A Study of the Effects of Using Hands on Lab Activities and Simulations, to Improve Student Attitudes and Knowledge about Biomedical Science Technology, Genetic Disorders, and Disease.

Mr. Loren R. Price
Teacher Biology, Marine Science
Grades 9-12
Northeast High School (Oakland Park, FL)
BROWARD COUNTY SCHOOL DISTRICT
700 NE 56 Street
Oakland Park, FL 33334
School Phone 754 322 1550
Cell Phone 954 547 4738
School email- Loren.Price@browardschools.com
Alt phone email – LRPrice1@GMail.com

ABSTRACT:

The purpose of this study is to describe the effects of using hands on lab activities and simulations to excite students about biomedical science technology and improve students understanding of genetic disorders and disease.

My 9-12 grade Biology students were given a survey a few weeks into the course regarding their attitudes toward science, all subjects, and varied learning styles. The questions also addressed attitudes toward biotechnology uses, ethics, and knowledge of techniques. In the pre survey, Students showed a neutral to generally positive attitudes toward science, biotechnology, and hands-on activities like labs and simulations and negative attitudes toward textbook learning of facts. The themes of Bench to Bedside and some of the resources, labs, simulations, and links discovered through B2B were used and will continue to be infused into the course.

The survey was re administered at the end of the course and data analyzed. Students continued to show a general positive attitude toward science and biotechnology, an increased positive attitude toward learning through simulation and computer simulation labs, and an increase in knowledge of biotechnology and genetics.

Many of the resources, links, and labs have been used also with my Marine Science classes and were shared throughout my department, especially within my small department biology common planning community, and the coordinator of our school's after school Weird Science Club.

RATIONALE:

The theme of biotechnology in science can incorporate more than 20 national science standards when incorporated into the biology curriculum. According to the University of Florida, new Florida biotechnology companies have increased 21 percent over the past 3 years, outpacing the rest of the nation. There are many job opportunities in the biotech industry, from sales and marketing, to research and development, to manufacturing and quality control and assurance. Biotechnology can impact the individual, society, and the environment, including medical and ethical issues. It has been used for over 6,000 years to make useful food produces like bread, yogurt, wine, and cheese. Genetic engineering of animals is also used to advance human health, enhance food production and quality, lessen environment impact, and improve industrial products.

Through the use of hands on lab activities, and virtual lab simulation activities I aim to excite students about biomedical science and improve their understanding of genetic disorders or disease. A 1988 study of 8th grade students by Stohr-Hunt found that students who engaged in hands-on activities every day or once a week scored significantly higher on a standardized test of science achievement than students who engaged in hands-on activities once a month, less than once a month, or never. A 2008 study by Foley and McPhee showed students in hands-on classes were more favorable to science and had a better understanding of the nature of science than students in textbook classes.

Some of the virtual lab activities will be conducted using computer simulations. This type of approach in learning has been used in the

Stanford University Medical School to teach physiology. In a 2003 publication, Huang stated that Biomedical Sciences has been mainly taught with conventional educational tools like textbooks, lectures, and wet-laboratories. His study found that new web technologies and online learning media could supply current biomedical information to the students in an engaging way, promoting their technology proficiencies and their professional development.

Finally, a 1996 study by Gokhale at the University of Illinois concluded that effective integration of computer simulation into traditional lecture-lab activities enhances the performance of the students. Guided computer simulation activities can be used as an educational alternative to help motivate students into self-discovery and develop their reasoning skills. Gokhale found that the lab activity could then focus on the actual transfer of knowledge improving the effectiveness and efficiency of the teaching-learning process.

This action research seeks to use hands-on lab activities and simulations to educate and excite students about biomedical science technology and improve their understanding of genetic disorders and disease.

ACTION RESEARCH INTERVENTION:

My action research intervention is to use hands on biotechnology simulation lab activities and computer based simulation lab activities presented and discovered through the Bench to Bedside program during the summer of 2011 throughout my Biology and Marine Science courses to excite students and increase their knowledge about biomedical science in its use of studying and treating genetic disorders and disease. I conducted pre and post surveys to assess knowledge and attitudes towards hands on learning and biotechnology. Over 20 national science strands for Biology were incorporated into these activities. These National Science Standards are listed after the data collection and analysis section.

CONNECTIONS TO BENCH TO BEDSIDE SUMMER INSTITUTE:

Hands on lab activities and computer simulation lab activities presented and discovered through the Bench to Bedside program during the summer of 2011 were used to excite students and increase their knowledge about biomedical science/technology, and genetic diseases. The following activities were implemented as well as other links infused into the course. I also intend on trying to do as many of the listed activities as possible that we were not able to get to if time permits in the future.

Many of the resources, links, SIFT links, interactive activities, and labs have been also used with my marine science classes as well as have been shared throughout my department, especially within my small department biology common planning team, and the coordinator of our school's after school "Weird Science Club."

PRE TEST: (30 minutes) It includes Likert scale type questions about attitudes toward science, learning styles, and biotechnology.

ACTIVITY - (less than an hour) B2B inspired me to use more virtual labs this year like this one conducted early in the first few weeks of school. While exploring Experimental design, we conducted a Virtual Lab from CLASS ZONE that coincides with the Biology Text, http://www.classzone.com/cz/books/bio_12_fl/get_center_home.htm?rg=labs

The link to an Interactive zoom of Cell Size and Scale from the carbon atom to a coffee bean was used during units about Chemistry of Life, Macromolecules, and Cells.
http://learn.genetics.utah.edu/content/begin/cells/scale/

The link to the poster "How Do Drugs Work?" that showed examples from the Protein Data Bank PDB archive Educational resources was tied into the unit about macromolecules like DNA and proteins. Emphasis was how structure related to function and how drugs fit into specific spaces.
http://www.pdb.org/pdb/101/static101.do?p=education_discussion/educational_resources/index.html#Posters-Exhibits
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

ACTIVITY or DEMO - BUILD A DNA MOLECULE – (10-15 minutes) to teach Complementary Base pairing and DNA Structure
http://learn.genetics.utah.edu/content/begin/dna/builddna/
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

1 DAY ACTIVITY- TOUR OF THE BASICS GENETICS INTERACTIVE ANIMATIONS - WEB QUEST with Guiding Questionshttp://learn.genetics.utah.edu/content/begin/tour/index.html
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

BEYOND THE BASICS WEB QUEST - GENETICS

Log on to: http://learn.genetics.utah.edu

1. What is DNA?
2. What does "DNA" stand for?
3. What is the four-letter DNA alphabet and what are the special rules by which the alphabet pieces bond together?
4. What is a gene?
5. What are genes made of?
6. How many genes do humans have?
7. For what molecule do genes contain the instructions for building?

8. What is a chromosome
9. How many chromosomes does a human cell hold?
10. How are the human sex chromosomes labeled?
11. How many different kinds of proteins does one cell contain?
12. Why do scientists use computer programs to model protein structure and function?
13. What provides the "blueprint" for making a protein?
14. What is heredity?
15. Why aren't children identical to either one of their parents?
16. In humans, how many chromosomes does each parent pass on to their offspring?
17. Does the second baby in the What is Heredity? animation inherit the exact same chromosomes as the first? Do both babies have a complete set?
18. What is a trait?
19. List the types of traits that exist?
20. Give an example of how an environmental factor can influence a trait. Briefly explain how the Hitchhiker's Thumb trait is determined using the following words: allele, dominant, recessive, homozygous, heterozygous. You may draw pictures if you wish.

DEMO or SHORT ACTIVITY - TRANSCRIBE AND TRANSLATE A GENE
http://learn.genetics.utah.edu/content/begin/dna/transcribe/
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

DEMO or SHORT ACTIVITY - PROTEIN SYNTHESIS - What makes a Firefly glow
http://learn.genetics.utah.edu/content/begin/dna/firefly/
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

ACTIVITY: (30+min) DNA MicroArray - simulation lab FLASH ANIMATION ACTIVITY
http://www.bio.davidson.edu/courses/genomics/chip/chip.html
Great intro about MicroArrays. Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.
Need computer cart or computer lab.

ACTIVITY: (40+ min) – Drinking Water Pathogens Simulation MicroArray Kits– Dr. Charles Lawrence UF

Students will conduct a hands-on lab simulation experience to investigate for pathogens in water. Students will gain knowledge and simulate the techniques of microarray technology as well as will gain knowledge of viral, bacterial, or protozoan pathogens that could be present in water and the diseases they can cause.
Need kits: (MicroArray card, forceps, MicroArray container (plastic tray), tube of water sample, waste container, tube of Labeling mix, water, food coloring (blue and green), tube of wash solution, paper towels, UV light.)
More detailed procedures and data sheets are in the MicroArray kits. Adjust group size depending on the number of kits and students.
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

ACTIVITY 5: (40+ min) – Virus MicroArray Simulation Kits– Dr. Charles Lawrence UF
Students will conduct a hands-on lab simulation experience to investigate for viruses in blood plasma of tourists. Students will gain knowledge and simulate the techniques of microarray technology as well as will gain knowledge of viral pathogens and the diseases they can cause.
Need kits: (MicroArray card, forceps, MicroArray container (plastic tray), tube with pellet banana yogurt, waste container, tube of Labeling mix, buffer tube, food coloring (yellow and blue), tube of wash solution, paper towels, UV light.)
More detailed procedures and data sheets are in the MicroArray kits. Adjust group size depending on the number of kits and students.
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

ACTIVITY: (40+ min) Virtual Lab – GEL Electrophoresis –
http://learn.genetics.utah.edu/content/labs/gel/
Students will conduct a computer simulation lab using gel electrophoresis technology. A short informational video explains the process. Next, the students perform the entire process online. Students learn how this technology can be used to sort DNA strands according to length or other molecules like proteins.
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

ACTIVITY: (30-40 min) –Virtual Lab - Create a DNA fingerprint NOVA -Solve the crime of who licked the lollipop. Guiding questions were also given. http://www.pbs.org/wgbh/nova/teachers/body/create-dna-fingerprint.html

NOVA - CREATE A DNA FINGERPRINT
http://www.pbs.org/wgbh/nova/teachers/body/create-dna-fingerprint.html

In this computer lab simulation you will solve a crime and discover who licked Jimmy Sweet's prized holographic NOVA lollipop by creating a DNA fingerprint using biotechnology.

1. Who are the suspects?
2. What is your task as NOVA Lab's chief technician?
3. STEP 1 - What do the restriction enzymes do?
4. STEP 2 Describe the Agarose Gel? and Describe how it will act like a molecular strainer.
5. STEP 3 Where is the DNA put into?
6. STEP 4 What type of charge do the DNA fragments have? Describe how the DNA fragments move through the gel.
7. STEP 4 What type of DNA fragments travel further down the gel? Why?
8. STEP 5 Describe what is transferred from the gel to the nylon membrane.
9. STEP 6 What are the probes you are adding to the nylon membrane in the tray?
10. STEP 7 What do you do with the excess probe liquid?
11. STEP 8 Write what the radioactive probes do to the x-ray film?
12. STEP 9 After the film is developed, what will it display?
13.CHOOSE THE CULPRIT? Who did the saliva match up with?

1 DAY ACTIVITY – Virtual Lab - CLICK AND CLONE-CLONE A MOUSE http://learn.genetics.utah.edu/content/tech/cloning/clickandclone/
In this activity students will learn about cloning by way of (SCNT) Somatic Cell Nuclear Transfer. The mission is to create a genetically identical clone of Mimi, a brown female mouse. Guiding Questions were given to the students as well.
Need computer cart or computer lab.
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

CLICK AND CLONE-CLONE A MOUSE http://learn.genetics.utah.edu/content/tech/cloning/clickandclone/

In this activity you will learn about cloning by way of (SCNT) Somatic Cell Nuclear Transfer. Your mission is to create a genetically identical clone of Mimi, a brown female mouse.

1. What is the difference between Somatic cells and Sex cells? Give examples of each?
2. What type of set of chromosomes do Somatic cells have? Haploid or Diploid? What Diploid does that mean?
3. What type of set of chromosomes do Egg or Sperm cells have? Haploid or Diploid? What does Haploid mean?
4. Write who Mimi, Medgo, and Momi are, include their colors?
5.List Materials needed.
6. STEP 1 Write what kind of cells are donated by Mimi? and what kind by Medgo?

7. STEP 2 What is being removed from the egg cell? What does enucleated mean?
8. STEP 3 Write what you are doing in this step?
9. STEP 4 What is another name for Cell division?
10. STEP 4 How is cell division stimulated in the petri dish? How many cells are present after the cell has divided a few times.
11. STEP 5 Write what you are doing in this step?
12. STEP 6 What does it mean that the embryo begins to differentiate its cells?
13. STEP 6 Write how long the pregnancy lasts?
14. STEP 6 What are you doing in this step.
15. What color did you Predict the baby mouse will be?
16. Why was the pup brown and not Grey like Medgo the egg donor or White like Momi who was pregnant with and delivered the pup?
17. Did this really happen? When and Where? What was the name of the first survivor?

The following links from the http://learn.genetics.utah.edu/ website were presented to my upperclassmen marine science students to explore as well as to my 10th grade biology students who finished exploring the other web labs. They were instructed to:
Write the title of lab and web address. Write a SUMMARY about the lab and a SHORT RESPONSE about your Opinion of the lab. Was the lab worthwhile? Was it an effective way to learn? What did you learn?

Explore the Following Virtual Online Labs
Write the title of lab and web address. Write a SUMMARY about the lab and a SHORT RESPONSE about your opinion of the lab. Was the lab worthwhile? Was it an effective way to learn? What did you learn?
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

GO GO STEM CELLS - http://learn.genetics.utah.edu/content/tech/stemcells/sctypes/

VIRTUAL DNA EXTRACTION LAB
http://learn.genetics.utah.edu/content/labs/extraction/

Neurofibromin activity in cells. See how a mutated protein can affect normal cell division.
http://learn.genetics.utah.edu/content/begin/dna/neurofibromin/

The New Science of Addiction: Genetics of the Brain

http://learn.genetics.utah.edu/
Drugs of Abuse
http://learn.genetics.utah.edu/content/addiction/drugs/abuse.html
Mouse Party - the effects of drugs on the brains of mice.
http://learn.genetics.utah.edu/content/addiction/drugs/mouse.html

ACTIVITY: (40+ min) Virtual Lab - PCR VIRTUAL LAB - http://learn.genetics.utah.edu/content/labs/pcr
Students will conduct a computer simulation lab using PCR (Polymerase Chain Reaction) technology. The students perform the entire process online learning the lab techniques and steps of PCR. In doing so, they will learn how this technology is used to diagnose diseases, identify bacteria and viruses, match criminals to crime scenes, and in many other ways.
Need computer cart or computer lab.

POST TEST: (30 minutes) It is the same as the PRE TEST.

FUTURE ACTIVITIES IF POSSIBLE:

ACTIVITY 1: (30 minutes) – Students will participate in a micropipette lab to teach techniques of pipetting or micro pipetting. This technique will be useful in later labs.
SC.912.N.

ACTIVITY 2: (40+ min.) DIAGNOSING DIABETES TAKE-OUT LAB activity DIAGNOSING DIABETES LAB Students will learn background information about the mechanisms of the causes and types of diabetes and will conduct a test using a hands-on simulation lab experience to determine if a person has type 1 or 2 diabetes. Students will learn about sugars, cells, hormones, and genetic disorders.
Need kits: (looking into materials)
More detailed procedures and data sheets are in the kits. Adjust group size depending on the number of kits and students.
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

ACTIVITY 3: (40+ min) – ELISA Allergy Test Simulation Kits– Dr. Charles Lawrence UF
Students will conduct a hands-on pipetting lab simulation experience to investigate allergies by detecting the presence of an antibody or antigen using an Enzyme-Linked ImmunoSorbent Assay or ELISA.
Need kits: (looking into materials)
More detailed procedures and data sheets are in the kits. Adjust group size depending on the number of kits and students.
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

ACTIVITY 4: (40+ min) – Citrus Disease MicroArray Simulation Kits– Dr. Charles Lawrence UF
Students will conduct a hands-on lab simulation experience to investigate for pathogens in citrus. Students will gain knowledge and simulate the techniques of microarray technology as well as will gain knowledge of pathogens and the diseases they can cause in citrus.
Need kits: (MicroArray card, forceps, MicroArray container (plastic tray), tube with citrus sample yogurt pellet, waste container, tube of Labeling mix, buffer tube, food coloring (yellow and blue), tube of wash solution, paper towels, UV light.)
More detailed procedures and data sheets are in the MicroArray kits. Adjust group size depending on the number of kits and students.
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

ACTIVITY 5: (40+ min) – Environmental MicroArray Eco-Array Simulation Kits– Dr. Charles Lawrence UF
Students will conduct a hands-on lab simulation experience to investigate for estrogenlike and antiandrogenic chemical and certain other environmental chemicals that have an affect on human health and ecological well-being. Students will gain knowledge and simulate the techniques of microarray technology as well as will gain knowledge of chemicals that might inadvertently be disrupting the endocrine system of humans and wildlife.
Need kits: (MicroArray card, forceps, MicroArray container (plastic tray), tube with fish cell sample yogurt pellet, waste container, tube filled with small beads mRNA beads, buffer tube, elution buffer tube, labeling mixture tube, food coloring (yellow, blue, and green), tube of wash solution, paper towels, UV light.)
More detailed procedures and data sheets are in the MicroArray kits. Adjust group size depending on the number of kits and students.
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

ACTIVITY 6: (40+ min) – Southern Blot DNA Fingerprinting Simulation Kits– Dr. Charles Lawrence UF
Students will conduct a hands-on lab simulation experience to investigate “The High Rise Killer” and their DNA fingerprint to solve a crime. Students will gain knowledge and simulate the techniques of DNA fingerprinting using the Southern Blot.
Need kits: (looking into materials)
More detailed procedures and data sheets are in the kits. Adjust group size depending on the number of kits and students.
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

ACTIVITY 7: (40+ min) Creating a Stem Cell Line - EdHeads.org/activities/stem1
Students will conduct a computer simulation lab and learn how grow stem cells and test for what type of stem cells are present in a sample. This activity also include a business aspect, taking the students from the research/development stage to marketing the stem cell line.
Need computer cart or computer lab.
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

ACTIVITY 8: (40+ min.) SCIENE TAKE-OUT LAB activity STEM CELLS LAB 10kits x 10.80 = $108
Students will use a hands-on simulation lab to test for specific types of stem cells in the body and their functions. Students will stimulate growing stem cells and will investigate potential uses.
Need kits: (looking into materials)
More detailed procedures and data sheets are in the kits. Adjust group size depending on the number of kits and students.
Numerous strands are addressed within SC.912.L.14, 16, 18 as well as SC.912.N.

DATA COLLECTION AND ANALYSIS:

A variety of data collection and analysis techniques were used to assess the target audience.

My 9-12 grade Biology students were given a survey a few weeks into the course regarding their attitudes toward science, all subjects, and varied learning styles. The questions also addressed attitudes toward biotechnology uses, ethics, and knowledge of techniques. This same survey was given as a post survey toward the end of the course. Questions and data are presented here.

Mr. Loren R. Price **Bench to Bedside – 2011/12** **PRE/POST-TEST/SURVEY**

ATTITUDE TOWARD SCIENCE LEARNING

1. Which subjects to you like to study most in school? RANK from like a lot (5) to don't like at all (1)

(5) Like a lot (4) Like (3) Neutral (2) do not like some (1) don't like at all

a. _____ Science
b. _____ Social Studies (history)
c. _____ Math
d. _____ Reading
e. _____ English
f. _____ Fine Arts
g. _____ Foreign Language
h. _____ Computer Science
i. _____ Business

2. How hard is science for you? (Circle a number from 1-5) very hard to easy

(5) Very hard (4) Hard (3) Neutral (2) Easy (1) Very Easy

3. Do you AGREE or DISAGREE with the following sentences:

a) _____ **"The science in school is not related to my everyday life."**
b) _____ **"Understanding scientific ideas is more important than memorizing facts.**
c) _____ **"Science is too complicated for most students to understand."**
d) _____ **"Science is more important for boys than for girls."**
e) _____ **"The science principles in textbooks will always be true"**

4. Textbook assignments are effective for me to learn science.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

5. I prefer to learn from a textbook than through hands-on activities.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

6. I learn better from a textbook than through hands-on activities.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

7. Hands on activities are an effective way for me to learn science.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

8. Lectures and notes are an effective way for me to learn science.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

9. Computer simulation labs are an effective way for me to learn science.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

10. Hands on simulation labs are an effective way for me to learn science.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

11. I have performed biotechnology labs or biotechnology simulation labs.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

ATTITUDES TOWARD BIOTECHNOLOGY

12. Bioethics education should be discussed in science lessons.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

13. Human cloning and the issues associated with it should be discusses in science lessons.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

14. I accept that the genetic modification of food, animals and humans is a good thing.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

15. I think it is acceptable to modify genes in the gens of micro-organisms and plants.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

16. Altering the genes of plants so that they will grow better in salty soils is acceptable.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

17. I think that adding genes to plants to increase their nutritional value is acceptable.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

18. Altering genes in tomatoes to make them ripen more slowly and have a longer shelf life is a good use of biotechnology?

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

19. Using genetically engineered micro-organisms to break down human sewage is a good thing.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagre

20. Altering genes in fruit to improve their taste is a good idea.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

21. Consumption of genetically modified food is risky

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

22. I agree with the use of genetic engineering if it helps with therapy of genetically determined diseases

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

23. I support the use of food biotechnology to modify plant's genetic structure to be more resistant to damage by insects, thereby reducing pesticide applications

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

24. Altering the genes of plants so that they will grow better in salty soils is acceptable to me

I agree with the use of plants in which genes increasing quality and productivity were inserted

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

25. Inserting genes from human cells into the fertilized eggs of sheep is acceptable to me

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

26. I support changing the genes in cattle to make their meat more nutritious to eat

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

27. Manipulations with DNA are unethical

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

28. Men do not have rights to intervene to DNA, it is against nature.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

29. Use of GM microbes to decomposing human sewage is acceptable to me

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

30. I support the use of genetic engineering for non food purposes such as production of human medicines

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

31. I agree with production of insulin with using genetically modified microbes

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

ATTITUDES STEM CELLS
In general, I approve of embryonic stem cell research.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

32. "There is a type of medical research that involves using special cells, called embryonic stem cells, that might be used in the future to treat or cure many diseases, such as Alzheimer's, Parkinson's, diabetes, and spinal cord injury. It involves using human embryos discarded from fertility clinics that no longer need them. Some people say that using human embryos for research is wrong. Do you favor or oppose using discarded embryos to conduct stem cell research to try to find cures for the diseases I mentioned?"

FAVOR OPPOSE UNSURE

33. "Do you favor or oppose expanding federal funding for embryonic stem cell research, which is the practice of conducting scientific research on cells extracted from human embryos in an attempt to find cures or treatments for diseases?"

FAVOR OPPOSE UNSURE

KNOWLEDGE of BIOTECHNOLOGY and TECHNIQUES/TOOLS

34. I have knowledge of genetics.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

35. I have knowledge of biotechnology.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

36. I have knowledge of cloning.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

37. I have knowledge of Gel Electrophoresis.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

38. I have knowledge of MicroArrays.

(5) Strongly Agree (4) Agree (3) Neutral (2) Disagree (1) Strongly Disagree

Attitudes toward School Subjects Ranked Highest to Lowest

Increase in Science due to a decrease in Fine Art. Increase in attitude toward English. Same like but less disliked Social Science. There was a decrease from like to neutral for business and a dislike toward computer science increased. Reading and math continued to be disliked.

PRE

Like A lot: Fine Art, Science, Like Business, Social Science, Like some Computers,

Dislike A lot: Reading, Dislike English, Math, Foreign language

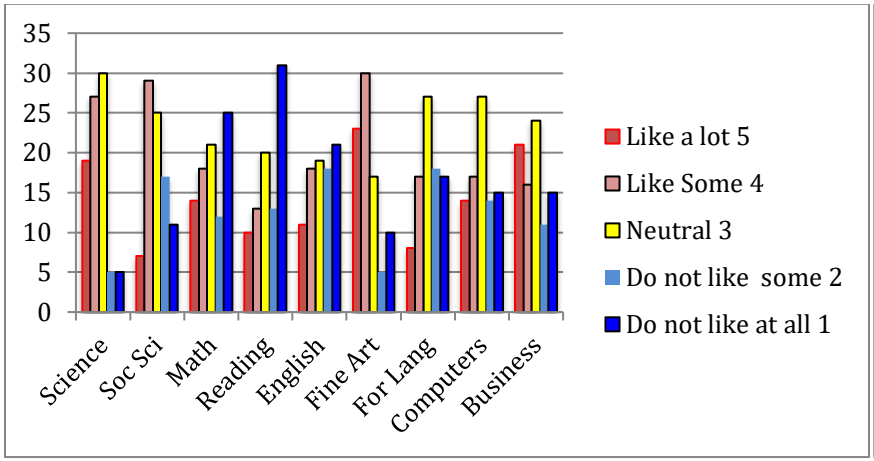
POST

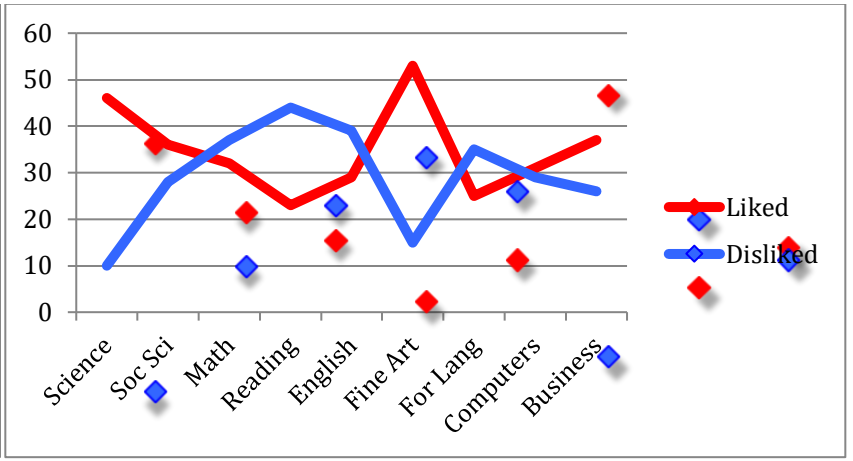
Like A lot: Science, Like Social Science, Fine Art, Foreign Language, Like English

Dislike A lot: Reading, Computer Science, Dislike Math

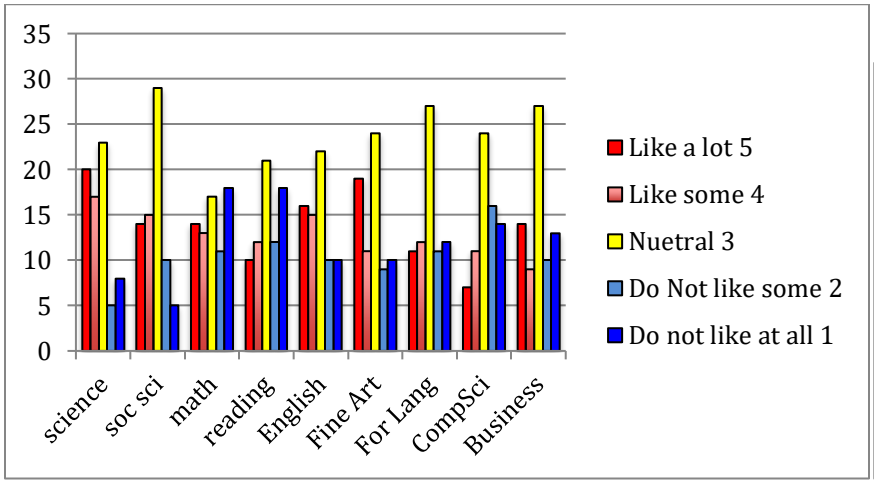
Neutral: Business

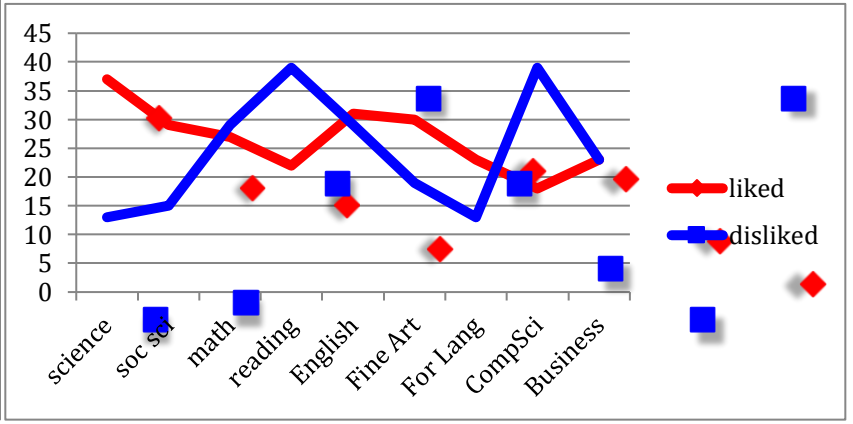
PRE SURVEY - 86 people





POST SURVEY – 73 people





Attitudes Toward Learning Styles Ranked Highest to Lowest

Hands on simulation and computer simulation labs showed an increase in feelings of effective way to learn compared to traditional hands on labs. A major increase seen in students who agree they have performed biotechnology. Lecture and text were still viewed as effective. Most students in both pre and post survey, strongly disagreed or disagree that they learn better from a text or prefer learning from a text.

PRE

Strong Agree/Agree: that hands on labs, hands on simulation labs, lecture notes, computer simulation labs, and learning from the text are effective ways to learn.

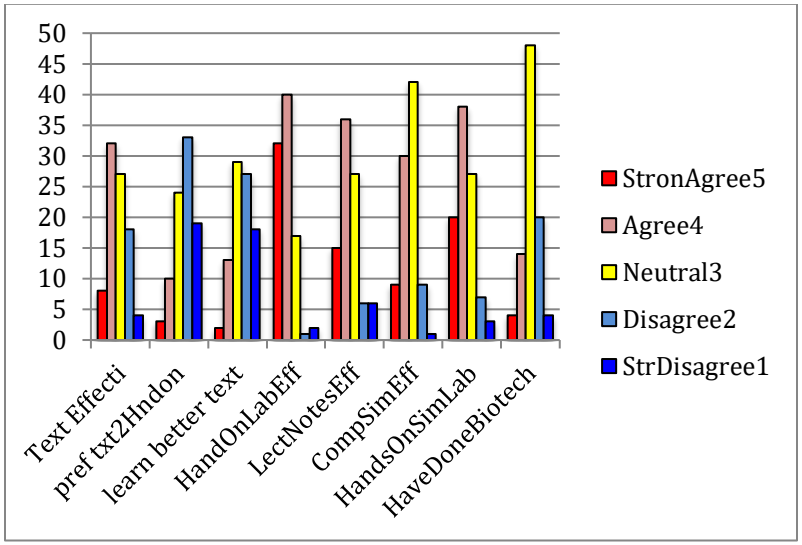
Strongly Disagree/Disagree: that they learn better from a text, prefer learning from a text, that they have performed biotechnology.

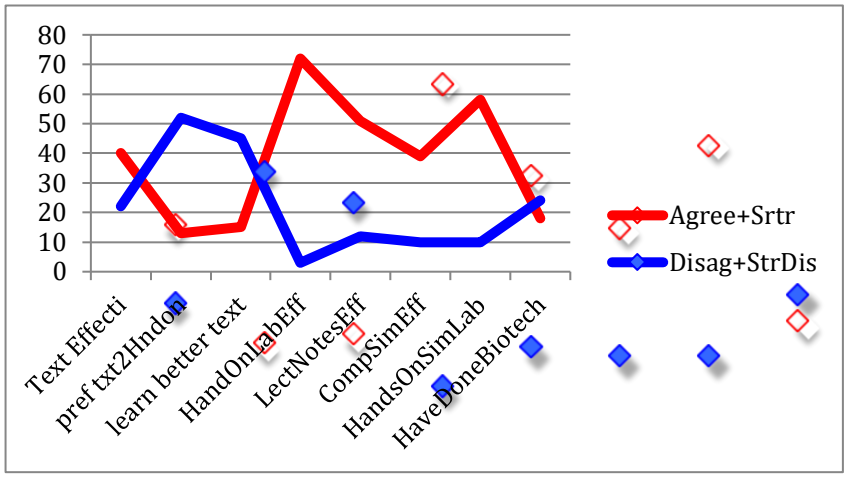
POST

Strong Agree/Agree: that hands on simulation labs and computer simulation labs are effective ways to learn, that they have performed biotechnology, that lecture notes, hands on labs, and learning from the text are effective ways to learn.

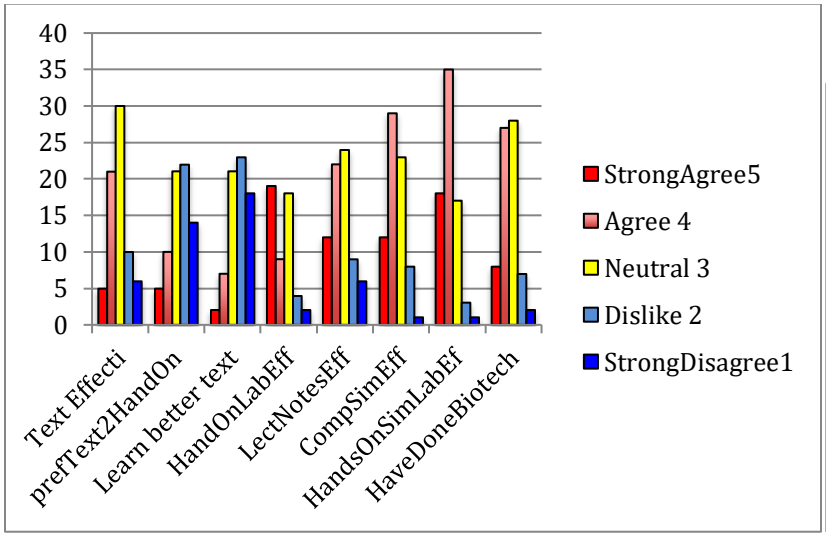
Strongly Disagree/Disagree: that they learn better from a text or prefer learning from a text.

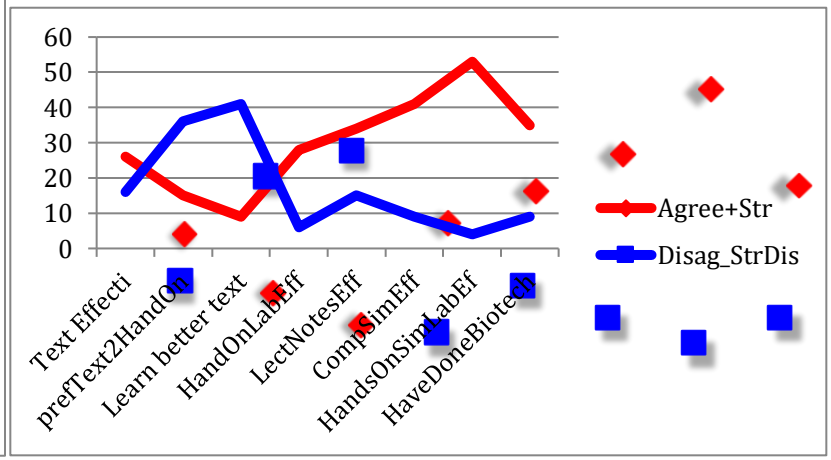
PRE


50
45
40
35
30
25
20
15
10
5
0
Text Effecti
pref txt2Hndon
learn better text
HandOnLabEff
LectNotesEff
CompSimEff
HandsOnSimLab
HaveDoneBiotech
StronAgree5
Agree4
Neutral3
Disagree2
StrDisagree1


80
70
60
50
40
30
20
10
0
Text Effecti
pref txt2Hndon
learn better text
HandOnLabEff
LectNotesEff
CompSimEff
HandsOnSimLab
HaveDoneBiotech
Agree+Srtr
Disag+StrDis

POST


40
35
30
25
20
15
10
5
0
Text Effecti
prefText2HandOn
Learn better text
HandOnLabEff
LectNotesEff
CompSimEff
HandsOnSimLabEf
HaveDoneBiotech
StrongAgree5
Agree 4
Neutral 3
Dislike 2
StrongDisagree1


60
50
40
30
20
10
0
Text Effecti
prefText2HandOn
Learn better text
HandOnLabEff
LectNotesEff
CompSimEff
HandsOnSimLabEf
HaveDoneBiotech
Agree+Str
Disag_StrDis

Attitudes towards biotechnology such as GMO's, bioethics, uses of, stem cells etc.

Fairly consistent Pre and Post results.

High agreement/agreement with being taught bioethics, discussing human cloning discussed, genetically modifying food, animals, and humans, GMO's, embryonic stem cell research, producing insulin using microbes, gene therapy, altering plant for nutrition, to grow in poor soils, and for insect resistance, using microbes to treat sewage, genetic engineering.

Agreement that eating GMO's is risky, manipulating DNA is unethical,

Slightly less agreement that humans have no right to intervene in DNA, its against nature.

Less disagreed in post survey with altering plant genes to grow in salty soils.

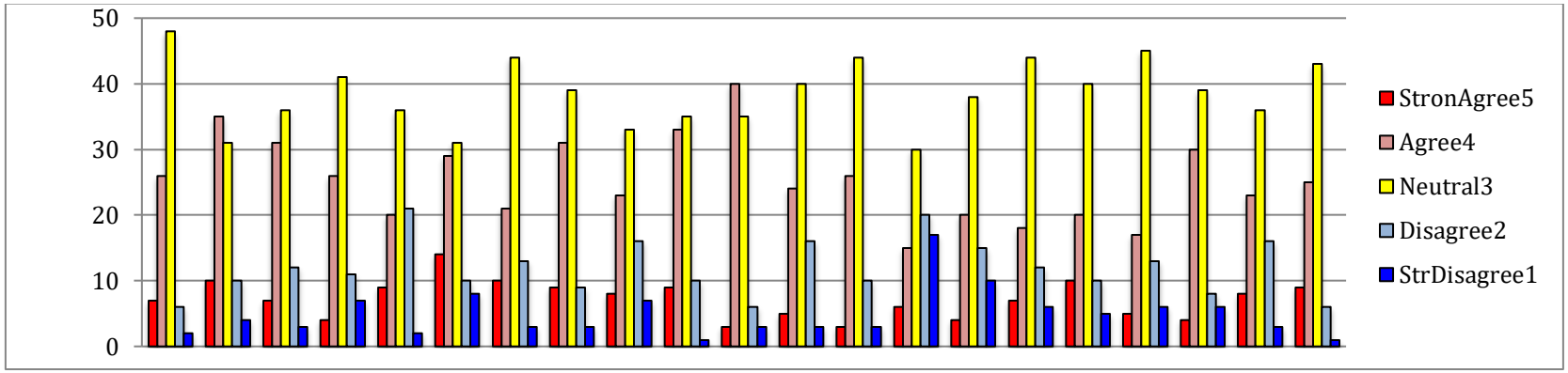
Less agreement in the post survey with altering tomato genes to give it a longer shelf life.

Shift from agreement in the pre toward Neutral in the post survey for altering fruit genes to make them taste better.

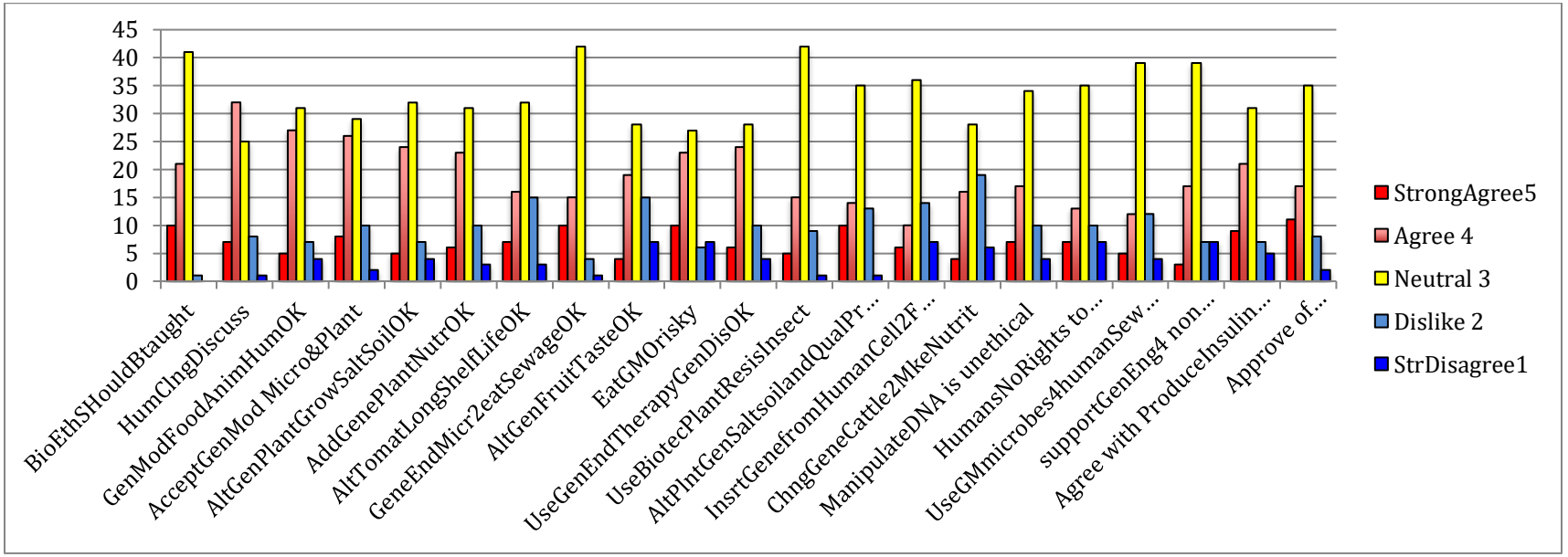
More disagreed in the post survey with altering cattle dna to make it more nutritious.

Most disagreed in the pre survey with inserting genes from humans in to sheep embryos. While more disagreed in the post, far fewer disagreed than in the pre and may have shifted toward neutral.

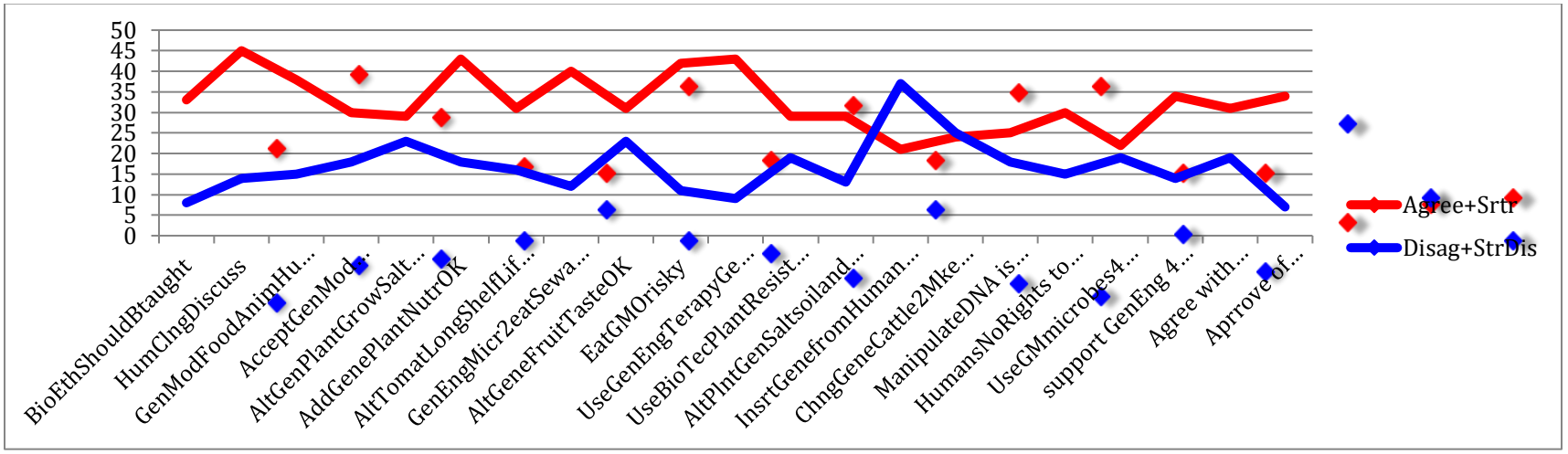
PRE


50
40
30
20
10
0
StronAgree5
Agree4
Neutral3
Disagree2
StrDisagree1

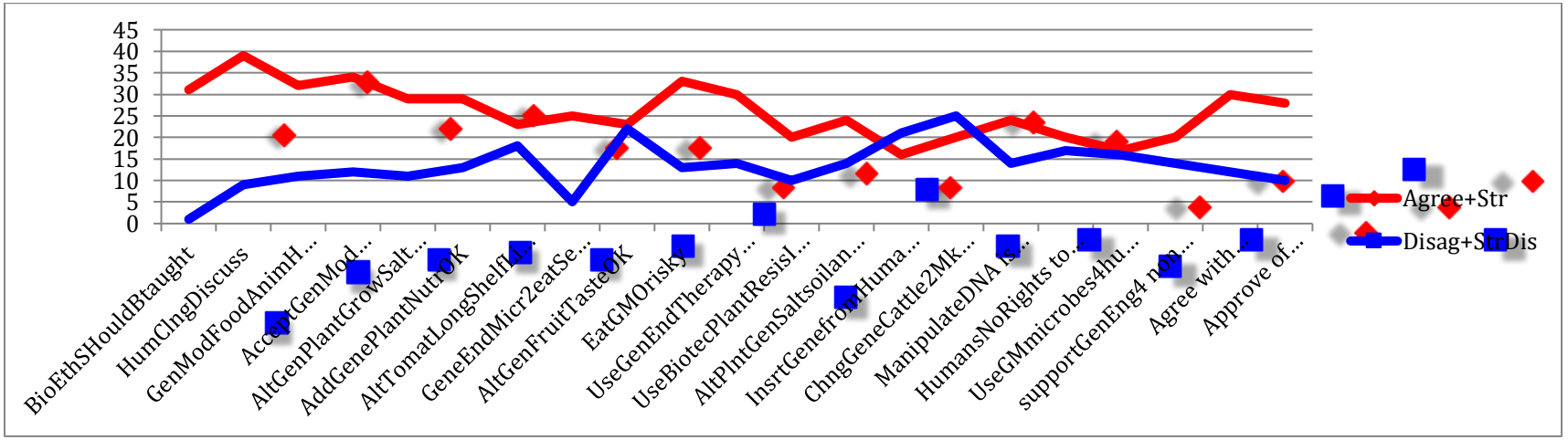
POST


45
40
35
30
25
20
15
10
5
0
BioEthSHouldBtaught
HumClngDiscuss
GenModFoodAnimHumOK
AcceptGenMod Micro&Plant
AltGenPlantGrowSaltSoilOK
AddGenePlantNutrOK
AltTomatLongShelfLifeOK
GeneEndMicr2eatSewageOK
AltGenFruitTasteOK
EatGMOrisky
UseGenEndTherapyGenDisOK
UseBiotecPlantResisInsect
AltPlntGenSaltsoilandQualPr…
InsrtGenefromHumanCell2F…
ChngGeneCattle2MkeNutrit
ManipulateDNA is unethical
HumansNoRights to…
UseGMmicrobes4humanSew…
supportGenEng4 non…
Agree with ProduceInsulin…
Approve of…
StrongAgree5
Agree 4
Neutral 3
Dislike 2
StrDisagree1

PRE


50
45
40
35
30
25
20
15
10
5
0
BioEthShouldBtaught
HumClngDiscuss
GenModFoodAnimHu...
AcceptGenMod...
AltGenPlantGrowSalt...
AddGenePlantNutrOK
AltrTomatLongShelfLif...
GenEngMicr2eatSewa...
AltGeneFruitTasteOK
EatGMOrisky
UseGenEngTerapyGe...
UseBioTecPlantResist...
AltPlntGenSaltsoiland...
InsrtGenefromHuman...
ChngGeneCattle2Mke...
ManipulateDNA is...
HumansNoRights to...
UseGMmicrobes4...
support GenEng 4...
Agree with...
Aprrove of...
Agree+Srtr
Disag+StrDis

POST


45
40
35
30
25
20
15
10
5
0
BioEthSHouldBtaught
HumClngDiscuss
GenModFoodAnimH...
AcceptGenMod...
AltGenPlantGrowSalt...
AddGenePlantNutrOK
AltrTomatLongShelfLi...
GeneEndMicr2eatSe...
AltGenFruitTasteOK
EatGMOrisky
UseGenEndTherapy...
UseBiotecPlantResisI...
AltPlntGenSaltsoilan...
InsrtGenefromHuma...
ChngGeneCattle2Mk...
ManipulateDNA is...
HumansNoRights to...
UseGMmicrobes4hu...
supportGenEng4 no...
Agree with...
Approve of...
Agree+Str
Disag+StrDis

KNOWLEDGE OF BIOTECHNOLOGY

There seemed to be an increase in confidence for knowledge of biotechnology, genetics, cloning, and major increase for microarrays. Some students still remained unsure of their knowledge of gel electrophoresis but numbers had a major decreased compared to the pre survey

PRE

Strong Agree/Agree: that they have knowledge of genetics and biotechnology, Agree some knowledge of cloning.

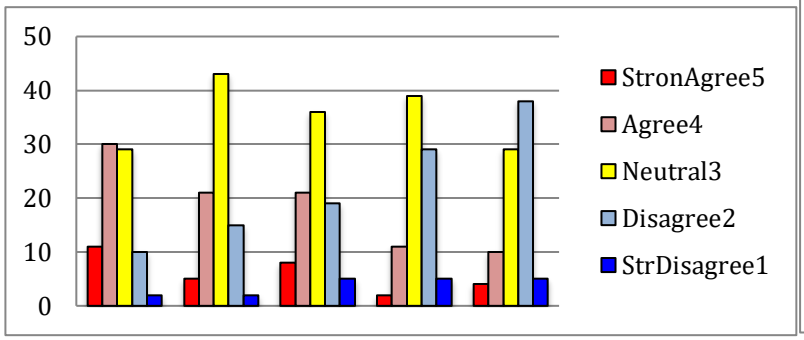
Strongly Disagree/Disagree: that they have knowledge of micro arrays, gel electrophoresis.

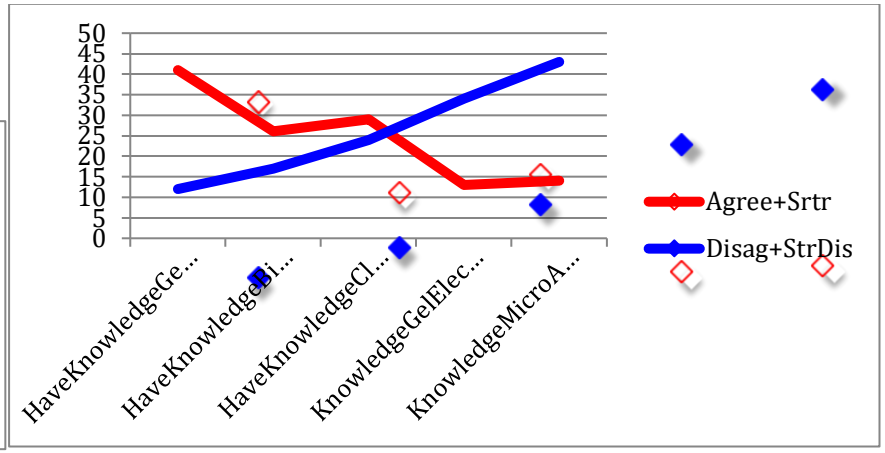
POST

Strong Agree/Agree: that they have knowledge of genetics, biotechnology, cloning, and microarrays.

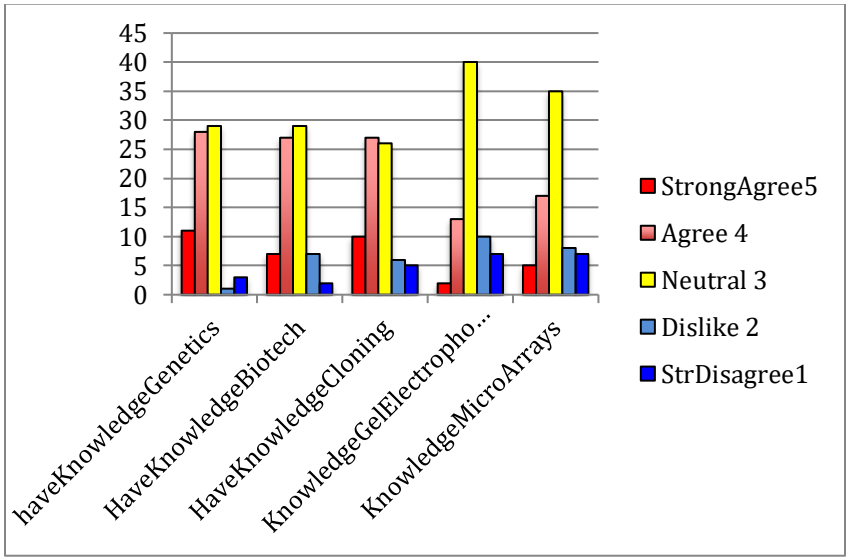
Disagree: that they have knowledge of gel electrophoresis.

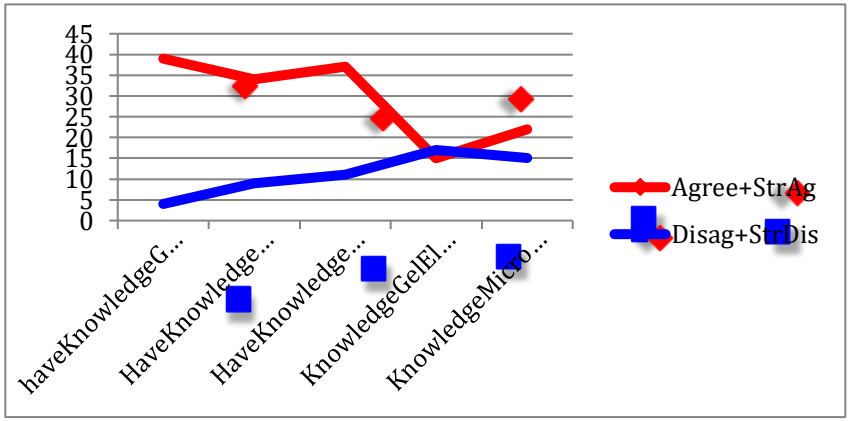
PRE


50
40
30
20
10
0
StronAgree5
Agree4
Neutral3
Disagree2
StrDisagree1


50
45
40
35
30
25
20
15
10
5
0
HaveKnowledgeGe...
HaveKnowledgeBi...
HaveKnowledgeCl...
KnowledgeGelElec...
KnowledgeMicroA...
Agree+Srtr
Disag+StrDis

POST


45
40
35
30
25
20
15
10
5
0
haveKnowledgeGenetics
HaveKnowledgeBiotech
HaveKnowledgeCloning
KnowledgeGelElectropho...
KnowledgeMicroArrays
StrongAgree5
Agree 4
Neutral 3
Dislike 2
StrDisagree1


45
40
35
30
25
20
15
10
5
0
haveKnowledgeG...
HaveKnowledge...
HaveKnowledge...
KnowledgeGelEl...
KnowledgeMicro...
Agree+StrAg
Disag+StrDis

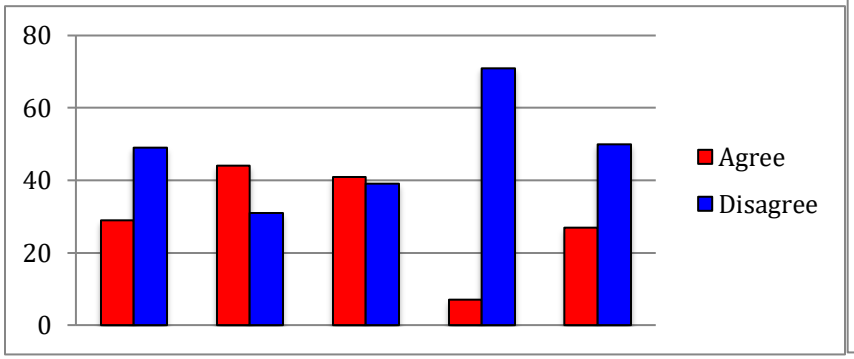
ATTITUDES TOWARD SCIENCE

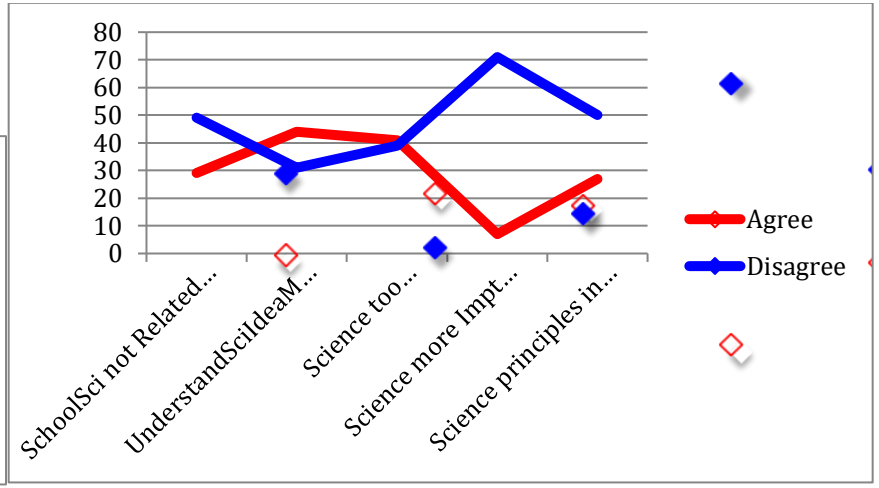
Pre and Post surveys seemed fairly consistent.

Most disagree that school science does not relate to everyday life, that it is too complicated, that it is more important for boys, or that science principles will always remain true.

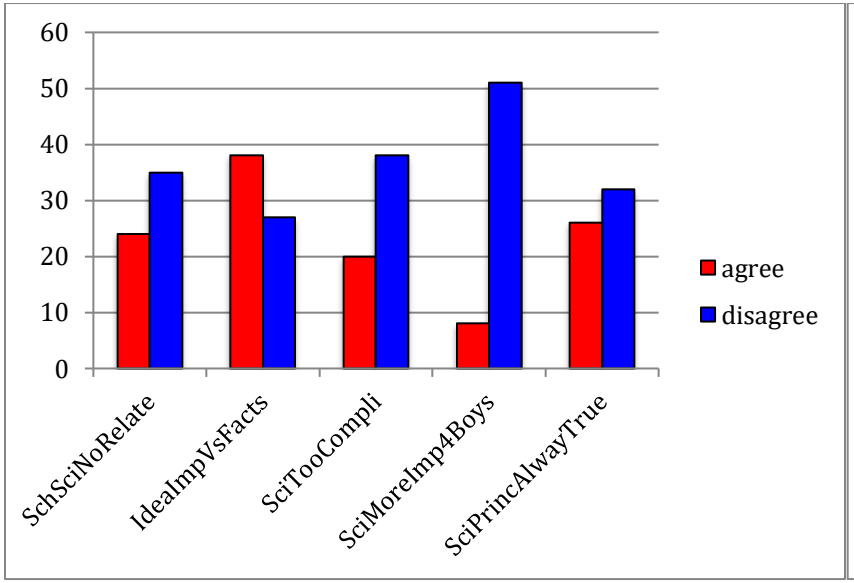
In the post survey less students agreed that science was too complicated compared to almost neutral in the pre survey.

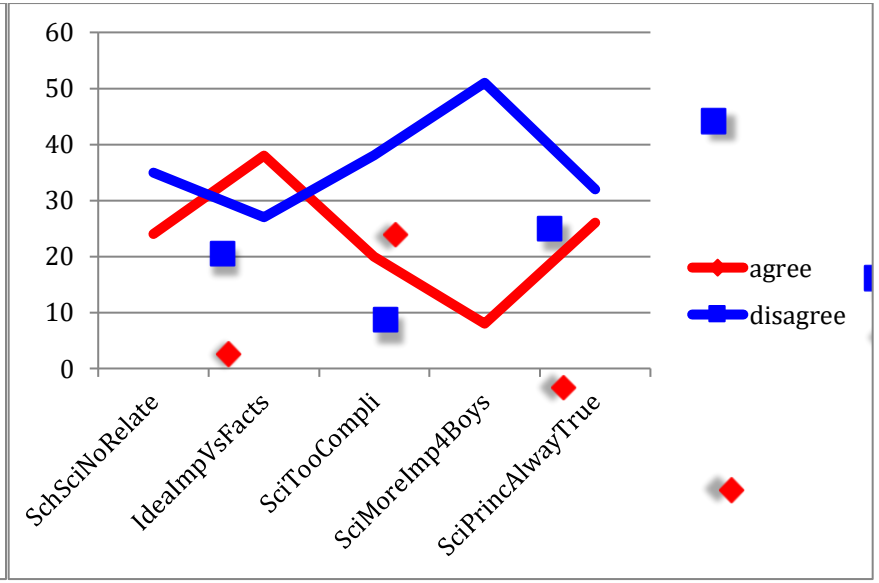
PRE


80
60
40
20
0
Agree
Disagree


80
70
60
50
40
30
20
10
0
SchoolSci not Related...
UnderstandSciIdeaM...
Science too...
Science more Impt...
Science principles in...
Agree
Disagree

POST


60
50
40
30
20
10
0
SchSciNoRelate
IdeaImpVsFacts
SciTooCompli
SciMoreImp4Boys
SciPrincAlwayTrue
agree
disagree

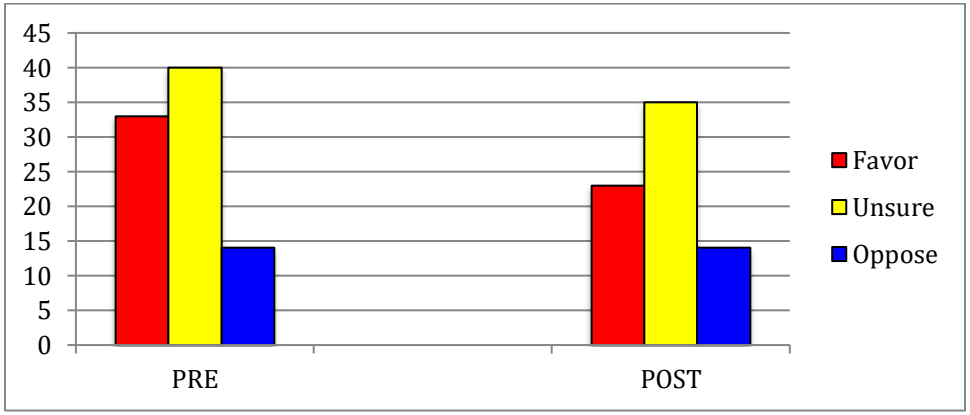

60
50
40
30
20
10
0
SchSciNoRelate
IdeaImpVsFacts
SciTooCompli
SciMoreImp4Boys
SciPrincAlwayTrue
agree
disagree

Attitude toward using discarded embryos for embryonic stem cell research to treat or cure disease or spinal cord injury.

PRE – most favor or were neutral. Less were opposed

POST – fewer favored than in the pre. Less were opposed.

"There is a type of medical research that involves using special cells, called embryonic stem cells, that might be used in the future to treat or cure many diseases, such as Alzheimer's, Parkinson's, diabetes, and spinal cord injury. It involves using human embryos discarded from fertility clinics that no longer need them. Some people say that using human embryos for research is wrong. Do you favor or oppose using discarded embryos to conduct stem cell research to try to find cures for the diseases I mentioned?"

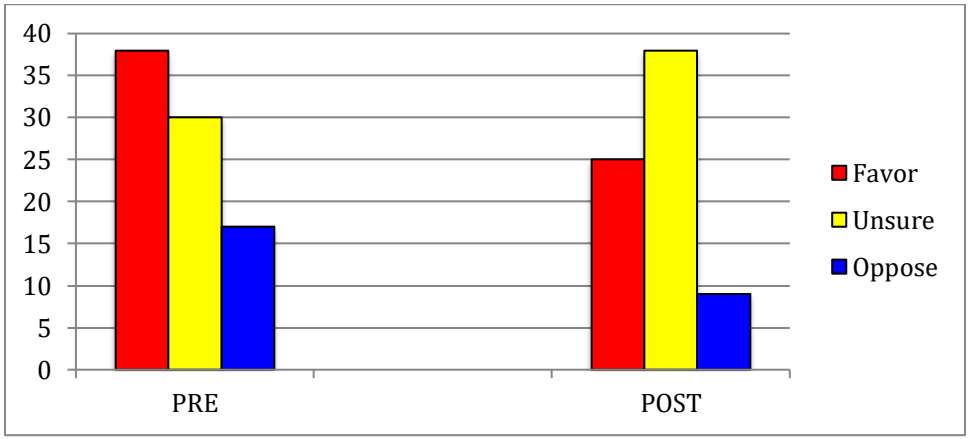


Attitude toward expanding federal funding for embryonic stem cell research.

PRE – most favor, some are neutral, least oppose

POST – Less favor than in the pre survey, more are neutral than in the pre survey, and less are opposed compared to the pre survey.

"Do you favor or oppose expanding federal funding for embryonic stem cell research, which is the practice of conducting scientific research on cells extracted from human embryos in an attempt to find cures or treatments for diseases?"



Students showed a neutral to generally positive attitudes toward science, biotechnology, and hands-on activities like labs and simulations and negative attitudes toward textbook learning of facts. The themes of Bench to Bedside and some of the resources, labs, simulations, and links discovered through B2B were used and will continue to be infused into the course. The survey was re administered at the end of the course and data analyzed. Students continued to show a general positive attitude toward science and biotechnology, an increased positive attitude toward learning through simulation and computer simulation labs, and an increase in knowledge of biotechnology and genetics.

Finally, the hands on lab activities and lab simulation activities were used as a performance based assessment. Teacher observed and noted participation of students. Forms of assessment for the hands-on activities varied from filling in charts or designing graphs to answering questions, writing lab procedures, analysis, and writing conclusions. Open-ended responses were also used as assessment.

NATIONAL SCIENCE STANDARDS:

SC.912.L.14.1 Describe the scientific theory of cells (cell theory) and relate the history of its discovery to the process of science.

SC.912.L.14.2 Relate structure to function for the components of plant and animal cells. Explain the role of cell membranes as a highly selective barrier (passive and active transport).

SC.912.L.14.3 Compare and contrast the general structures of plant and animal cells. Compare and contrast the general structures of prokaryotic and eukaryotic cells.

SC.912.L.14.5 Explain the evidence supporting the scientific theory of the origin of eukaryotic cells (endosymbiosis).

SC.912.L.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.912.L.14.11 Classify and state the defining characteristics of epithelial tissue, connective tissue, muscle tissue, and nervous tissue.

SC.912.L.14.12 Describe the anatomy and histology of bone tissue.

SC.912.L.16.3 Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic information.

SC.912.L.16.4 Explain how mutations in the DNA sequence may or may not result in phenotypic change. Explain how mutations in gametes may result in phenotypic changes in offspring.

SC.912.L.16.5 Explain the basic processes of transcription and translation, and how they result in the expression of genes.

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.16.8 Explain the relationship between mutation, cell cycle, and uncontrolled cell growth potentially resulting in cancer.

SC.912.L.16.9 Explain how and why the genetic code is universal and is common to almost all organisms.

SC.912.L.16.10 Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues.

SC.912.L.16.11 Discuss the technologies associated with forensic medicine and DNA identification, including restriction fragment length polymorphism (RFLP) analysis.

SC.912.L.18.1 Describe the basic molecular structures and primary functions of the four major categories of biological macromolecules.

SC.912.L.18.2 Describe the important structural characteristics of monosaccharides, disaccharides, and polysaccharides and explain the functions of carbohydrates in living things.

SC.912.L.18.3 Describe the structures of fatty acids, triglycerides, phospholipids, and steroids. Explain the functions of lipids in living organisms. Identify some reactions that fatty acids undergo. Relate the structure and function of cell membranes.

SC.912.L.18.4 Describe the structures of proteins and amino acids. Explain the functions of proteins in living organisms. Identify some reactions that amino acids undergo.

SC.912.L.18.11 Explain the role of enzymes as catalysts that lower the activation energy of biochemical reactions. Identify factors, such as pH and temperature, and their effect on enzyme activity.

SC.912.N.1.1 Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following:

1. pose questions about the natural world,

2. conduct systematic observations,
3. examine books and other sources of information to see what is already known,
4. review what is known in light of empirical evidence,
5. plan investigations,
6. use tools to gather, analyze, and interpret data (this includes the use of measurement in metric and other systems, and also the generation and interpretation of graphical representations of data, including data tables and graphs),
7. pose answers, explanations, or descriptions of events,
8. generate explanations that explicate or describe natural phenomena (inferences),
9. use appropriate evidence and reasoning to justify these explanations to others,
10. communicate results of scientific investigations, and
11. evaluate the merits of the explanations produced by others.

SC.912.N.3.5 Describe the function of models in science, and identify the wide range of models used in science.

SC.912.N.4.1 Explain how scientific knowledge and reasoning provide an empirically-based perspective to inform society's decision making.

SC.912.N.4.2 Weigh the merits of alternative strategies for solving a specific societal problem by comparing a number of different costs and benefits, such as human, economic, and environmental.

SC.912.N.2.2 Identify which questions can be answered through science and which questions are outside the boundaries of scientific investigation, such as questions addressed by other ways of knowing, such as art, philosophy, and religion.

SC.912.N.2.4 Explain that scientific knowledge is both durable and robust and open to change. Scientific knowledge can change because it is often examined and re-examined by new investigations and scientific argumentation. Because of these frequent examinations, scientific knowledge becomes stronger, leading to its durability.

SC.912.N.2.5 Describe instances in which scientists' varied backgrounds, talents, interests, and goals influence the inferences and thus the explanations that they make about observations of natural phenomena and describe that competing interpretations (explanations) of scientists are a strength of science as they are a source of new, testable ideas that have the potential to add new evidence to support one or another of the explanations.

SC.912.N.3.1 Explain that a scientific theory is the culmination of many scientific investigations drawing together all the current evidence concerning a substantial range of phenomena; thus, a scientific theory represents the most powerful explanation scientists have to offer.

OTHER NATIONAL STANDARDS IN MATH or other academic areas covered need to be further investigated. Extension activities may include a research based project about a genetic disorder or disease.

LITERATURE CITED:

Erdogan, M., Ozel, M., Us ak, M., and Prokop, P., (2009) .Development and Validation of an Instrument to Measure University Students' Biotechnology Attitude. Journal of Science Education Technology 18:255–264

Foley, B. J. & McPhee, C. (2008). Students' Attitudes towards Science in Classes Using Hands-On or Textbook Based Curriculum. *AERA.* Retrieved December 02, 2009 from the World Wide Web: http://www.csun.edu/

Gokhale, A. (1996). Effectiveness of Computer Simulation for Enhancing Higher Order Thinking. Journal of Industrial Teacher Education, 33: 4.

http://www.bio.org/

http://www.biotechinstitute.org/teachers/careers

http://learn.genetics.utah.edu/

http://www.medreps.com/biotechnology-sales-job-news/florida~s-emerging-biotech-industry-outpaces-national-growth/

http://www.pollingreport.com/science.htm

Huang, C. (2003). Changing Learning Environments with new interactive and media-rich instruction environments: virtual labs case study report. Computerized Medical Imaging and Graphics, 27: 157-164

Kidman, G (2009). Attitudes and Interests Towards Biotechnology: the Mismatch Between Students and Teachers. Eurasia Journal of Mathematics, Science & Technology Education, 2009, 5(2), 135-143

Stohr-Hunt, P. M. (1996). An analysis of frequency of hands-on experience and science achievement. Journal of Research in Science Teaching, 33: 101–109.

BUDGET AND BUDGET JUSTIFICAITONS

item #840731 Microplate, Small, pack/10, (96-well plate) = $ 23.50 x 2 = $ 47
item #840733 Microplate, Large, pack/10, large (24-well plate) = $ 18.50 x 2 = $ 37
DIAGNOSING DIABETES TAKE-OUT LAB activity DIAGNOSING DIABETES LAB 10kits x 10.80 = $108
SCIENE TAKE-OUT LAB activity STEM CELLS LAB 10kits x 10.80 = $108
Also checking out other Science take-out labs from http://sciencetakeout.com
UV Lamps x 3 @ $ 11.00 = $ 33.00
Disposable Centrifuge tubes - Sample tubes - $ 34 pack 50 size 15mL and $ 21.50 pack 50 size 50 mL
Color Printer and Scanner - $ 80 - 100
Memory sticks (jump drives)
Poster paper
Assorted color printer paper - $ 16
Food coloring 4 boxes x $ 4 = $ 16
Thick transparency sheets
UV sensitive paints assorted colors – 4 bottles = $ 20
Yogurt ?
Miscellaneous supplies $ 100
TOTAL = ~ $ 645

Also any other materials needed for the simulation hands on activities that are not in the equipment lockers

MODIFICATIONS FROM THE ORIGINAL PROPOSAL

Originally I thought I might teach 9th grade science and collaborate with the English teachers for a school wide initiative toward a cross-curricular research project/paper. We would also use biomedical science technology and hands on lab activities and simulations to improve and excite students understanding of genetic disorders and disease. Students would research about a genetic disorder, write a research paper, and create a display, a poster or informational brochure following the guidelines set by Mr. Millan-Garcia's genetics course at the University of Florida.

This past school year I have been teaching Biology to grades 9-12 and Marine Science to grades 10-12. I decided to narrow down my action proposal to use hands on biotechnology simulation lab activities and computer based simulation lab activities presented and discovered through the Bench to Bedside program during the summer of 2011 throughout my Biology and Marine Science courses to excite students and increase

their knowledge about biomedical science in its use of studying and treating genetic disorders and disease. In addition I would use this material, resources, and links to infuse into the curriculum and cover the necessary benchmarks and national science standards for Florida's new EOC End of Course Exam for Biology.

LEARNINGS FORM THE ACTION PROPOSAL

Response from the students has been positive. They enjoyed the activities. Students were actively engaged. I feel it has been an effective way of learning. There were some frustrations expressed with regards to internet speed. More virtual interactive and simulation labs are planned for the future including Science Take Out Testing for Diabetes and other Simulation Labs designed by Dr. Charles Lawrence of UF. In the future I would plan ahead more and make a more logical progression on where to incorporate the information and or make it more spread out. I would make more guiding questions for the additional interactive computer labs. I would also use some of these interactive activities as demos when computers are not available to the students. I also learned that action research is a process where you need to adapt and that it is constantly evolves and grows. It has also been great sharing what I have leaned and the links with my fellow teachers.

DISSEMINATION

Many of the resources, links, SIFT links, interactive activities, and labs have been also used with my marine science classes as well as have been shared throughout my department, especially within my small department biology common planning team, and the coordinator of our school's after school "Weird Science Club." My Action Research and finding have been presented and discussed with my common planning team as well as other members of the science department and school personnel with whom I collaborate. As far as presenting at a conference or writing a paper for a journal, it sounds like a lot of work! However, I know I am capable of learning how to present or write and I would be honored if I were asked to. With a busy schedule, I probably would not actively seek out to do so, but I am always open to ideas and opportunities. The only symposiums that I have presented were through ICORE and Bench to Bedside at the University of Florida.

THANK YOU

Thank you to the entire staff of UF-CPET, especially Mary Jo, Julie, Houda, Drew, Chuck, the Barnes, and fellow B2B participants for your inspiration and support in this experience.