# ESE Center Based Populations - Benefits of Providing Hands-on Lab Experiences

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**Abstract:** Learning style research indicates kinesthetic learning style is more prevalent than visual and auditory learning styles among secondary school students (Rajshree S. Vaishnav. March 2013). Secondary students in ESE center placements have instruction primarily targeted toward visual and auditory learning styles due to safety concerns related to the high impulsivity and volatility of the population. Most labs are taught using a virtual platform. Providing ESE center based students with opportunities to practice additional hands-on (kinesthetic) lab activities should improve their engagement, understanding and retention of the required curriculum and standards.

NGSSS Standard, SC.912.N.1.2, Describe and explain what characterizes science and its methods has been difficult for my students to comprehend. Providing a connecting kinesthetic lab, repeating the lab skills several times with increasing complexity, over the course of a semester, should improve student understanding and retention.

**Rationale:** Exceptional Student Education students who are placed into a center school are a mixture of School Based Mental Health, Emotional and Behavioral Disorders, Other Health Impaired, and students with multiple exceptionalities who are educated in the most restrictive public school environment possible. Federal guidelines under the Individual Disability Education Act require that exceptional students be taught in the least restrictive environment. ESE students in an ESE center placement exhibit the highest levels of need. These students are staffed into an ESE center, require a guardian to approve the placement yearly and three levels of Multi-Tiered Systems of Support steps to be implemented prior to ESE center consideration. Even with very extreme issues, behaviors and volatility, only a small percentage of ESE students are served within an ESE Center. These students are placed into a center-based setting due to their volatility, impulsivity, unique learning styles, needs, and behaviors.

Within the center-based setting there are numerous procedures and protocols that must be followed to ensure student and staff safety. Due to these constraints, my high school science classroom is not equipped with laboratory facilities. Every activity and lesson that is planned must be done with an understanding of the student population and dynamics. Recognition of carefully pairing any type of interaction between students as well as maintaining 100% supervision of students at all times is required due to safety concern. Consideration needs to be given to the tools and supplies provided to the students so that student impulsivity, externalizing behaviors, and inability to recognize consequences do not create a dangerous situation for students or staff in the center. Students are screened into school with metal detectors, are not allowed to bring backpacks and all school supplies are provided. Due to these parameters, it is difficult to implement experiential activities such as hands-on labs within a ESE center-based setting. A majority of my labs are taught using virtual lab experiences. While this platform is able to show the students the skills and information, this type of instruction targets only the auditory and visual learning styles. Learning style research indicates kinesthetic learning style is more prevalent than visual and auditory learning styles among secondary school students (Rajshree S. Vaishnav. March 2013).

Providing center-based ESE students with text dependent reading assignments is not effective due to a high percentage of low level readers, lack of engagement with text assignments and general disinterest in subject based reading. Teaching the population through a combination of PowerPoint presentations, videos, lecture, virtual labs and activities has been effective for some students but has not been able to meet the varying needs of the population. Test results from the previous four years indicate students show the lowest level of performance on the nature of science standards when compared to other standards. Specifically focusing on NGSSS Standard, SC.912.N.1.2, Describe and explain what characterizes science and its methods, as a focus for the hands-on lab should be able to provide a competency to assess. Providing the students with some of the basic skills to help improve the foundational understanding of the concepts included in this Practice of Science standard should also show an increase in the students' understanding/application of the concept when encountered in a standardized test format. Ultimately, the premise is that providing the students with the hands-on experiences should help student learning gains.

Research comparing virtual labs with hands-on labs indicates, "The biggest disadvantage of virtual labs is that they are removed from the reality of the lab, which may already be removed from the reality of "science" (Rebecca K. Scheckler. 2003). Research has shown that a positive high correlation exists between kinesthetic learning and academic achievement (Rajshree S. Vaishnav. March 2013). Students tend to have low retention rates in subject areas where they have viewed but not practiced hands-on skills. Virtual exercises can be substituted for kinesthetic activities, however, they lack the immediacy of the supervision and contact with experienced teachers and materials. Only mature and self-motivated learners do well in virtual environments where class meetings do not structure their time and they must actively seek help when confused (Rebecca K. Scheckler. 2003). The ESE students in my classes often lack the ability to work independently. They require a high level of support, encouragement and supervision. My students tend to lose interest in virtual labs because they are not interacting with the lab, they are passively viewing the information.

Providing my ESE students with applicable practiced laboratory skills at the beginning of the school year will help my students to engage personally with the material. Repeating the lab activity with increasing complexity two additional times during the first semester should provide the students with a high level of exposure to a skill set that can be related to NGSSS Standard, SC.912.N.1.2. An expected outcome will be that the students will have a higher degree of engagement with the material, better understanding of the subject, higher retention of information, and applied skills.

The area of focus for this action research project is to determine if my students will perform better when provided with a hands-on lab activity focusing on lab skills and connected with the nature of science standard. The lab that will be used and adapted is the use of micropipettes. My belief is the students' understanding of basic laboratory skills (safety, measurement, and the care and handling of equipment) as well as their understanding of the nature of science standards will improve due to the addition of kinesthetic lab activities in place of virtual lab activities.

**Intervention:** The teaching strategy that will be implemented for the action research proposal is for my Earth Space and Environmental Science students to complete a hands-on lab instead of a virtual lab. The Earth Space and Environmental Science students will utilize micropipettes to complete an introductory hands-on lab exercise as well as two supplemental practices of increasing complexity. This action research proposal differs from how I have previously taught lab safety skills because it is a hands-on lab as compared to a virtual lab. Previously, I have completed a virtual lab and shown a PowerPoint Presentation when I have taught lab safety and lab skills. The reason I have done this through a virtual platform is because I do not have lab facilities available in my classroom. Since my students can be so impulsive, having lab materials accessible can be dangerous. Providing my students with the opportunity to use a lab tool (micropipette) that I can wrap a lab safety and lab skills lesson around while also connecting with the nature of science standards should allow the students to become more engaged in the lesson. Repeating the lesson with higher level of complexity several additional times 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 5 question Likert scale assessment to gain a baseline result of (1) the student's assessment of their lab safety knowledge (2) the student's assessment of his/her lab skills (3) the student's assessment of their interest level in the material (4) the student's assessment of their understanding of SC.912.N.1.2 (5) the student's assessment of hands-on lab activities compared to a virtual lab activities.

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 locker materials of micropipettes from CPET at the University of Florida will be utilized in order to practice the lab skill 3 times during the fall semester.

**Literature cited:** Rajshree S. Vaishnav. March 2013. LEARNING STYLE AND ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL STUDENTS. Voice of Research Vol. 1 Issue 4

Rebecca K.Scheckler. 2003. VIRTUAL LABS: A SUBSTITUTE FOR TRADITIONAL LABS? Journal of Developmental Biology Volume 47

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# “Hands-on” It’s Not Always a Negative Concept!

## KEY QUESTION

Does providing Emotional and Behavioral Disability and School Based Mental Health Students who are placed in an ESE center high school science class with hands-on labs improve their understanding of the nature of science standards more effectively than providing these students with virtual lab experiences?

## SCIENCE SUBJECTS

Environmental Science, Biology, Earth Space Science, ACCESS Points High School Sciences

## GRADE AND ABILITY LEVEL

9-12 grade students who are served in an ESE Center comprised of 100% Emotional and Behavioral Disorders, Other Health Impaired and School Based Mental Health students. Students range in ability from low cognitive students taught using ACCESS Points curriculum to students with average abilities whose learning is impacted by their documented disability/disabilities. Students frequently are capable of performing at grade level but are hindered by both internal and external factors which impact their ability to function and learn within a typical public school environment.

## SCIENCE CONCEPTS:

1. Science lab procedures and protocols are vital for safety.

2. Scientific inquiry is a multifaceted activity.

3. The processes of science include the formulation of scientifically investigable questions, construction of investigations into those questions, the collection of appropriate **measurable, accurate and verifiable data**, the evaluation of the meaning of the data, and the communication of the evaluation.

## OVERALL TIME ESTIMATE:

Lesson should take 1 class period (48 minutes) for 3 separate classes during the course of the 1st semester.

## LEARNING STYLES

Combination of visual, auditory and kinesthetic. A majority of the lesson is kinesthetic learning.

## VOCABULARY:

**Micropipette -** Lab tool used for the measurement of minute volumes.

**Microliter -** The milliliter is the most commonly used measure in medicine and cooking. It's defined as one-thousandth of a liter. A microliter is one-thousandth of a milliliter. A microliter is abbreviated as (µl).

> In relation to the base unit of [volume] => (liters), 1 Microliters (µl) is equal to 1.0E-6 liters, while 1 Milliliters (ml) = 0.001 liters.

## LESSON SUMMARY:

The lesson will cover the basics of lab safety and the use of micropipettes. The content will be covered through brief direct instruction, modeling, guiding and independent lab activity

Adapted from "Wet Lab, How to Use a Micropipette".

Link to Lab Activity https://www.nwabr.org/sites/default/files/IntroToMicropipettingJuly2012.pdf

## STUDENT LEARNING OBJECTIVES WITH STANDARDS:

The student will be able to...

1. Explain that scientific knowledge is based on observation and inference.
    - SC.912.N.1.2, Describe and explain what characterizes science and its methods

2. Safely and accurately measure small amounts of liquids using a Micropipette.

    - 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:

    - Pose questions about the natural world, **(Articulate the purpose of the investigation and identify the relevant scientific concepts).**
    - **Conduct systematic observations,** (Write procedures that are clear and replicable. Identify observables and examine relationships between test (independent) variable and outcome (dependent) variable. **Employ appropriate methods for accurate and consistent observations;**

**conduct and record measurements at appropriate levels of precision. Follow safety guidelines).**

- Examine books and other sources of information to see what is already known,
- Review what is known in light of empirical evidence, (Examine whether available empirical evidence can be interpreted in terms of existing knowledge and models, and if not, modify or develop new models).
- Plan investigations, (Design and evaluate a scientific investigation).
- **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), (Collect data or evidence in an organized way. Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration, technique, maintenance, and storage).**
- Pose answers, explanations, or descriptions of events,
- Generate explanations that explicate or describe natural phenomena (inferences),
- Use appropriate evidence and reasoning to justify these explanations to others,
- Communicate results of scientific investigations, and
- Evaluate the merits of the explanations produced by others.

## MATERIALS:

- SMARTBOARD
- Micropipettes P20/ P200/ P1000 (1 each per student)
- Micropipette tips P20 / P1000
- Parafilm
- Colored Water (Red, Blue, Yellow) 4 oz each per student
- Clear wells

(For more detailed information related to # of materials needed, refer to "Advance Preparation, Gather Materials)

## BACKGROUND INFORMATION

Students will be learning basic lab safety protocol as well as how to use a micropipette to accurately measure small volumes of liquid.

Knowledge of metric measurement (volume) is needed. Anchor chart of other visual means of presentation should also be available to assist in the conversion of volumes.

### Conversion of Microliters to Milliliters

The base unit for volume is liters (Non-SI Unit)

Microliters symbol/abbrevation: (µl)

Milliliters symbol/abbrevation: (ml)

**Converting Microliters to Milliliters (µl to ml)**

1 µl = 0.001 ml.

1 x 0.001 ml = ***0.001*** Milliliters

Students need to be familiar with the identification of the number/letter system used in laboratory clear wells.

## ADVANCE PREPARATION

GATHER LAB MATERIALS / Visual Aid:

- P20 Micropipette and tips - 1 Micropipette each per student. 1 box tips per student pair.
- P200 Micropipette and tips - 1 Micropipette each per student. 1 box tips per student pair.
- P1000 Micropipette and tips -1 Micropipette each per student. 1 box tips per student pair.
- Parafilm 1 each per student
- Waste container 1 each per student
- Red food coloring diluted 5 drops:100 ml water, 1 each per student
- Green food coloring diluted 5 drops:100 ml water, 1 each per student
- Yellow food coloring diluted 5 drops:100 ml water, 1 each per student
- Disposable gloves – 1 pair per student

- Copy of JKC Micropipette PPT (adapted from lindblomeagles.org/ourpages/auto/2012/12/4/41353168/Micropipettes.ppt)

## PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:

**PROCEDURE**:

Explain to students the **learning objective** of this lesson. Some teachers may find it useful to write the standard(s) to be addressed on the board.

- SC.912.N.1.2 Describe and explain what characterizes science and its methods
- 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:

➢ Pose questions about the natural world, **(Articulate the purpose of the investigation and identify the relevant scientific concepts).**

➢ **Conduct systematic observations,** (Write procedures that are clear and replicable. Identify observables and examine relationships between test (independent) variable and outcome (dependent) variable. **Employ appropriate methods for accurate and consistent observations; conduct and record measurements at appropriate levels of precision. Follow safety guidelines).**

➢ Examine books and other sources of information to see what is already known,

➢ Review what is known in light of empirical evidence, (Examine whether available empirical evidence can be interpreted in terms of existing knowledge and models, and if not, modify or develop new models).

➢ Plan investigations, (Design and evaluate a scientific investigation).

➢ **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), (Collect data or evidence in an organized way. Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration, technique, maintenance, and storage).**

➢ Pose answers, explanations, or descriptions of events,

➢ Generate explanations that explicate or describe natural phenomena (inferences),

➢ Use appropriate evidence and reasoning to justify these explanations to others,

➢ Communicate results of scientific investigations, and

➢ Evaluate the merits of the explanations produced by others.

**Lesson Target**: Learn how to use micropipettes to accurately measure small volumes of liquids.

Tell students that Micropipettes are a laboratory tool which is commonly used in many types of biology labs today to measure very small volumes of liquids. To put the volumes measured in context, review the following with students:

1000 = 1 liter (or 1.06 quarts)    1000 (μl) = 1 ml

Show JKC PowerPoint Presentation. Read through slides showing the key points of interest on the Micropipette. Notes on the bottom of the slides assist in presentation. Presentation should take no longer than 10 minutes.

Review lab protocols with students, including use of precautions and sanitation. All materials used in the lab are non-toxic and require no special disposal.

Students are sent to tables. Materials are kept in a central location which each student can access and move the materials to their table. Students practice safety protocols including gloves and cleaning of any spills at their tables.

Students are given verbal directions to use each of the Micropipettes by:

Placing a tip onto the Micropipette (P20) and measuring up 10 units of red water.

Placing a tip on the Micropipette (P200) and measuring up 100 units of green water.

Placing a tip on the Micropipette (P1000) and measuring up 200 units of yellow water.

Students practice measuring up and dispensing small, accurate volumes of colored water into clear wells using the Micropipette. As students become comfortable with using the different sizes of Micropipettes the can compare their clear wells with other students' clear well samples to determine accuracy.

When students have gained the measurement skill set, they can be provided with a scaffolded lesson which includes stated volumes, water color and clear well to be filled. These directions will create designs which students can observe to determine their accuracy with measurement and use of the Miocropipette.

## ASSESSMENT SUGGESTIONS

Student will be provided with instructions to create a design in the clear well using predetermined volumes of various colored water. Students will be assessed by the color and shape of designed compared to directions.

## EXTENSIONS:

### Activities:

Students can continue to refine their lab skills by creating a design that can be created in clear wells. Students will experiment with their design and create a list of amounts of color per well. Students will switch information and attempt to recreate the original student design. Students will need to write down the volumes used as well as the coordinates on the clear well plate in order for the activity to be reproducable.

**Literature:**

"How to Use a Micropipette" Adapted by Kelli Henry April 2011 from:
http://www.bio.davidson.edu/Courses/Bio111/Bio111LabMan/Preface%20D.html
https://www.mcdb.ucla.edu/Research/Goldberg/HC70AL_Su14/pdf/How%20to%20Use%20a%20Micropipettor.pdf

## RESOURCES/REFERENCES:

Introduction to Micropipetting: Working with Small Volumes. Northwest Association for Biomedical Research – Updated July 19, 2012.
https://www.nwabr.org/sites/default/files/IntroToMicropipettingJuly2012.pdf

"How to Use a Micropipette" Adapted by Kelli Henry April 2011 from:
http://www.bio.davidson.edu/Courses/Bio111/Bio111LabMan/Preface%20D.html
https://www.mcdb.ucla.edu/Research/Goldberg/HC70AL_Su14/pdf/How%20to%20Use%20a%20Micropipettor.pdf