Kansas Corn:
The Art of Lab Work- Pipetting Skills Development

This lab is made possible with the support and content contributions of the Kansas Corn Commission.

kscorn.com

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Grade Level: Middle School

Overview

Any educator electing to perform demonstrations is expected to follow *NSTA Minimum Safety Practices and Regulations for Demonstrations, Experiments, and Workshops*, which are available at http://static.nsta.org/pdfs/MinimumSafetyPracticesAndRegulations.pdf, as well as all school policies and rules and all state and federal laws, regulations, codes and professional standards. Educators are aunder a duty of care to make laboratories and demonstrations in and out of the classroom as safe as possible. If in doubt, do not perform the demonstrations.

The corn industry has made major advances in the last thirty years. Many of these advancements have come on the heels of an increased incorporation of biotechnology into the seed development sector. Since 1996, when the first herbicide resistant varieties were brought into production, many of the most important advancements have developed thanks to countless hours spent in laboratories developing and cultivating new varieties. The skills we need to develop in the next generations of these scientists must be discretely taught. There is no better way to do that than through hands-on laboratory experiences. Simply put, there is no substitution for putting the tools in the hands of the learner. In this investigation, students will have an opportunity to develop skills relative to volumetric measurement on a very small scale. Students will be using adjustable volumetric pipettes to accurately measure small amounts of liquids, as precisely as possible, using authentic tools that can be found in 21st century labs across the country and the world. Students will also see a cross over between the development of lab skills and the art of lab work by precisely depositing specific volumes in order to create patterns or pictures of their own design.

Kansas College and Career Ready Standards Addressed:

Science and Engineering Practices from Next Generation Science Standards

- Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
  - Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials)
  - Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.

Math

- **5.MD.1.** Convert among different-sized standard measurement units within a given measurement system (e.g. convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems. **(5.MD.1)**

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Kansas College and Career Ready Standards (Continued)

Math (Continued)

- **7.RP.2.** Recognize and represent proportional relationships between quantities: **7.RP.2a.** Determine whether two quantities are in a proportional relationship, e.g. by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin. **(7.RP.2a)**

Art

- **VA:Cr2.1.6** Demonstrate openness in trying new ideas, materials, methods, and approaches in making works of art and design.
- **VA:Cr2.1.7** Demonstrate persistence in developing skills with various materials, methods, and approaches in creating works of art or design.
- **VA:Pr4.1.7** Compare and contrast how technologies have changed the way artwork is preserved, presented, and experienced.
- **VA:Cr2.1.8** Demonstrate willingness to experiment, innovate, and take risks to pursue ideas, forms, and meanings that emerge in the process of art-making or designing.

Learning Objectives:

- Students will discover uses for basic laboratory equipment found in professional lab settings.
- Students will accurately operate a micropipette with precision sample placement.
- Students will understand the variety of agriculture-related jobs where basic laboratory skills are required to be successful.

Materials Needed:

- Mystery Tool Discussion Sheet (pg. S1, or available online at kscorn.com)
- Waxed paper
- Printed grids (1/5 inch graph paper can be printed for free from the following website: bit.ly/PipettingGridPaper)
- Micropipette (with 20-25 ul volume ability)
- Micropipette tips
- Small clear plastic cups
- Food coloring or water color paints (wet or dry)
- Pipette Technique PowerPoint (available online at www.kscorn.com)

Safety Considerations: Be aware of students with sensitivity to certain artificial dyes. Using food grade dyes (liquid food coloring) or school sets of 8 color water colors eliminates most safety concerns.

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Procedures for Instruction

Length of time for preparation: 10 min
Length of time for classroom teaching: 30-45 minutes or longer depending on your preference

Preparation Procedure/Instructions:

- Print 1/5-inch graph paper (available at bit.ly/PipettingGridPaper). Cut each sheet in half, allowing one half sheet per student.
- Cut waxed paper to the appropriate size to cover the graph paper and extend slightly on all sides. One sheet of waxed paper per student is needed.
- Prepare colored water samples.
    - Note: If using food coloring, simply combine 20-30 ml of water and a few drops of food coloring in a small plastic cup. Most liquid food coloring comes in red, blue, yellow, and green, which is more than sufficient to complete this lab.
    - Note: If using dry water color paints, pop out the paint oval and crush a small amount of the dry paint into a powder. Add the powder to a plastic cup or clean test tube and add water until the sufficient shade is created. Shaking to completely mix all the pigment with the water. You can mix paint colors slightly easier than with food coloring. From one paint set you can make a wide array of hues.
    - Note: If using wet water color paints, squeeze a small amount (approximately a dime size) into the test tube, add 10-15 ml of water to the tube, cap and shake. If the mixture creates bubbles simply allow to sit for a few minutes.
- Make enough cups of food coloring so each student has access to at least 2 different colors. Students can share colors with partners or as a group as well. Make sure they are easily accessible as spilling of the cups may occur.
- Setting up the station: You can either tape the waxed paper directly around the graph paper, wrapping the waxed paper onto the back side of the graph paper and taping all four sides, or you can simply tape both graph paper and waxed paper to your table or lab surface.
- Provide at least 2 micropipette tips per micropipette for color changes.

Classroom Discussion:
Introduce the topic and assess students for prior understanding:
Mystery Tool Discussion Sheet (pg. S1, or available online at kscorn.com)

- Hand each student/group a pipet or hold one in front of the class and ask the students:
    - What is the purpose of this equipment?
    - What are some of the major features we can use as clues to understanding its purpose?
    - Where might we find this equipment?

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Classroom Discussion (Continued)

- How would you operate this equipment?
- Using the Mystery Tool Discussion Sheet, have students work together in teams or collaborative groups to work through the questions above.
  - They can record their responses and ideas on a table or chart in their science journal or a piece of paper.
  - Each member of the team will be responsible for demonstrating or reporting out their group's response to each of the four questions above. This allows for all members of the team to equally participate. You can also number off the questions and purposely select students for each question based on their ability or comfort.
  - Depending on time allowed you can go through each question and have each group share out their responses. After all groups are finished you can come up with a class conclusion on each question.
  - As a teacher, you can keep a running list of the responses on the board or simply provide encouragement.
- Reveal its true purpose! Show students the pictures of the pipette being used in a lab facility. Resources can be found on the Pipette Technique PowerPoint. How would lab work connect to Ag Education? Everything from the creation of new herbicides and pesticides to the development of new seed varieties.

Procedure for Lab:

Part 1: Overall Pipette Function, Volume Selection and Use

Pipette Technique PowerPoint (available online at www.kscorn.com)

- Note: The Pipette Technique PowerPoint includes photos of proper use and technique for students to reference.
- Have students practice the soft and hard stops on the micropipette. Set the volume to 25ul and practice, paying special attention to how far the students must move their thumb to reach the soft and hard stop. Now move to the 50ul volume and repeat. Note the difference in the distance your thumb must move in order to draw up and expel the different volumes.
- Set pipette to 25 ul, practice drawing up a sample. Depress to the soft stop, place tip of the pipette into the solution, being careful not to touch the sides or the bottom of the container, release your thumb allowing the plunger to move back up, drawing the solution into the pipette tip. Note the amount of liquid in the tip, and the absence of any air bubbles.
- Over the waxed paper covered grid, expel the sample in one square. Depress the plunger all the way to the hard stop. Hold the hard stop as you bring your hand and the tip of the pipette above the small sphere of fluid on the waxed paper before releasing the plunger. If you release the plunger before removing the tip from the fluid, you will draw the fluid back into the pipette.

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Procedure for Lab: Part 1 (continued)

- Change the volume to 50 ul and repeat the process above in an area at least 2 squares away from your first sphere. Note the difference in the size of the sphere relative to your first sample. This sphere should be approximately twice as large since you are selecting to use twice the volume.
- Repeat these steps as many times as needed to become comfortable with proper technique.
- Using your pipette combine two spheres of sample, one 25 ul and one 50 ul, by placing the tip of the pipette into one sphere and carefully dragging the sphere toward the other sample until the two spheres merge.
- Adjust the volume of the pipet to 75 ul, try to draw up all of the sample in this now merged sphere. If you accurately used your pipette with proper technique you should be able to take in all of the sample without having bubbles at the end of your pipette tip.
- Continue to practice this skill, changing volume on the pipette and combining bubbles to draw up larger samples until you feel sufficiently comfortable.
    - Note: This is also a possible lab practicum assessment possibility, have students repeat this process in your process to ensure the proper technique is being use.

Part 2: The Art of Lab Work

- Have students utilize the skills they have just learned to create patterns or pictures on the grid paper.
- Students now have the ability to change volume, mix samples, and remove samples. They can use all of these skills to create their own designs.
    - Possibilities could include: initials of school, full school name, or mascot.
    - Students could make designs using the grid creating pixelated art, or you can replace the grid with white or other colored paper and allow them to create more free styled art without the grid.
    - Students can also mix samples of colors to develop multiple shaded of pigments on one sample sphere.
    - The possibilities are endless; students can literally spend hours doing this if you let them.

Note: Some students have difficulties steadying their hand when using pipettes. As precision in sample placement is part of proper technique, it is important to go slow and provide plenty of time for student to practice before any lab practicums or skills assessments. One possible aid to students is to place both elbows on the table while grasping the pipette in both hands during use. This technique allows for more stability by providing support for the arms and wrists.

Note: If you have students with special needs this lab can also be done using a 96 well plate to aid in dexterity of sample placement if necessary.

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Note: Providing some students with patterns to copy can also increase the chances of student participation. You can create any number of patterns for students to copy using grid paper and colored pencils or markers ahead of time. Ultimately, the more freedom you allow students with the activity the better they like it, generally speaking.

Note: Video and picture examples are available at kscorn.com

Reflection and Conclusion:
During these activities students will have developed some basic laboratory skills that will allow them to experience, on a very cursory level, the act of doing science. Allowing students to show some voice and choice in their chosen pattern in Part 2 also increases the likelihood of student participation. Some students don't strive for a science or agriculture related career because they feel like they don't have the ability. This lesson allows them to see how some simple techniques will allow them to become marketable in the biotech field, as well as other types of labs around the country and the world.

Assessments (Possible lab practicum): Have students show you as they go through the process of depositing two samples of different volumes, combining samples, and changing the volume of the pipette to withdraw the whole combined sample with one sample draw, as outlined in Part 1. This shows proper technique and is one step closer to using them in an actual lab setting.

Sources:
Graph paper – http://www.printfreegraphpaper.com/gp/c-i-15.pdf

Science and Agriculture careers:
Biotechnology and agriculture have been working hand in hand since humans started domesticating plants and animals. Humans have worked towards creating and finding specific breeds and lines of organisms in order to reach the ultimate goal of meeting the growing needs of humanity. In the 21st century, lab work and skills are very much a part of that solution. Jobs in fields such as biofuel development, food safety and product development, micro plant propagation, seed development, molecular biology, pathology, biochemistry, geneticists, entomologists, agronomists, and many others will be the key to the future of agriculture. Agriculture needs highly skilled individuals, with solid backgrounds in laboratory practices and practical work, if they are going to fill the positions that are needed to solve the problems of producing and protecting our resources and ourselves.

To learn more about agriculture careers visit www.agexplorer.com. You can also find career profiles at www.kscorn.com.