. The letter must contain:
      1. A brief description of the field of biotechnology.
      2. The importance of biotechnology to the field of science.
      3. Description of a major technique used in the field of biotechnology.
      4. What they learned about biotechnology and the field of science as a result of the inquiry-based lesson.
      5. Where they see the future of biotechnology in the year 2015.
   d. Students will be assessed based on the following 3 questions:
      1. Did they answer all the questions accurately?
      2. Does the letter reflect an accurate depiction of what took place in the Boot Camp?
      3. Are students realistically stating a probable future of biotechnology and research?

   (Time Estimate: 1 hour, 15 minutes)

23. Post Boot Camp Likert Assessment
   (Time Estimate : 30 Minutes)

Resources and References:
1. National Center for Case Study Teaching in Science
2. Debate Rubrics (under Classroom Debate Instructions)
   http://www.educationworld.com/a_lesson/lesson/lesson304b.shtml
3. Science Poster Project Rubric
4. Diagnosing Diabetes Kit
5. Creating a Stem Cell Line
   http://edheads.org/