The Effects of Integrating Biotechnology Related Case Studies and Laboratory Activities on the Interest and Performance of 9th and 10th Grade Students in an Honors Biology Class

for

Bench to Bedside
Action Research Proposal

by

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TOPIC: The Effects of integrating biotechnology related case studies and laboratory activities on the interest and performance of 9^{th} and 10^{th} grade students in an Honors Biology class.

ABSTRACT:
The topic deals with the effects of integrating biotechnology related case studies and laboratory activities on the interest and performance of an Honors Biology class containing 9^{th} and 10^{th} grade students. The independent variables are the students and the dependent variables are the test scores. The control groups are the classes that are being taught using the traditional method, while the experimental group is the class with the "flipped" teaching method and new biotechnology related case studies and laboratory activities. The students will be given an ATSI, Attitude Toward Science Inventory, survey before and after the unit. The numerical values from the survey will be used to assess and compare interest levels. They will also be given pre and post tests on the content of the biotechnology unit and the data will be collected, using an EXCEL spreadsheet, to evaluate performance levels.

RATIONALE:
Science is everything around us and is an ongoing process that we are always discovering more about our natural world. This is usually our introduction to our students which we always hope will be the hook for our students to want to learn more about science. However, I have found that without exciting stories, like in case studies and laboratory activities, or hands-on activities that are relatable and relevant, my students were never motivated; this is primarily the rationale behind this research. I have observed from years of teaching that student engagement in hands on activities and laboratory activities have proven to increase student interest. This was observed many years ago also in a study done to assess students interest levels in a science lab class, (Hofstein & Lunetta, Rev. Educ. Res. 52(2), 201–217, 1982). In another case study done on 183 students who were exposed to inquiry-based learning in science, the researcher found a significant increase in students' interest in science and problem-solving skills, (Paris, Yambor, Packard). Using some new, current case studies and laboratory activities in the Biotechnology unit, I hope to spark my students' interest, which I am confident will also improve their grades.
My main focus being directed toward student interest does not negate the importance of comprehension and ultimately test scores. The importance of test scores are no longer just for intrinsic rewards from students and parents, they are now of exceedingly great importance to teachers, administrators and school districts as well. The emphasis on testing and performance scores, now play a more significant role in teacher evaluations and salaries, and school rankings. The Florida bill (Chapter 2011-1, L.O.F.), has revised the evaluation system to focus on students' performance in Florida and its connection to teacher salaries, (Wise, Lynn, Gaetz, and Hayes).

INTERVENTION:
In an effort to evaluate the effect of the interest level of the students with the new biotechnology related case studies and laboratory activities that were done in the Bench to Bedside program, an ATSI survey was done before the biotechnology unit was done with all three Honors Biology classes. Data from pretest scores were also collected from all three classes. Two classes were taught the biotechnology unit, using the traditional method of powerpoint presentations, labs and worksheets; a

teacher centered method. The third class was taught the same unit using a flip classroom method with the biotechnology related case studies and laboratory activities; a student inquiry based technique. One traditional class was evaluated with the traditional multiple choice, short response type questions. The second traditional class and the non-traditional class were both evaluated using the Team-Based learning approach using the iRAT and tRAT scores. The ATSI survey was given at the end of the unit to all three classes and the data recorded. The post test scores were also collected and analyzed.

The unit plan will be on DNA to protein, the Central Dogma and will incorporate powerpoint notes, video clips, lab activities, webquests, and a research assignment.

Lesson Plan for the Experimental Group (Draft)

Day 1.

The students will do a Pretest on the Biotechnology unit. They will then take an attitude survey, Attitudes Toward Science Inventory (ATSI).
We will next do a KWL, then we will briefly discuss what this unit will include.
They will be given the vocabulary words to define and a vocabulary review worksheet where they will practice using the vocabulary words in context.
For homework, they will be assigned a you tube video on DNA structure and function on https://www.youtube.com/watch?v=z2oxK0wfyXY
They will also be encouraged to get notes from my edline page on the same information.

Day 2

The students will have 10 questions on DNA structure to complete for the first 10 minutes as a Bell ringer activity, to retrieve prior knowledge. We will review them as a question and answer session.
I will show a video clip on DNA structure and function and replication.
https://www.youtube.com/watch?v=qIQmB5mkUgg, then we will discuss the notes from edline and answer any questions or concerns.
The students will be given a copy of a DNA model to color, label and cut out nucleotides and connect them to make a model of DNA.
For homework, they will be assigned a video clip on Transcription and translation to watch.
https://www.youtube.com/watch?v=oC51lLTsyVo
They will also be encouraged to get notes from my edline page on transcription and translation.

Day 3

The students will have 10 questions about transcription and translation which they will do for the first 10 minutes as a bell ringer activity and to retrieve prior knowledge. We will review them as a question and answer session.
I will randomly place the students into groups of two which will be used to determine the genetic disorders that they will be doing.

We will review the information on transcription and translation after watching a video clip, https://www.youtube.com/watch?v=Ikq9AcBcohA, then I will answer questions and concerns.
The students will work on a DNA extraction lab using strawberries. Upon completion of the lab they will work in the previously chosen groups on the Identifying Disease Genes activity. Once they determine the genetic disorder that their group has, they will be given 4 days to work on a presentation about the disorder.
Their homework will be to start the research.

Day 4
The students will have 10 questions about the Central Dogma which they will do for the first 10 minutes as a bell ringer activity and to retrieve prior knowledge. We will review them as a question and answer session.
We will discuss regenerative medicine and the use of stem cells for 10 minutes.
The students will do a lab on Bioengineering a Liver. Once the lab is set up, they will do a webquest: What is Regenerative Medicine. They will complete the liver lab and data analysis. If they are not finished with the webquest, then they will complete as a homework assignment.
Another homework assignment will be to watch DNA mutations
https://www.youtube.com/watch?v=MOtRqBs0jxE

Day 5
The students will have 10 questions about the types of mutations which they will do for the first 10 minutes as a bell ringer activity and to retrieve prior knowledge. We will review them as a question and answer session.
We will discuss mutations and stem cell research for 10 minutes. The students will do the Science Take-Out lab on Stem Cells. They will have the last 10 minutes of class to discuss the research project with their group mates.

Day 6
The students will have 10 questions about stem cell research which they will do for the first 10 minutes as a bell ringer activity and to retrieve prior knowledge. We will review them as a question and answer session.
The first half of the group presentations will be done by the students and will be evaluated.
The last 30 minutes of class will be used to review using concept mapping, for the upcoming test.

Day 7

The first half of the group presentations will be done by the students and will be evaluated.
The last 30 minutes of class will be used to review using concept mapping, for the upcoming test.

Day 8

I will randomly place the students into groups of four which will be used to work on the group aspect of the test.

The students will be given a post test using the TBL approach. First they will do the test individually and the scores recorded. That will be the iRAT scores, they will then get a chance to work within a pre selected group on the same test. The scores will be recorded and that will be their tRAT scores. Those will be averaged into their grade to determine a final grade for the test.
The students will be asked to complete the ATSI again and the data will be analyzed along with the test scores data.

CONNECTION TO BENCH TO BEDSIDE:
Bioengineering in the classroom activity – decellularizing chicken liver
What is Regenerative Medicine webquest
Identifying Disease Genes
Stem Cells – Science Take-Out
Team Based Learning

DATA COLLECTION AND ANALYSIS:
Data will be collected from pre and post tests given to all groups. This will be analyzed using an EXCEL spreadsheet.
Data will be collected on students' attitudes. This will be analyzed using the ATSI survey. Copy of the survey below.

BUDGET:
Science Take Out Kit - from www.sciencetakeout.com
12 kits = $ 136.80
Triton X -100 solution - from www.fisherscience.com
50 mL = $ 93.90
SDS solution - from www.fisherscience.com
250 mL = $ 44.62

REFERENCES AND LITERATURE CITED:

Hofstein,Avi & Vincent N. Lunetta. (2003)*The Laboratory in Science Education: Foundations for the Twenty-First Century*.Science Education
Retrieved June 24th, 2015 from http://gpquae.iqm.unicamp.br/gtexperimentacao.pdf

Paris, Scott G., Kirsten M. Yambor & Becky Wai-ling Packard. (1998) *Hands-on biology: a museum-school-university partnership for enhancing students' interest and learning in science.* Elementary School Journal Vol. 98, p267-288,22p

Wise, Lynn, Gaetz, and Hays. Florida Pay Performance for teachers CS/CS/SB 736 – Educational Personnel by Budget Committee; Education Pre-K-12 Committee; and Senators Wise, Lynn, Gaetz, and Hays . Retrieved June 24th, 2015 from
http://www.flsenate.gov/Committees/BillSummaries/2011/html/0736ED

ATTITUDE TOWARD SCIENCE INVENTORY SURVEY

It is important that you respond to every statement, and that you fill in only one number per statement.
Attitudes Toward Science Inventory

ATSI ITEM STATEMENTS	STRONGLY DISAGREE	DISAGREE	UNDECIDED	AGREE	STRONGLY AGREE
1. Science is useful for solving the problems of everyday life.	1	2	3	4	5
2. Science is something that I enjoy very much.	1	2	3	4	5
3. I like the easy science assignments best.	1	2	3	4	5
4. I do not do very well in science.	1	2	3	4	5
5. Science teachers show little interest in their students.	1	2	3	4	5
6. Doing science labs or hands-on activities is fun.	1	2	3	4	5
7. I feel at ease in a science class.	1	2	3	4	5
8. I would like to do some extra or un-assigned reading in science.	1	2	3	4	5
9. There is little need for science in most of today's jobs.	1	2	3	4	5
10. Science is easy for me.	1	2	3	4	5
11. When I hear the word "science," I have a feeling of dislike.	1	2	3	4	5
12. Most people should study some science.	1	2	3	4	5
13. I would like to spend less time in school studying science.	1	2	3	4	5
14. Sometimes I read ahead in our science book.	1	2	3	4	5
15. Science is helpful in understanding today's world.	1	2	3	4	5
16. I usually understand what we are talking about in science.	1	2	3	4	5
17. Science teachers make science interesting for me.	1	2	3	4	5
18. I do not like anything about science.	1	2	3	4	5
	1	2	3	4	5

19. No matter how hard I try, I cannot understand science.					
20. I feel tense or upset when someone talks to me about science.	1	2	3	4	5
21. Science teachers present materials in a way that I understand.	1	2	3	4	5
22. I often think, “I cannot do this,” when a science assignment seems hard.	1	2	3	4	5
23. Science is of great importance to a country’s development.	1	2	3	4	5
24. It is important to know science in order to get a good job.	1	2	3	4	5
25. It does not disturb or upset me to do science assignments.	1	2	3	4	5
26. I would like a job that does not use any science.	1	2	3	4	5
27. Science teachers know when I am having trouble with my assignments.	1	2	3	4	5
28. I enjoy talking to other people about science.	1	2	3	4	5
29. I enjoy watching a science program on television.	1	2	3	4	5
30. I am good at working science labs and hands-on activities.	1	2	3	4	5
31. Science teachers do not seem to enjoy teaching science.	1	2	3	4	5
32. I like the challenge of science assignments.	1	2	3	4	5
33. You can get along perfectly well in everyday life without science.	1	2	3	4	5
34. Working with science upsets me.	1	2	3	4	5
35. I remember most of the things I learn in science class.	1	2	3	4	5
36. It makes me nervous to even think about doing science.	1	2	3	4	5
37. I would rather be told scientific facts than find them out from experiments.	1	2	3	4	5
38. Most of the ideas in science are not very useful.	1	2	3	4	5
39. It scars me to have to take a science class.	1	2	3	4	5
	1	2	3	4	5

40. Science teachers are willing to give me individual help.					
41. The only reason I am taking science is because I have to.	1	2	3	4	5
42. It is important to me to understand the work I do in the science class.	1	2	3	4	5
43. I have a good feeling toward science.	1	2	3	4	5
44. Science teachers know a lot about science.	1	2	3	4	5
45. Science is one of my favorite subjects.	1	2	3	4	5
46. Science teachers do not like students to ask questions.	1	2	3	4	5
47. I have a real desire to learn science.	1	2	3	4	5
48. If I do not see how to do a science assignment right away, I never get it.	1	2	3	4	5

SINGLE LESSON PLAN

Teacher: Mrs. Margaret Lawrence	Content Area/Grade:Biotechnology/9-10	Date:

Unit Name:	Bioengineering a Liver

Unit Goal What unit goal does this daily lesson address?	**Standard(s)/Benchmark(s)** What standard(s)/benchmark(s) does this daily lesson address?
1. Discuss the role of biotechnology techniques in the advancement of health care treatment, including diagnosis, monitoring, and therapy. 2. Discuss the role of tissue regeneration in health care treatment, and therapy. 3. Observe the removal of cells from a piece of liver using a cleaning agent.	**SC.912L16.3** Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic information. **SC.912.L16.10** Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues. **SC.912.L.16.12** Describe how basic DNA technology is used to construct recombinant DNA molecules, (DNA cloning).
Students will understand that… What should the students understand by the end of today's lesson?	**Essential Questions** What essential question(s) does this lesson address?
1. Cells can be decellularized by cleaning agents. 2. DNA replication will allow new cells to be added to a cell matrix and will regenerate.	1. Can tissues be decellularized? 2. Can new cells regenerate from a decellularized liver matrix. 3. How can regenerative medicine be helpful to the population?
Connecting Concepts How will you review yesterday's content and connect today's lesson to it?	**Organizing Students for Learning** How will students be organized today for the lessons activities?
1. Review the Central Dogma which will allow for new cells to be formed.	Students will be working in groups of two on the genetic disorder. Students will work in groups of four on the TBL testing activity.

LEARNING EXPERIENCES, INSTRUCTION AND RESOURCES

What activities or experiences (from your Unit Plan) will students engage in today?

Lesson Sequence

Activating Prior Knowledge	The students will use the KWL to review what they already know, what they want to know and later we will complete what they did learn.	☐ ABC Brainstorming ☐ KWL ☐ Anticipation Guide ☐ Card Sort ☐ Think-Pair-Share
Explicit Instruction	Use the video clip of the regeneration of a finger or a motivational hook. Class discussion on the Central Dogma.	☐ Motivational Hook ☐ Lecture ☐ Demonstration ☐ Note-taking Guide

<table>
<tr><th colspan="4">Lesson Sequence</th><th>Resources and Materials</th></tr>
<tr><td>Group Processing of New Information</td><td>The students will be asked to discuss their ideas about regenerative medicine after doing the webquest, then they will pair with their lab partners to discuss their opinions and will share with the class.</td><td>☐ Jigsaw
☐ Reciprocal Teaching
☐ Concept Attainment
☐ Think-Pair-Share</td><td rowspan="3">☐ Lab / Inquiry Activity</td><td rowspan="5">☐ Computer
☐ LCD Projector
☐ Paper
☐ Pencils
☐ Whiteboards
☐ Markers
☐ Butcher Paper
☐ Response Cards
☐ Post-it Notes
☐ Video Clip(s):

☐ Website(s): Given on the webquest review sheet

☐ Lab Materials:
Fresh chicken liver
Flask
Stir plate
SDS solution
Camera
Ruler
Scalpel
Stir bar
Triton X solution
Colored pencils
Dissection tray</td></tr>
<tr><td>Elaborative Questioning</td><td>In what ways could the use of stem cells be useful to the medical community?</td><td>☐ Inferential Questions
☐ Analytic Questions
☐ Philosophical Chairs</td></tr>
<tr><td>Demonstrating Understanding</td><td>Analysis and evaluation questions on the lab sheet will help to demonstrate understanding.</td><td>☐ Graphic Organizers
☐ Picture Notes
☐ Flow Charts
☐ Concept Maps
☐ Mnemonics
☐ Graffiti</td></tr>
<tr><td>Reflection</td><td>Complete the KWL sheet.</td><td>☐ Reflective Journals
☐ Think Logs
☐ Exit Ticket (Student Learning)</td><td colspan="2"></td></tr>
<tr><td>Daily Progress Monitoring Assessment</td><td>Complete the webquest on Regenerative Medicine and the lab on Bioengineering a Liver.</td><td>☐ Quiz
☐ Journal
☐ Exit Ticket (for Content)
☐ Response Cards</td><td colspan="2"></td></tr>
<tr><td colspan="4">Based on the results from your Daily Progress Monitoring Assessment, what concepts need to be revisited in the next lesson?</td><td>Homework</td></tr>
</table>

UNIT PLAN

Unit Title: Biotechnology	**Content Area/Grade: Biology / 9th - 10th grade**
Teacher: Mrs. Margaret Lawrence	**Implementation Time Frame: 8 days / 120 mins per day**

STAGE 1: THE DESIRED RESULTS
What are my learning goals?

Unit Goal Students will understand that…	**Standard(s)/Benchmark(s)** What standard(s)/benchmark(s) does this daily lesson address?
1. Describe the function of DNA, RNA, and protein in living cells and the Central Dogma. 2. Demonstrate how the structure of DNA influences its function, analysis, and manipulation. 3. Construct a model of the DNA. 4. Describe the basic process of DNA replication and the transmission of genetic information.	**SC.912L.14.6** Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health. **SC.912L16.3** Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic information. **SC.912L16.4** Explain how mutations in the DNA sequence may or may not result in phenotypic change. Explain how mutations in gametes may result in

Related Misconceptions What misconceptions are predictable?	**Students will know…** Vocabulary, terminology, definitions
Misconceptions lie in the lack of facts about biotechnology which are usually associated with genetically modified foods. Lack of information lead people into believing that biotechnology techniques are not natural and may lead to major diseases.	**Vocabulary :** Enzyme, DNA, RNA, Replication, Transcription, Translation, Mutation, Point mutation, Frameshift mutation, Chromosomal mutation, Gene mutation, Decellularization, DNA polymerase, DNA Helicase, RNA polymerase, tRNA, mRNA, rRNA, Translocation, Duplication, Deletion, Insertion , Central Dogma,
Essential Questions What questions will foster inquiry, understanding and transfer of learning?	
1. How is DNA important to living things? 2. How do mutations occur? 3. What kinds of diseases/disorders are caused by mutations? 4. How can genetic disorders be treated or cured?	

Students will know…
key facts, formulas, critical details, important events, important people, timelines

Other Essential Knowledge

The transfer of the genetic code from DNA to RNA through the process of transcription is followed by the decoding of the message into a protein through the process of translation; this is called the Central Dogma.
Scientists important in the discovery of DNA are Rosalind Franklin, James Watson, Francis Crick, Erwin Chargaff.
A change in the DNA is called a mutation and can be caused by various external and internal factors. This change will result in changes in the protein sequence which could be harmless, helpful and results in genetic variation in species or sometimes lead to genetic disorders that could be harmful or deadly.

Students will be able to…
Specific skills students will acquire as a result of this unit

1. How to do use the scientific method in doing research
2. How to put together a model of a DNA molecule.
3. How to use lab equipment.
4. How to use case studies in research.
5. How to do a webquest on the computer.
6. Reading comprehension.
7. Analyzing and graphing data.
8. Working cooperatively in small groups.

STAGE 2: ASSESSMENT EVIDENCE

What evidence will show that my students have achieved the learning goals?

Performance tasks:

Through what specific "real-world" performance task(s) will students demonstrate their understanding of the learning goals?

The students will do an activity to determine mutations that cause particular types of genetic disorders, they will then research the disorders and present it to the class. They will also research the use of stem cells in treating or curing these disorders.
They will have pretests and post tests to evaluate how much they have learned.
They will do bell ringer questions to check prior knowledge of work done at home and from previous lessons.
They will do lab activities that will allow them to analyze data, draw conclusion, and make evaluations.
They will have in class question and answer sessions each day, which will give some ideas as to how well they are comprehending the information.

Rubric

By what criteria will "performance of understanding" be judged?

1. A pretest of the content.
2. Lab grade on the DNA Extraction of Strawberries.
3. Webquest evaluation for completion.
4. Research project on a genetic disorder.
5. Lab grade on Stem Cells – Science Take-Out.
6. Lab grade on Bioengineering a Liver.
7. Post test on content.

Other Evidence: What other evidence needs to be collected in order to monitor student progress on these concepts and skills along the way?	**Self-Assessment/Reflection** How will students reflect and self-assess their learning?
1. Retrieve prior knowledge with bell ringer exercises. 2. Visual monitoring as they work on labs and the webquest. 3. Question and answering sessions as we discuss the various types of disorders and biotechnology techniques.	The bell ringer activity will allow them get immediate feedback on the information that they read for homework. They will use a Team Based Learning approach to complete their post test. They will compare it first with their pretest, then they will get points from their iRAT and tRAT scores.

STAGE 3: LEARNING EXPERIENCES, INSTRUCTION, AND RESOURCES
What activities will help my students achieve the learning goals?

What **W**here	**What** is expected? How will you ensure that students are aware of the learning goals? **Where** are your students? How will you establish your students' prior knowledge?
	Learning goals will be posted on the board daily and discussed periodically during lessons. Students will explain their goals as they attempt labs and presentations. Bell ringer questions at the beginning of class will be used to retrieve prior knowledge.
Hook **H**old	How will you **hook** students at the beginning of the unit? How will you **hold** their attention throughout the units?
	"60 Minutes" video clip on the use of DNA in determining genetic disorders in families. Video clips on genetic disorders and discussion of disorders. Lab activities, webquests, case studies along with class discussions will be used to hold their attention throughout the unit.
Experience **E**xplore **E**quip	What critical input **experience** will help students **explore** the key ideas and essential questions? How will you **equip** your students with needed skills and knowledge?
	The labs on decellularization, stem cells and DNA extraction will help students explore the key ideas and essential questions. Reading assignments, video reviews, research and case studies will equip the students with the needed skills and knowledge.
Reflect **R**ethink **R**ehearsing **R**evising **R**efining	How will you encourage students to **reflect** and **rethink**? How will you guide students in the process of **rehearsing**, **revising**, and **refining** their work?
	Using concept mapping and the Team Based Learning activities will help the students to do all of the reviewing and rethinking and refining of their work.
Exhibit **E**valuate	How will you help students to **exhibit** and **self-evaluate** their developing skills, knowledge and understanding throughout the unit?
	The students will present their genetic disorder research to the class and will detail their knowledge of genetic disorders, how they occur, and how they can be treated or cured. They will also listen to other students' presentation and will be able to ask questions and evaluate their work.
Tailor	How will you **tailor** your instruction to meet the different needs, interests and abilities of all learners in your classroom?
	By using a variety of techniques I hope to meet the needs of all of the learners in the class. There will be reading activities, hands on activities, presentations, writing exercises, individual and group activities.
Organize	How will you **organize** and sequence the learning activities to maximize the engagement and achievement of all students?
	The students will have the opportunity to work on individual assignments as well as to work in small groups. In small groups they will work on lab activities as well as the TBL which will give each student a role in the group. The genetic disorder assignment will also have students working in pairs which again will allow for individual engagement.

Big Idea:		Standard(s)/Benchmark(s):
Unit:		Sample Activities
Grade:		
Score 4.0	**In addition to Score 3.0, in-depth inferences and applications that go beyond what was taught.**	
Score 3.0	**The student:** **The student exhibits no major errors or omissions**	
Score 2.0	**There are no major errors or omissions regarding the simpler details and processes as the student:** • Recognizes or recalls specific terminology • Performs basic processes, such as: **However, the student exhibits major errors or omissions regarding the more complex ideas and processes**	
Score 1.0	**With help, a partial understanding of some of the simpler details and processes and some of the more complex ideas and processes.**	
Score 0.0	**Even with help, no understanding or skills demonstrated.**	