# A study on the impact of introducing Biotechnological labs and activities to middle school and high school students to determine how they affect student attitudes towards Biotechnology and personal independent research.
# Final Report

By

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**Abstract:**

The area of biotechnology is quickly overwhelming the general population as the mainstream media such as newspapers, TV reports and social media is replete with news of daily discoveries involving DNA, genes of different organisms, new vaccines, and stem cell cures. To meet the challenge of preparing students to be able to understand the new discoveries, to encourage students to consider STEM for a career and to encourage students to do independent research projects, I have set up a middle and high school weekly Hands-on-Science class at the SALT homeschool coop. For the purpose of this action proposal, I will look at September, October, November and December classes where 4 units from our Bench to Bedside Biotechnology class will be taught. The STEM Career Interest Survey will be completed at the beginning of the first class or education program in 4H and completed again at the end of the class and education program in 4-H in December to determine if a shift in attitude has occurred in the students attitudes toward STEM and Biotechnology due to the intervention. I plan to use a pretest, a posttest and a midterm test to determine the retention of the material in both the classes and the 4-H club educational program. Data will be reported to SSP Advocate Program, CPET Bench to Bedside program and 4-H state program in February and at the end of the school year

**Rationale:**

I am teaching a Biotechnology class at a monthly Enrichment Day at Olivet Private School. I will be teaching one class of approximately 50 minutes for $5^{th}$ through $12^{th}$ grade. My goal through this Biotechnology class is to introduce interesting and stimulating hands on activities to students with the Bench to Bedside lessons. The hands on lessons I plan on teaching were chosen to:

a. Introduce students to the interesting and diverse tools of science
b. Teach students to think scientifically
c. Teach students the engineering process
d. Teach students how to design a science experiment
e. Expose students to the field of biotechnology and potential career opportunities
f. Encourage the students to conduct an independent research project for scientific competition.

At the start of this school year, I expect that a student entering the classroom will be wondering what Biotechnology actually is. I have spoken to many adults that did not know what biotechnology is so therefore I expect that students will have similar questions. The area of biotechnology is quickly overwhelming the general population as the mainstream media such as

newspapers, TV reports and social media is replete with news of daily discoveries involving DNA, genes of different organisms, new vaccines, and stem cells cures. Grace found the same issue in 1997 when he is quoted saying "Unfortunately, many of those in the general population lack the background knowledge to understand the scientific basis behind much of the technology involved in these discoveries and in fact there is a large amount of anxiety associated with this lack of knowledge (Grace 1997)." According to Moreland, Jones and Cowie- "Biotechnology is an expanding area of scientific and community interest, one that it is important students understand because of its potential impact on them and their communities. The challenge for teachers and science and technology educators is how to provide learning experiences in this area." I have set up the Biotechnology classes to help meet this challenge. Homework will be a component of every lesson to help solidify and expand the information presented in class.

Goals for the Biotechnology class:

- Introduce students to the diverse tools of science
- Teach student to think scientifically
- Teach students the engineering process
- Teach students how to design a science experiment
- Expose students to the field of biotechnology and the potential career opportunities
- Encourage the students to conduct an independent research project for scientific competition.

I studied through the use of the STEM Career Interest Survey how this class affect the attitudes and understanding the students have towards

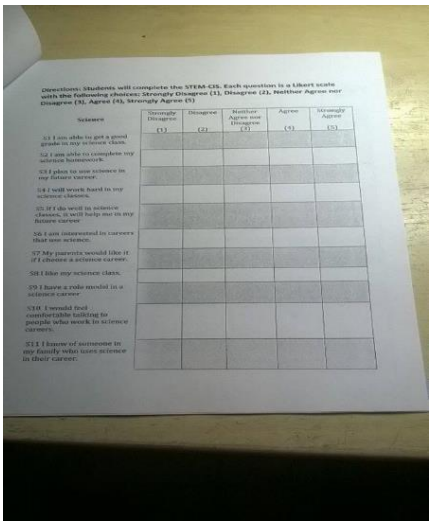
- Doing well in a particular class or activity
- Science, mathematics, engineering and biotechnology as a field of study and as a career
- How doing well in a class will affect their future career
- What my parents desire for my career
- biotechnology and its potential career opportunities
- Feelings about conducting an independent research project for scientific competitions.

"Since interest and importance contribute, respectively, to intrinsic and extrinsic motivational patterns that are determining factors in learning and behavior (Ryan and Deci 2000), understanding how these two dimensions interact with each other and with knowledge and attitudes provides a baseline for the design of improved education strategies."(Maria João Fonseca , Patrício Costa , Leonor Lencastre & Fernando Tavares (2012)) I expected hands on activities, would increase student's interest and improve their attitudes about the subject

thereby increasing their motivation to learning the material and desire to participate in Hands on Independent Research.

As a SSP Advocate, I have agreed to serve as "an advocate for 3-5 underrepresented students (African-American, Latino, Native American, low income) to transition them from conducting a scientific or engineering research project to completing applications to scientific competition(s)." (Society for Science & the Public - Advocate Grant (2016)) One of my goals as an SSP Advocate is to use the Hands-on Science class and the educational lockers used in my other classes and 4-H club as a method to interest students in completing a science research project and competing in scientific competitions. Some of these classes are SALT Hands-on-Science, Grace Homeschool Connections Honors Chemistry, Grace Homeschool Connections Assistant teacher Honors Biology, Grace Homeschool Connections Assistant teacher General Science, Classical Conversations Challenge A class, Little Prodigy School of Music-Biology and Chemistry 3 day camps, Olivet Private School - Science Fair and Biotechnology Enrichment classes and Research Coast Florida Junior Academy of Science 4H Club.

**Action Research Intervention - Data Collection Techniques and Student Assessments**



I used the "STEM Career Interest Survey" (STEM-CIS) (Friday Institute for Educational Innovation, 2014; Kier et al., 2014) which "is a Likert-type (1 = strongly disagree to 5 = strongly agree) instrument (See Appendix 1). The scales measured the following constructs: perception of supportive environment for pursuing a career in science, interest in pursuing educational opportunities that would lead to a career in science, and perceived importance of a career in science, and interest in a career in STEM." I also planned to use the 21st century skills survey which will determine a student's interest in particular areas of science and measure the students perception of their skills they currently have which are needed to compete in the STEM job market. The STEM Career Interest Survey and 21st century skills survey was completed at the beginning of the first class, in January and will be given at the end of the class to determine if a shift in attitude has occurred in the student's attitudes toward STEM and Biotechnology. I asked whether students in the Biotechnology class are interested in doing an independent research project in September, November and at the end of the school year. Follow up with information regarding RCFJAS will occur for those students that express interest in doing an independent research project.

I completed a midterm test to determine the retention of the material in the classes. I also completed a before lesson quiz and an after lesson quiz.

"Studies that have used in-school and out-of-school interventions designed to connect underrepresented students to STEM professionals and careers show promise in increasing awareness and interest in STEM careers (Kier et al., 2014)." I planned to use the data to improve the RCFJAS 4-H program and develop a program for the Multicultural center. I also plan to use the information collected to help develop a biotechnology program that I can teach in the 2017-2018 school year at several homeschool co-ops and after school programs. Through these programs we hope to encourage high school students to purse internships and summer programs such as Project Seed or Center for Precollegiate Education and Training (UF CPET) summer programs.

Data will be reported to SSP Advocate Program, CPET Bench to Bedside program and 4-H state program in February and at the end of the school year.

A STEM Career Interest Survey and a 21st century skills survey will be given in September before the intervention starts and again in December after the 4 interventions are completed. Comparisions will be made to indicate the change in perceptions and attitudes regarding the various STEM catagories. The data will be used to improve the RCFJAS 4-H program and develop a program for the Multicultural Center. Ultimately, I desired to expose students to careers in STEM and Biotechnology and see some students eventually choose to enter those fields as a career.

**Changes to Action Research Intervention**

I was unable to teach the Biotechnology class at Olivet Day so I was not able to use it as my intervention. I am teaching a Hands-on-Science class at the SALT homeschool coop so I decided with the parents' permission to turn this weekly class into my intervention. My goal through this Biotechnology class is to introduce interesting and stimulating hands on activities to students with the Bench to Bedside lessons. The hands on lessons I plan on teaching were chosen to:

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I had originally also planned to compare the results to the results of the same intervention program presented to the 4-H club as an educational program but due to the time constraints of the clubbers we were unable to do these interventions therefore no comparisons will be made between the groups.

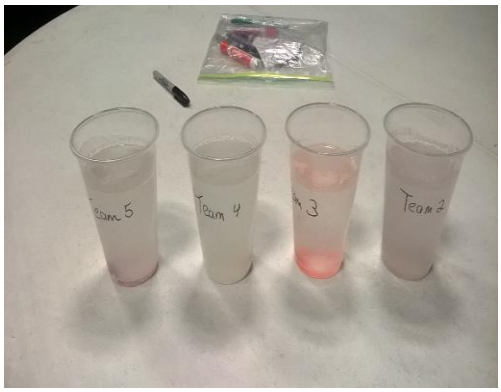
**Connections to B2B Institute**

The hands-on science class completed the following B2B Institute biotechnology activities so far this year.

- **What is it? Dichotomous key -**to teach student how to use a dichotomous key as part of the Indian River Lagoon Unit
- **Pipet by Design** Unit- utilized this unit to teach metric system and scientific equipment
- Unit on surface tension using the "**Water Molecules Kit**" locker
- **Diagnosing Diabetes-** used this unit to teach about diabetes
- Endocrine System unit using the **endocrine system locker:** Includes plush ovary, testicle, thyroid, pancreas, brain.
- **Designing a Protective Drug Coating-** to teach medical engineering and clinical Trials
- Digestive System Unit using the **digestive system locker:** Includes plush colon, rectum, stomach, intestine, stomach ache, food poisoning, E. coli, salmonella, norovirus, and ulcer

**Here are a few pictures of the students doing these units.**

Designing a Protective Drug Coating Unit




**Pipetting by Design**


## Data Collection and Analysis

The class consisted of 11 students in the grades and with the ethnicity and income listed in the table below.

| Grade | Ethnicity |
|---|---|
| 4 th grade – 1 student | American Indian |
| 5 th grade - 2 students | Hispanic |
| 6 th grade - 4 students | Asian |
| 7 th grade - 2 students | African American |
| 8 th grade - 2 students | Low Income |

Six before and midterm STEM Career Interest Survery were completed(STEM-CIS). Unfortunately a public school holiday and a stomach flu epidemic affected my abilities to get the midterm survey from all the students. I will be collecting the rest of the surveys and plan to update the data accordingly.

The statistics for the surverys collected to date are shown in the tables below.

| grade | male | female |
|---|---|---|
| 5 | 2 | 0 |
| 6 | 0 | 1 |
| 7 | 0 | 2 |
| 8 | 0 | 1 |

| ETHNICITY AND INCOME | |
|---|---|
| AFRICAN-AMERICAN | 1 |
| ASIAN | 1 |
| CAUCASIN | 2 |
| LATINO | 2 |
| NATIVE AMERICAN | 2 |
| LOW INCOME | 4 |

There are so many ways to look at these surveys but to keep it in the time frame I had to complete my work, I chose to compare male verses female. The results are shown in the table below. M1 and M2 are individual males and F1-F4 are individual females.

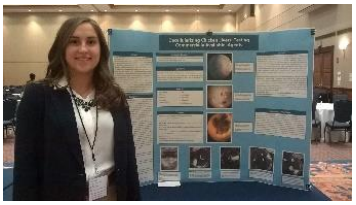
| Stem Area Interest Questions Overview | Male interest | | Female interest | | | |
|---|---|---|---|---|---|---|
| | **M1** | **M2** | **F1** | **F2** | **F3** | **F4** |
| **Science** | S | I | SD | SD | I | I |
| **Mathematics** | D | I | SI | SD | I | D |
| **Engineering** | I | NA | SI | I | D | D |
| **Biotechnology** | I | NA | S | S | S | S |

**Key**

I- Increase SI- Slight Increase S- Same SD- Slight Decrease D- Decrease NA- Not applicable

The data set is currently too small a sample set to determine trends but a preliminary review indicates there is a slight increase in interest STEM due to the biotechnology lessons. I will be continuing to use this survey with a some slight changes in all my science classes and 4H club to help determine the interest of the students and determine the effectiveness of the hands on activities and teaching. I will be having students complete the survey at the end of the year to see if the interest in STEM continues to rise.

Through the biotechnology activities available to me through Benches to Bedside, I intended to encourage high school students to purse internships and summer programs such as Project Seed or Center for Precollegiate Education and Training (UF CPET) summer programs. I currently have a student that completed the Engineer me a Liver packet, a science fair project on the subject, attended Junior Science Engineering and Humanities Symposium and is applying to the CPET summer program-Explorations in Biomedical Research program. She competed in the Martin County Regional Science Fair where she won the States Trophy, Woman in Science Award, the Society of In Vitro Biology Award, the Mad Scientist award, Regeneron Talent Search Research Award, the United States Air Force Award, and a bid to ISWEEEP with her project. This was her first science fair project but she did extremely well and has advanced to State Science Fair. She plans to go to college for biotechnology or bioengineering.



I desired to use the biotechnology activities to expose students to careers in STEM and Biotechnology and see some students eventually choose to enter those fields as a career. This goal has been met because I have 5 students attending Junior Science Engineering and Humanities Symposium to explore STEM fields as a career through the lab visits and presentations.

Through the 4-H club, I also have 3 students registered for the Saint Lucie County Science Fair and 2 students registered for the Martin County Science Fair. All 5 students are planning to enter the STEM career field.

I was able to use the pipetting by design unit at the Multicultural Center exposing the at risk children at the center to Biotechnolgy and science research.

I desired to expose the public to field of biotechnology and our 4-H club was able to complete this goal by participating in the Indian River Lagoon Science Festival where we used the Pipetting by Design and the water molecules kit to teach the public about the tools of Biochemistry.

I also used the biotechnology activities in my Classical Conversations science class this class has completed the following Biotech activities

- **What is it? Dichotomous key** –taught the unit as I introduced lizards and frogs research project to the students
- **Pipetting by Design** Unit- utilized this unit to teach metric system in the math portion of the class
- **Endocrine system locker**: Includes plush ovary, testicle, thyroid, pancreas, brain when we were discussing the human body
- **Digestive system locker**: Includes plush colon, rectum, stomach, intestine, stomach ache, food poisoning, E. coli, salmonella, norovirus, and ulcer when we were discussing the human body

Drop by drop, student by student, person by person, raising the level of people interested in stem careers has been our goal in the classes I teach and in our 4H club. I am glad to be able to say that we have been successful with all 5 students attending JSHES are planning to enter a STEM field. A chemisty student is planning a career in weather. I just completed a reccomendation for a young man who from our 4H club that had not planned to go to college, but thank to his attendance to JSHES he is now applying to a agricultural science program. One young man from the 4H club failed most of his classes last year as he struggled with who he wanted to be but due to his work at the 4H farm, completing a science fair project he is now a straight A student and no longer the class clown. He is currently talking about being a high school science teacher. One young lady who attended the Indian River Lagoon Science festival is still talking about the 4H club display and plans to do a science fair project. She plans to go to college for a STEM related career.

The pictures above are pictures of students that attended the Junior Science and Engineering Symposition this year. Each student in these pictures is planning to enter a STEM related career. Part of the reason these students are considering STEM for their career is the wonderful work that the Center for Precollegiate Education and Training (UF CPET) does for teachers and students. I am thankful for UF CPET and all the programs they provide.

**Literature Cited**

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**Budget and Justification-**

Thanks to the Bench to Bedside Grant I was able to bring these wonderful opportunites to my students in 7 different classes and to the Public at the Indian River Lagoon Festival at a minimal cost. Thanks to a discount card I have, copies for each project averaged about $5. There was some items to be purchased but overall for those supplies the cost was about $50. I never could have exposed my students to the equipement and wonderful activities without this grant. I must admit that am disappointed that the grant is ending. My science fair student is wanting to repeat her project and the family had to discuss the feasiblity of doing so since the cost for the locker will now be about $30. I was hoping to use some of the other units this year

for my Hands on Science class and I am balancing the cost over using some other ideas. I want to thank the grant and CPET for the awesome opportunity this class and grant provided.