Hands-on Lab Experiences for All Levels of High School Students

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Abstract:

This action research plan was designed to help secondary science students become more confident in their ability to participate in hands-on science laboratory activities. Extensive research has been conducted to help students and teachers determine the different learning styles that each learner has. By utilizing different techniques, it is expected that students will be able to comprehend more of the material that is presented to them. The goal of this activity is to instruct the students in various laboratory techniques that will be required throughout the schoolyear.

The Florida State D.O.E. NGSSS Standard, SC.912.N.1.2, "Describe and explain what characterizes science and its methods" is a standard within the Practice of Science. Each course will have its own prescribed equipment that will be utilized, but the basic understanding of what the scientific method is and how to use it are universal throughout all sciences.

Rationale:

The focus of this action research project is to determine if my students will have a better comprehension of how to use various pieces of lab equipment and will develop better laboratory techniques when provided with a hands-on lab activity. I believe that students will perform better and have better overall understanding about the scientific method if they get to perform a variety of laboratory activities. This lab activity is tied to the Florida State standard SC.912.N.1.2. The lab that will be used is a one that requires the students to perform a variety of measuring devices, including the use of micropipettes. The goal is to increase student confidence in the lab setting, as well as their ability to perform the required tasks that many of the high school lab activities require.

I teach a wide-range of students, from the very high students in AP Physics to the lower achieving students in Biology. Most of the students that I teach in Biology have an IEP for either SLD (specific learning disability) or EBD (emotional behavior disability). I strongly believe that all students can learn science, but they need to be shown (sometimes more than once) how to do it.

Intervention:

The interventions (teaching strategy or innovation) that will be implemented for the action research proposal is with either my Low-Level Biology students or my Honors Chemistry students. The students to complete a laboratory activity that will require them to measure a variety of objects using various pieces of equipment. In addition to the "traditional" pieces of laboratory equipment, students will utilize micropipettes to complete an introductory hands-on lab activity. This action research proposal differs from how I have previously taught laboratory skills because it will include the micropipettes. Providing my students with the opportunity to use a lab tool (micropipette) that the other biology students will not be using will be a neat opportunity for them. Hopefully, the students will appreciate this fact and be more engaged in the lesson. I will be repeating the lesson with higher level of complexity, which should help the students to become comfortable with their skills and understanding level.

Data Collection and Analysis:

At the beginning of the school year the students will be given a 10-question assessment to gain a baseline result of the student's assessment of their own lab skills and the student's assessment of their understanding of science standard SC.912.N.1.2.
This assessment will be given again after completion of each of the micropipette labs. The student assessments will be compared to determine if the student's data indicated that their understanding and ability had increased.

Connections to CATALySES Summer Institute:

The use of the Pipetting by Design lab and the lockers for the lab activity.
https://www.cpet.ufl.edu/wp-content/uploads/2012/10/Pipetting-by-Design-lesson-plan-6_2012.pdf
The use of the following measurement lab.
http://s3.amazonaws.com/scschoolfiles/747/metric_measurement_lab_activity_for_pre_ap.pdf

Literature Cited:
Lopez, Doreen, Schroeder, Linda (28 June 2018). Retrieved from https://files.eric.ed.gov/fulltext/ED500848.pdf

CPalms (2018) *Biology Standards, Nature of Science.* Retrieved from http://www.cpalms.org/Public/search/Standard

Cunningham, Janet (28 June 2018). *CATALySES Summer Institute.*

Retrieved from http://s3.amazonaws.com/scschoolfiles/747/metric_measurement_lab_activity_for_pre_ap.pdf

Retrieved from https://www.cpet.ufl.edu/wp-content/uploads/2012/10/Pipetting-by-Design-lesson-plan-6_2012.pdf

Permission:
Permission was received from the Principal of Forest High School. Consent was received in April 2018.

Measuring to become a Mad Scientist

KEY QUESTION: How can learning how to measure correctly in the lab make you a "mad scientist"?

SCIENCE SUBJECT: Biology and Honors Chemistry

GRADE AND ABILITY LEVEL: Lower-Level Biology and Honors Chemistry. Grades 9-12.

SCIENCE CONCEPTS:
1. Measuring in the lab.
2. Describe and explain what characterizes science and its methods" is a standard within the Practice of Science.

OVERALL TIME ESTIMATE: Lesson and lab activity (including pre and post tests) should take approximately 2 class periods (100 minute blocks)

LEARNING STYLES: Visual, auditory, and or kinesthetic (combination of all 3)**.**

VOCABULARY:
Basic measurement units and equipment. (Common knowledge for all science teachers).

LESSON SUMMARY:
The activity will teach the students the basics of scientific measurement and the skills needed to perform the necessary lab activities for the school year.
This content will be covered with a pre-test, a lecture, videos, lab demonstrations, student hands-on lab activity, and then a post test.

STUDENT LEARNING OBJECTIVES WITH STANDARDS:

The student will be able to...

1. practice using the metric system SC.912.N.1.2.

2. become familiar with metric system units, converting between large and small metric units SC.912.N.1.2.

3. learn and practice the proper technique for measuring small volumes of liquid using a micropipette SC.912.N.1.2.

MATERIALS:

(1) Multicolor Food Coloring Package (Red, Blue, Yellow, Green)
(2) 10mL aliquots of Colored Water (Color of water needed is dependent upon which protocol each group is using)
   A- DNA: Red and Blue water
   B- GATC: Blue and Green water
   C- Gator: Green and Brown water
   D- UF: Orange and Blue water
   E- Virus: Purple and Red water
   F – Atom; Red, Orange and Blue water
   G – Flask; Blue, Orange and Red water

H – DNA Strand; Blue and Red water
I – Insect; Green and Blue water
J – PCR; Green, Orange and Blue water

(3) (1) 96 Well Plate
(4) • (1) P20 Micropipette
(5) • (1) P200 Micropipette
(6) • (1) 2- 200ul Tip Box
(7) Meter stick
(8) Graduated cylinder
(9) Triple beam balance
(10) Thermometer

BACKGROUND INFORMATION:

Introduction:

The purpose of this activity is to practice using the metric system. To conduct a scientific investigation, a researcher must be able to make accurate measurements. In today's exercise you will become familiar with metric system units and converting between large and small metric units. In each of the sections that follow, you will familiarize yourself with the appropriate metric units that scientists commonly use, and then you will take the measurements of some everyday objects.
The metric system is the standard system of measurement in the sciences, including biology, chemistry, and physics. It has tremendous advantages because all conversions, whether for volume, mass (weight), or length, are in units of ten.
This ten-based system is similar to our monetary system, in which ____ cents equals a dime, and ____ dimes equals a dollar.

Standard Metric Units:

The International System of Measurement (SI), commonly called the metric system, has been adopted as the official system of measurement by most countries. Unlike our traditional system of measurement (inch, foot, yard, mile), the metric system is based on standard units that can be easily converted by simply multiplying or dividing by ten. The standard metric unit for length is the meter. Gram is the standard unit of mass and liter the standard unit of volume. Temperature is measured in degrees Celsius (or Kelvin).

Background for Micropipettes:

Micropipettes are precise instruments used to accurately measure very small quantities of liquids in science laboratories. Image 1 shows a micropipette and the main components of the instrument. They are available in a variety of sizes to best match your measurement needs. The size of the micropipette is indicated directly on the instrument. The most commonly used micropipettes are the P10, P20, P200, and P1000. The number following the "P" refers to the maximum volume in microliters (μl) that can be measured using the instrument.

ADVANCE PREPARATION:

Gather all equipment necessary for the lab. Prepare all solutions needed for the pipette activity. Get all the cards with the directions for the pipette activity printed and laminated.

PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:
Introduce topic to the students and have them complete the pretest.
After the pretest has been completed, use the PowerPoint to introduce the students (students should take notes) to the lab activities. There are videos embedded within the PowerPoint that demonstrate how to perform each of the lab activities.
Students are to complete the lab sheets as they work through the lab.
After the completion of the lab, students will take the same test (the pretest). Scores will be compared to see if the students improved or have a better understanding of lab techniques after learning about and performing lab experiments.

EXTENSIONS:

ACTIVITIES: Students will be utilizing these skills throughout the school year for most of their lab acitvities. They will become more proficient as the year progresses.

LITERATURE:

RESOURCES/REFERENCES:
http://s3.amazonaws.com/scschoolfiles/747/metric_measurement_lab_activity_for_pre_ap.pdf

https://www.cpet.ufl.edu/wp-content/uploads/2012/10/Pipetting-by-Design-lesson-plan-6_2012.pdf