Lost …

knowledge and skills from the Nature of Science benchmarks

FOUND…

A Study to evaluate the impact of Biotechnology-infused labs in a Chemistry Honors course drawing from the use of the scientific method as it applies to students' attitude towards learning science and the ability to solve daily problems they face.

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Abstract:

Behind all scientific discoveries lies the curiosity or observation of someone we call a scientist. In our high school classrooms across America there are many students who will one day become an active scientist. **My goal** is to help the students in my Chemistry Honors this year discover the joy of becoming a problem solving scientist by applying the simple steps of the Scientific Method and realize how we use this process daily as we go about addressing life. **I will take** pre and post assessments to measure understanding of the process and student attitude towards the usefulness of science in their lives. I will use hands on activities from B2B beginning with; A Tree of Genetic Trait lab and progress to other complex activities to allow students to see how scientific discoveries come about using the same process seen in our Science Fair projects and other class activities.

Rationale:

I understand when students feel they do not relate to the content of the course they are taking or, when students feel so lost about the purpose they loose interest in the class. Either way, students shut down. Recently I participated in course to renew a professional license for the State of Florida. As I progressed through the training I could not relate to the vocabulary, the instructions provided or the materials provided. I began to drift and loose interest. Fortunately for me I was able to choose another route for my required learning and I had a reason to continue. I completed the activities and my renewal requirements. Through this I realized what I went through was similar to what students go through regularly in science classes they are not drawn into and/or have no "reason" to take.

I have taught high school science courses in six schools in my 16 year career in education. I have spent many years in business and returned from business to teach in high school I experienced a significant number of high school graduates unable to remain in a quality workforce with a high school diploma. Graduates were not prepared to apply simple independent problem solving skills as they entered the work force in a major corporation and would either quit or be fired for lack of these skills in addition to simple business conduct expectations. Many new hires were not willing to learn and apply new concepts to solve simple problems. As I observed the necessary problem solving skills are applications of the concepts and/or processes we teach throughout our schools in the Scientific Method.

Many if not most students who are taking average science classes do not want to be there and see no relevance of the course to their lives. The state of Florida has provided learning objectives in the form of Benchmarks that direct what we are to teach in each content area. Therefore many of our classes may seem drill-like and meaningless to students depending on the approach of the teachers in the classroom. Connecting all science content areas are the Benchmarks called Nature of Science. The concepts or objectives of these benchmarks fall in line with knowledge and skills to lead students to become more successful in scientific thinking which would increase academic performance in any other classes but more importantly, these benchmarks focus on a model for thinking that is truly a method for problem solving. I know that most of my students will not become professional scientists or even choose a science related field for their work. However, **IF** I can provide them with skills to successfully solve problems through practicing a series of steps leading to solutions, analyze results, and apply this to any life situation, **THEN** I will help students move more effectively into the realm of critical thinking and successful life skills.

The Nature of Science benchmarks focus on understanding and applying the Scientific Method. This requires the understanding of the steps, learning new vocabulary, recognizing the steps in a given situation and applying this to multiple situations, not just identifying the different steps in a prescription-type lab. "Teaching the Scientific Method is a fundamental way for students to practice thinking critically. By performing science experiments and analyzing the resultant data, you are helping to build the next generation of creative thinkers." (Lewis, p 1)

I will teach the Chemistry Honors course through interactive inquiry based labs using the B2B resources and regularly model and interact with the basic problem solving steps. As the students repeat and talk about what we are learning in class, the Scientific Method will become more familiar and as we apply this process to real life situations, it will become relevant. As I interact with my colleges, I find that most teachers do not spend enough time integrating this way of thinking into their courses but rather introduce the Scientific Method as linear steps, complete a couple of activities and move into their curriculum. Students do not see the relevance or the connection of the Scientific Method to their lives or the next science course they take. Because I had the opportunity to attend B2B and see the challenges and successes in applying the Scientific Method at its best, I am better equipped to explain and support both teachers and students who do not see this problem solving process as valuable to use and apply in our classes.

Inadequate problem solving skills turns out to be one of the principal causes of academic failure in areas such as physics and chemistry. Students and teachers tend to focus on the mathematical competency skills rather than the content knowledge. During the most recent science book adoption process in the State of Florida, most of the publishers were required to include more inquiry hands on activities which emphasized the application of the scientific method. As evidenced in the new science books used in my classroom, the Nature of Science benchmarks are infused into every chapter and not just the first chapter in the text. In the past we would introduce the Scientific Method in Chapter one or two and then… never really see the applications even though labs were performed regularly. With the current emphases in CORE competencies and higher order questions, the infusion of the Nature of Science benchmarks throughout the texts becomes very valuable as our daily resource and reminder to help students succeed in problem recognition and problem solving.

It seems students in general have not learned how to solve problems but merely memorize solutions explained by the teacher as simple exercises in application. Most teachers do not apply the gradual release model of teaching in their classrooms and thus seem to provide the answers and knowledge already worked out, with the failure of teaching through student discovery of facts. It manifests itself in a low degree of transfer of learning and in pupils either "recognizing" problems which have already been solved or giving up. (Fisher and Frey, 2008)

Many articles in print suggest that there are still serious shortcomings in our theoretical understanding of problem-solving , including lack of knowledge and understanding of the strategies actually used by those who solve problems, although some useful studies have been reported. As a result, the very idea of what is to be understood by "problem-solving" is seen by the various authors from very different angles. Some see problems-solving as almost synonymous with thinking; others see problem-solving as a particularly complex form of learning which has to be preceded by simpler forms of learning. However, it is suggested that problem-solving can only be achieved through the adoption of teaching strategies which reflect the process and nature of investigations- that is to say, of something for which there does not exist an obvious solution at the beginning. (Perez and Torregrosa, 2007) Students are not

used to searching for solutions or predicting outcomes. Once this becomes a practice, problem-solving begins to be a more common process for them.

The scientific method is traditionally taught in a linear 5-7 step method and usually memorized in elementary school. The word method and process are used interchangeably. The process is still used to validate studies and serve as the backbone for a PhD. candidate's dissertation. More recently the scientific process is also referred to as a problem solving process.

The processes/steps are as follows:

- **OBSERVATION**: A researcher garners an idea through review of the research literature to date, observations through clinical practice or even conjecture that seems to hold truth - for example, Pavlov noting the behavior of his dogs at meal time or Newton being bonked on the head by a falling apple.
- **RESEARCH**: A researcher garners an idea through review of the research literature to date, observations through clinical practice or even conjecture that seems to hold truth - for example, Pavlov noting the behavior of his dogs at meal time or Newton being bonked on the head by a falling apple.
- **FORM AN HYPOTHESIS**: From this initial idea, a scientist develops a hypothesis - a tentative explanation – into what he or she believes to be the truth.
- **DESIGN AN EXPERIMENT:** The next step involves the development of a method for testing this hypothesis.
- **CONDUCT THE EXPERIMENT INCLUDE DATA GATHERING AND ANALYSIS:** The research is then conducted using the detailed method chosen and the data is then analyzed.
- **DRAW A CONCLUSION:** The findings are reported to the scientific community and future directions are determined. If the findings support the hypothesis, additional research will be conducted by other scientific teams towards replicating the same results, giving additional weight to the hypothesis, or demonstrating that the same results cannot be reproduced, indicating the hypothesis is not valid. This process may also uncover information that gives researchers new ideas, new hypotheses for research.(Read, 2011)

More recent text books and publications support the idea that the once linear process is more like a web. You may at any point return to research and redefine a hypothesis, design another experiment and so forth. As student experience the Inquiry Activities and see how they are able to re-design even the simple activities, they will begin to understand the more recent model and see how it does apply to the daily problems and situations they face.

The goals of education include preparing students for their future in the world we live in. With appropriate problem solving skills, students will find themselves more successful than others who cannot apply such skills. As students emerge from high school and move into higher education or the workforce, not longer can workers expect to succeed without critical problem solving skills. They will be expected to solve problems and make decisions either individually or as part of teams. These decisions may affect only themselves or a very wide variety of people and/or organizations.
The suggested steps for solving problems that is accepted in business are best summarized below.

You will note the close correlation to the scientific process:

1. **Identify and clarify the problem.**
2. **Gather information.**
3. **Evaluate the evidence.**
4. **Consider alternatives and implications.**
5. **Choose and implement the best alternative.** (Guffey, 1998)

As students learn and apply the scientific process in my Chemistry Honors course by completing a series of Biotechnology labs and applying related chemistry content within the course of Chemistry Honors to their daily life, my project to move them from a step process approach to the Scientific Method applied only to content in science class into a way of thinking to approach any problem or obstacle, should result in a changed attitude towards science courses, improved academics and a well prepared young person for the workforce ahead.

The labs will connect to the Nature of Science Benchmarks. I will be able to insert several segments of taped lectures which explained the science process needed in research of new medical solutions. I will use a variety of interventions and data collection means to answer the follow questions that will drive my study. The classroom interventions include a variety of interactive learning strategies including share-pair and student centered chunking and talking techniques.

Sub Questions:
Why are lab processes important?
What is the scientific thinking process?
What are the students' attitudes towards the scientific process?
Will students recognize the need for ongoing problem solving?
Will using labs help students to identify problem solving steps?
Will the Biotechnology labs and support improve student performance?
Will students be able to take a problem and apply the problem solving steps they have learned?

I continually engage in conversation with instructors in higher education and in the business world. I am constantly asking the question; what do you expect of my students as they leave high school? Of course knowledge in specific content areas will be the educators answer, but in most cases they ask for problem solving skills to be high on our list. Students who can solve problems can improve their academics. I also wanted to conduct a study that I could apply in multiple years and in any science content area. I decided to focus on a study to evaluate the impact of Biotechnology-infused labs in Physical Science Honors course on students' problem solving ability and attitude towards learning science.

My Action Research Interventions include:

- I will use Biotechnology labs starting with the Tree of Genetic Traits during the first quarter of school. Very little introduction is needed and this will help students understand that sciences are interconnected.
- I will collaborate with my department and ask for input constructing two different pre and post assessments.

- The first will be to measure the knowledge around the scientific process, its application and steps. I will use a short assessment that will provide data at the begining of the school year and repeat a similar assessment in January and May to provide additional data points.
- The second assessment will be used to measure how students feel about learning and applying science. This will be more of an attitude check.
- Data collection will be taken in the assessments.
- Students will keep a journal for two purposes. One will reflect knowledge and application of the scientific process and the other will reflect their attitude towards learning.
- I will maintain a journal to track classroom behaviors and attitudes.
- I will construct a rubric when reading and recording journal entries.
- I will use the gradual release model of instruction increasing students' role in the learning process as time passes.
- Provide a final project where students will demonstrate the application of their problem solving skills when selecting a produce they currently use and predict the process required to bring their product to market. This will be a final project in May.

To accomplish these interventions, I will use a variety of classroom strategies. I will use the gradual release and focus lesson model from Fisher and Frye as I apply the 5e's model of scientific lesson planning and delivery.

Connections to Bench to Bedside Summer Institute:

I will be using not only the lab resources from Bench to Bedside that were demonstrated this summer; I hope to have a group of students visit the University. I will request at least one classroom support visit to expose students to a research scientist and access any other resources that we have been provided as I explore all the web based information we have been given. The water kit can be used as we study bonding and the characteristics of water. It provides a variety of hands on activities that can be used in the appropriate unit in my course.
I will integrate the power points and recorded lectures to help students to see and hear the stories of how scientific discoveries come about and hopefully appreciate all the work that it takes to bring a product to market.
Dr Greg Schultz started the session with an amazing presentation about wound healing and how one process in the healing of wounds led to other product development. Many students hear and understand about diabetics. The pictures were graphic and will catch attention. I hope to have rich discussions from just this one presentation about what ifs and where can we go and how do we help prevent these conditions.
All of the students I teach have taken General Biology. The presentations on Stem Cell research will open up discussions. We may even be able to include the "Ethics in Biomedical Research" presentation that provided a great explanation about ethic in general and its applications to life situations. Students see the examples on TV and movies, but I can present current up to date medical ethics with this lecture material
Some students may be thinking about discovering some new product. I can use the examples of the "Business Incubators" that were presented by MS Breedlove. What success stories. We also heard about how these businesses started while students were still in college. Dream students, dream!

One of the more important applications of B2B was the collaboration and sharing of the colleagues present. I gained a lot of tips and connections that I will be able to draw on throughout the year.

Data Collection and Analysis

I will be collecting both qualitative and quantative data. My data collection and analysis will be based on the assessments described in the Action research Intervention sections. Notebooks as mentioned above will be used regularly and entries used for the data collection process. I may find opportunities to do individual interviews and will log those in my journal as other data points.

By examining the pre and post test, I will be able to determine and present the results of knowledge and skills learned and through the presentation of the data from an assessment on attitude that is on a Likert scale present a change in attitude towards learning and science classes. Students final projects will reflect their interest and depth of understanding of the Scientific Method/problem solving process. The students will provide ideas for the rubric to evaluate their final project. The student journal will reflect their journey through the year.

Literature cited:

References

1. Fisher, D., & Frey, N. (2008). *Better Learning Through Structured Teaching* (2008 ed.). Alexandria, Virginia: Association for Supervision and Curriculum Development.

2. Guffey, M. E. (1996). Business Communication: Process and Product. *Cincinnati: couth-Western college Publishing*, 2E.

3. Herreid, C. F. (2010). Explaining the Seven Steps of the Scientific Method. *Journal of College Science Teaching*, (39.6), 68.

4. Lewis, B., & Finn, W. (2011). The Scientific Method of Research. Retrieved from http//bipolar.about.com/od/researchstudies/a/scientific_method.htm.

5. Perez, D. G., & Torregrosa, J. M. (2007). Innovations and Development, A Model for Problem-Solving in Accordance with Scientific Methodology. *EUR.J.SCI.EDUS.,1983*, *5*(4), 447-455.

6. Read, K., & Finn, W. (2012). The Scientific Method of Research. Retrieved from http://bipolar.about.com;od;researchstudies/a scientific_method.htm.

Budget:

Biotech Labs	**Locker is free**
Yellow Bus	**$500 for trip to UF**
Miscellaneous Lab	**School provides**
Guest speakers	**Thank you cards**

Permissions:

Permission to conduct a field trip to UF will need to be requested from the appropriate administrator. Parent permission will be needed for the field trip. I do not think any other permission will be needed.