Team Final Report on Teacher and Student Learning

Please completed the form and have to your Team Leader **by May 30th**

Teacher(s)/School: James Hefti / Pulaski High School

SUNY Oswego faculty member: Sue Witmer

Teacher Participant Names: James Hefti (Biology Teacher), Carl Nylen (Chemistry Teacher and STEM Club Co-Advisior) and Tom Pullen (Technology Teacher and STEM Club Co-Advisior)

Course Name & Academic Year: EDU505 - Formative Assessment to meet the Common Core Learning Standards / 2013-14

Please answer the following questions:

Please update us on any changes you made to your team action plan:

We changed the name of our high school science club to STEM Club.

Analysis of Data on Teacher Learning: We examined our reflections on the 6 shifts, and CCLS and found the following: (Support each claim with examples/evidence)

The main focus of our aquaponics project was the Common Core Literacy Standards for Science Major Understandings - 2.2a :

> Development of a research plan involves researching background information and understanding the major concepts in the area being investigated. Recommendations for methodologies, use of technologies, proper equipment, and safety precautions should also be included.

By researching plans and then modifying a design and constructing it students gained tremendous experience in STEM disciplines while also addressing Common Core Literacy Standards. Our group spent over ten hours reviewing and modifying aquaponics systems for our situation. According to our pre-test / post-test evaluation system students felt confident in their abilities to design and build aquaponics systems since over 80% of all students reported they could not do so prior to the project, but over half of all students interviewed stated they could do just that as a result of the experiences they gained during STEM Club.

Analysis of Data on Student Learning: We examined the levels of excitement to be able to utilize interests for and understandings of Science, Technology, Engineering and Math through participation in the Pulaski High School STEM Club and found the following: (Give examples/evidence for each claim).

Our pre-test results stated that 100% of students strongly agreed with the portion of the statement listed in red. Fortunately, student interest did not wane at all despite several months of challenging issues, time-consuming presentations that would make most people sick and constant setbacks that impeded progress in a linear fashion.

Interview responses to questions pertaining to what set this project apart from other projects completed focused mainly on the fact that students felt more involved in the learning process when the format was "figure it out as you go." Students also seemed to appreciate the fact that this project was so hands-on and an application of learning.

Aquaponics Project Data Analysis

#	**Statement to evaluate aquaponics attitudes and aptitudes**
1	I can describe the advantages and disadvantages of growing fish and plants in an aquaponics system.
2	I can design a system that will allow me to grow fish and plants together.
3	I can construct a system that will allow me to grow fish and plants together.
4	I know how to monitor environmental conditions using computers and probeware.
5	I know what to do when fish and plant pathology issues arise.
6	I can propagate vegetable garden plants.
7	I understand basic aquaculture techniques.
8	I know how to harvest the vegetables and fish raised in an aquaponics growing system.
9	I know how to market the products of the aquaponics growing system to generate income.
10	I am excited to be able to utilize my interest for and understanding of Science, Technology, Engineering and Math through participation in the Pulaski High School STEM Club.

These are the statements that students evaluated themselves on in a pre-test / post-test fashion. By comparing students' responses regarding whether or not they agreed or disagreed with each statement and the level to which they felt the way they did it can be assumed that any differences from the pre-test to the post-test will be the result of experiences gained while participating in the aquaponics project.

Pre-test results:

Aquaponics Attitudes and Aptitudes	1	2	3	4	5	6	7	8	9	10
% Positive response	31.3	18.8	12.5	18.8	6.3	12.5	12.5	12.5	6.3	100.0
% Indifferent response	0.0	0.0	0.0	12.5	0.0	8.3	0.0	8.3	12.5	0.0
% Negative response	68.8	81.3	87.5	68.8	93.8	81.3	87.5	62.5	81.3	0.0

Post-test results:

Aquaponics Attitudes and Aptitudes	1	2	3	4	5	6	7	8	9	10
% Positive response	87.5	56.3	50.0	56.3	62.5	100.0	75.0	93.8	87.5	100.0
% Indifferent response	12.5	18.8	25.0	12.5	37.5	0.0	6.3	0.0	12.5	0.0
% Negative response	0.0	18.8	25.0	6.3	0.0	0.0	18.8	6.3	0.0	0.0

The first statement requests that students evaluate their ability to describe the advantages and disadvantages of growing fish and plants in an aquaponics system. Only about a third of all students (31.3%) actually felt like they could do so prior to this project. The post-test results clearly state that almost all students (87.5%) felt like they could describe the advantages and disadvantages of aquaponics. Students learned what can be good and bad about aquaponics.

The second statement inquires about how students feel about their ability to design a system that will allow them to grow fish and plants together. Only 18.8% of all students interviewed (or roughly 1 in 5) stated that they could do so before the project. As a result of participation in the project about 3 out of 5 students (56.3%) stated they could do so. Students learned aquaponics design components.

Statement #3 required students to declare if they felt they could construct a system that will allow them to grow fish and plants together. Clearly students did not have much confidence in their ability to construct prior to the project (87.5% did not believe they could). Only 25% of students whom participated in this project did not feel they could do so after actually building one for STEM Club. This provides evidence stating that students felt like they could build an aquaponics system.

The next statement (#4) requests that students evaluate their ability to monitor environmental conditions using computers and probeware. Approximately 69% of students said they could not do so in the pre-test. In the post-test that number declined to only about 6%. This confirms that students learned how to use probes and computer applications to test the water chemistry of the aquaponics system.

The fifth statement requests that students evaluate their knowledge of what to do when fish and plant pathology issues arise. This statement resulted in the statistically most negative response (93.8%) on the pre-test. On the post-test 62.5% of all students interviewed stated that they had knowledge of what to do. This clearly indicates that as a result of having to remedy fish and plant pathology issues during this project students gained confidence in their understanding of diseases.

It is suspected that most students probably did not know what propagation was prior to this project. Statement #6 inquires about what students know about propagating vegetable garden plants. Only 12.5% of students said they knew how to propagate plants before this project compared to an overwhelming 100% afterwards! It is clear that students learned the meaning of this word and learned how to turn seeds into plants as a result of this project.

Not too many students stated that they understood basic aquaculture techniques – the focus of statement #7 – prior to this project (12.5% said they understood and 87.5% said they did not. As a result of this project the percentages

just about reversed as 75% said they did understand aquaculture techniques and about 19% said they did not. It appears as though 5 months of taking caring of the tilapia resulted in some effective learning.

In the eighth statement, students were asked to rate their ability to harvest the vegetables and fish raised in an aquaponics growing system. Approximately 3 out of 5 students stated that they did not know how to do so prior to this project. Following the project, a convincing 93.8% of all students stated they could do so. The experiences of this project clearly improved their abilities in this category.

Statement #9 investigates how students would market the products of the aquaponics growing system to generate income. It was uncommon for students to know how to do this prior to the project, as only 6.3% of all students interviewed knew how to do this. As marketing lettuce to faculty members became a very enjoyable activity for many students it is surmised that they learned a lot about doing so. Not a single student stated that they did not know how to do so following the project.

The final statement asked about the level of excitement students possessed regarding their newfound ability to utilize their interest for and understanding of Science, Technology, Engineering and Math through participation in the Pulaski High School STEM Club. All students were excited about doing so both prior to the project and afterward. It was very rewarding to see students so enthusiastic about their involvement.

When asked what did they like about designing, constructing and caring for the aquaponics growing system a student responded by saying, *"I enjoyed constructing the aquaponics system, I never would have thought of building something as complex as this on my own. Following the original assembly there was a lot of trial and error which I enjoyed. We were all learning as we went which was fun and a new way of learning I liked. We had a plan, but every day we worked on it was different."*

When asked to explain what set this project apart from other school projects you have completed another student responding with, *"This project was very special – most people have heard of the term hydroponics but not aquaponics. Once we started building the system our activities sparked great interest in this form of growing plants and fish together."*

Another student was asked how participation in this project impacted education and career plans. The student said, *"My involvement in this project definitely made me consider an occupation in the STEM field. After we visited SUNY Morrisville to see their aquaponics center I decided to visit again to see what programs and courses I could do there."*

A different student identified a highlight from this project for the year by saying, *"One huge highlight from this project was the interest and support from other students and teachers. Seeing this project up and running and producing vegetables we can sell to raise money to re-invest in the project is very satisfying and like nothing I have ever done before in school."*

In an oral interview conducted with two students whom were both heavily involved with every aspect of this project throughout the year an overall theme emerged. They kept returning to the notion that a lot of times they don't feel like they get the opportunity to apply the knowledge they work so hard to generate in their classes. The aquaponics project was different. It was obviously really hands-on, but what many students liked was the fact that they had a role in figuring out everything that was to happen next. They weren't being told what to do – they had to figure out what to do. Figuring out what to do required a deeper level of thinking and thus their understanding of issues, concepts and processes became more complex.

Aquaponics Project Reflection

The aquaponics project completed by the Pulaski STEM Club this year has been the most successful project I have been involved with during my teaching career. I have never been involved with anything that has resulted in as much learning as this project did. Students were inspired, teachers were interested, the community wanted to know what was going on – we even managed to create a buzz amongst administrators from neighboring schools. I believe every single student involved with this project, which included 19 high school STEM club participants and all Pulaski biology students, was intrigued by each new development in this project, of which there were many.

I am proud to have been a leader in this project along with my fellow STEM club advisors. I thoroughly enjoyed the processes required to make this a success. We started out brainstorming, and then we reviewed. The next step was to test. After testing we could design and construct. Following construction we could see if our plan worked, troubleshoot when needed and expand. Each of these stages of the project required tremendous dedication – in terms of both time and a willingness to persevere when things got complicated.

I learned a great deal about aquaculture and how to grow plants indoors from this project. There are many unique challenges to soil-less agriculture. There are many unique challenges to raising fish for food production sans filtration. It took a lot of reading, searching the internet and thinking outside the box to blend these two scientific endeavors. I have grown plants hydroponically before and I have raised fish. Never have I blended the two experiences in one system, though. That required some personal development that I have not really needed to do to be successful in my teaching in a while. I really enjoyed literally being the student again. It was good for me to learn the details of aquaponics so that I could guide my students in the right direction.

My students learned about an outstanding form of agriculture that utilizes all their science, math and technology skills. A successful aquaponics projects unites a student's ability to apply the knowledge they possess plus her or his ability to identify knowledge they must gain. This project presented new challenges on a daily basis and I think students really enjoyed that aspect of it. Student learning was highlighted by cohort percentage increases in their abilities to: describe advantages and disadvantages of growing fish and plants together; design and construct an aquaponics system; monitor environmental conditions using computer applications and probeware; remedy plant and fish pathology issues; propogate vegetable plants; understand basic aquaculture techniques; harvest fish and vegetables raised indoors; and market the produce and fish raised for profit.

I learned so much from this project it is hard to narrow it down to just a few things upon which to report. In general, I learned how to grow food indoors. I learned the art and science of aquaponics. The science, technology, engineering and math principles became part of my daily way of thinking. Those benefits of participating in this project were definitely valuable. There were also some more intangible things that will make me a better teacher as a result of the aquaponics experiences.

Some of the more intangible things I took away from this project is learning the importance of applying knowledge. Students need an outlet to work with the knowledge gained from taking courses. Getting "hands-on" was definitely meaningful to students, as announced during the learning outcomes interviews. I learned the value of prject-based learning from this project. I intend to modify all of my teaching programs to take advantage of all of the outside the box learning that takes place in STEM challenges such as these.

I think the biggest success in this entire project was the lettuce raft system. Lettuce is the perfect aquaponics / hydroponics plant. The simplicity of the raft system makes it an ideal classroom growing system. Along with my STEM club co-advisors I will be sharing information about our aquaponics systems at the November 2014 STANYS (Science Teachers' Association of New York State) conference. During our presentation we will show our audience how to build a medium-scale aquaponics system. We will also demonstrate the lettuce raft system. We will build one during the workshop and raffle it off so a lucky individual can bring it back to his or her school and use it with students immediately.

We raised over $100 selling the lettuce we raised in our raft system. At $2 a quart-sized bag we were able to turn a profit in only a month's time. Had we started this at the beginning of the year we probably could have purchased the proper lighting for the tomato hydroponic display that was an absolute flop.

Our tomato growing system produced more vegetation than most people have ever seen on tomato plants. Unfortunately after three months of vegetative explosiveness our growing system never promoted the flowering of the tomatoes. Since they never flowered they never produced any fruit. It seemed like a shame to have these huge robust plants but no fruit. We identified lighting issues as the culprit for the lack of tomatoes. The repaired light fixtures and donated bulbs we used simply did not put off the intensity or wavelength of light our plants required to go from vegetative mode to reproductive mode. We discovered that our lighting was giving off only about 750 lumens, a measurement of light intensity. A sunny day typically produces about 10,000 lumens uninhibited. We intend to address lighting issues for next year by improving our arsenal of bulbs, fixtures and reflectors.

This project incorporated professional development due to the constant need for new information. Most of the professional development we underwent was due to necessity and on our own or by working together. It was enjoyable to keep learning and expand our knowledge base on STEM topics. Probably the best professional development received happened during our March 11, 2014 field trip to SUNY Morrisville. We explored the greenhouse technology programs, horticulture, aquaculture, biodiesel production and the Morrisville Aquaculture Center. By meeting with professors and experts in the field we were able to educate ourselves as our students learned about college course offerings and the opportunities that are out there in STEM disciplines.

I kept a log of hours spent toward this project. It can be viewed in an Excel spreadsheet. While the total number of hours reported states I spent 99.0 hours on this project it was much more than that in reality. I did not document each and every hour spent watering, planting, caring for fish, cleaning pipes, etc… As I stated at the beginning of my reflection I have not been involved with a project of this magnitude before. I feel so good about the project I gladly would put in double the hours for next year just to see how much more there is to learn about aquaponics!