Water Filtration Lesson Plan for Ag in Motion

A Senior Project

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Bachelor of Science in Agricultural Science

by

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Abstract

The purpose of this project was to create a new lesson plan for the Ag in Motion program. The Ag in Motion program brings science activities to middle schools that may not have the resources to provide hands-on laboratory activities. The organization suggested developing an activity regarding water and its properties. A water filtration activity was developed by working with the Director of Ag in Motion and conducting research regarding hands-on learning. The lesson plan was designed to meet Next Generation Science Standards and show students the importance of clean water supplies. This lesson plan includes a materials and procedure guide as well as a research notebook for students to record data.

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Chapter 1

Introduction

In June of 2010, the National Ag Science Center created the idea of building a mobile laboratory classroom in efforts to give middle schools in California a chance at a high quality agricultural science laboratory experience. They set out to accomplish this idea by making lessons that fuse agriculture into the middle school science standards set by the state. After months of building the trailer and developing and testing out lesson plans, California's first mobile agricultural science classroom was produced. This mobile lab program is known as "Ag in Motion." Ag in Motion has been in service since 2011 and since then, every middle school in Stanislaus County has been visited and utilized the technology and exciting lessons the mobile classroom has to offer.

Statement of the Problem

Currently, the National Ag Science Center and members of Ag in Motion are looking to expand and build more mobile classrooms to travel around the greater area of California. Ag in Motion is looking to expand to Monterey and San Luis Obispo counties. This expansion, combined with the new changes in the state's education standards and the agriculture industry, leads to the need for new lesson plans in the mobile labs. As the mobile labs move to different counties, the middle school science curriculum taught in the area may not match up with the current selection of laboratory lessons Ag in Motion offers nor be relevant to the surrounding agriculture industries. There are several science standards that have not been addressed by the current lab activities, such as water and its vital role in agriculture.

Importance of the Project

This project is important in increasing the number of agricultural science lesson plans Ag in Motion can offer to middle schools while encompassing more state education standards. More specifically, a lesson plan regarding scientific properties of water is desired for the program. This project will benefit middle school students, teachers, and California's industry of agriculture. Students gain access to high quality, hands-on laboratories that their teachers may not be able to provide due to time constraints or tight budgets. The agriculture industry will benefit from this increased usage of the mobile labs since the industry can have the opportunity to sponsor the lab stations while future generations of agriculturalists learn important concepts regarding agriculture. The Ag in Motion program would also benefit from the development of new lesson plans since they would not have to spend the time or money to create new activities, but still can distribute the lesson plans in their mobile classrooms.

Purpose of the Project

The purpose of this project is to create a water science lesson plan for Ag in Motion to utilize in the mobile classrooms and allow students the opportunity to learn about this key component in agricultural production.

Objectives of the Project

The objectives of this project are to develop a water science lesson plan by:

- Gathering information on the California Education Standards that address water and its scientific properties.
- Contacting local middle schools to research what lesson plans they currently implement that revolve around water.
- Researching existing lesson plans and laboratory activities from teachers and schools.

- Explaining the importance of water to the agriculture industry and why learning about water is beneficial.
- Outlining what standards will be addressed in the lesson plan.
- Constructing an outline of the new lesson plan on water.
- Creating a finished water lesson plan for the Ag in Motion instructors.

Definitions of Important Terms

Ag in Motion: A mobile laboratory classroom that services the Central Valley of California and gives middle school students high quality, hands-on, and stimulating lessons about agricultural science (Ag in Motion).

Ag in Motion Mobile Classroom/Laboratory: A truck and trailer that travels the state (currently just the Central Valley) and services over 8,000 schools and is equipped with the necessary supplies for laboratory activities (Ag in Motion).

Hands-on Learning: Interactive methods of education via technology or physical participation in the learning of concepts.

National Ag Science Center (NASC): Located in the Central Valley, The National Ag Science Center is the leading non-profit provider of hands-on agricultural science education and career connections that also help teachers understand the connection between science and agriculture (Ag in Motion, 2014).

Summary

Ag in Motion is a program that addresses core science standards in a way that makes learning fun and exciting. Each lesson incorporates agriculture to support the activities. Local agricultural companies often sponsor the mobile lab as well. As the National Ag Science Center expands the Ag in

Motion program, the addition of new lesson plans will be critical. This project developed a new lesson plan that covered water and its scientific properties and how it pertained to agriculture while meeting educational standards. As the drought in California continues, students need to be aware of the importance of water and the roles it plays in sustaining agriculture. Learning about water in a hands-on mobile laboratory is the perfect environment for students to study the science and interactions of water. Since the current curriculum included in the Ag in Motion laboratory exercises lacks a lesson about water, this project will greatly benefit the program while teaching students about agriculture.

Chapter Two

Literature Review

The purpose of this project was to develop a water laboratory curriculum for the Ag in Motion program. This mobile laboratory brings hands-on science activities to middle schools in California. This program allows students to apply the concepts they are learning in the classroom to the agricultural industry. As the Ag in Motion program expands, new curriculum will need to be added to fit the changing educational standards, as well as offer teachers a greater variation in laboratory choices. Chapter two will focus on education methods, education at the middle school level, and the importance of agriculture and agricultural education.

Education Methods

Students learn at different rates through various ways. As educators, it is vital to present curriculum in ways that are simple to grasp, yet memorable. With technology becoming a major teaching tool, it is important to understand how students are learning with this method of education. According to Devlin, Feldhaus, and Bentrem, primary and secondary educators are focusing on "how to educate and engage students that live in a world of ubiquitous information and communications-related digital technologies (e.g. web, hand-held devices, cell phones, and gaming consoles)" (Devlin, et al., 2013). It is believed that student engagement is directly linked to academic motivation, persistence, and higher education completion (McGlynn, 2008).

According to Gulek and Demirtas (2005), there is considerable evidence that using any type of technology (computers, lab equipment, etc.) in the classroom as an instructional tool heightens student learning and educational outcomes as well as a measurable increase in the engagement and level of concentration of students (Devlin, et al., 2013). With research proving the benefits of technology in the

classroom, it is important to provide students opportunities to utilize every resource available. However, with tight financial resources and time constraints, hands-on methods of teaching and learning can be restricted.

Hands-on interactive lab activities are a great method to support curriculum in science classes. Several studies have been done to test the effectiveness of hands-on science lessons and concluded with positive outcomes. Hands-on based learning programs at the middle school grades have been found to overall enhance student performance, mainly as it relates to laboratory skills and skills of graphing and understanding data (Mattheis & Nakayama, 1988). Evidence has also been reported that shows this method of learning increased students' scientific literacy and understanding of scientific processes (Lindberg, 1990), knowledge of the terminology and conceptual understanding (Lloyd & Contreras, 1987), critical thinking (Narode et al., 1987), positive outlooks toward the study of science (Kyle et al., 1985; Rakow, 1986), and higher achievement on tests of technical knowledge (Glasson, 1989). A majority of students were better able to apply the knowledge learned in the activities to everyday experiences.

The benefits of getting hands-on learning experiences can be achieved in several ways. Educational expositions such as fairs, mobile labs, tours, and field trips allow students to get out of the classroom and learn in a new environment. Fairs, field trips, and tours allow students to experience new topics by observing or participating in demonstrations. With planning and time allotted, teachers can give their students a new method of learning besides classroom lessons. A newer method of learning is the concept of mobile lab classrooms. The University of Alberta recorded the success of implementing a mobile lab on the campus back in 2003. They concluded, "Most of the feedback we have received has been very positive. Our classroom observations indicate that the Mobile Lab has improved the learning situation compared with the use of standard labs," (Davies, et al., pg. 29, 2003). Several testimonies have stated the same positive reaction to the Ag in Motion mobile lab in California that travels to middle

schools for seventh and eighth graders to utilize. The labs offered comply with California State Standards while presenting a high quality, entertaining, and engaging lesson for students.

Education at the Middle School Level

California currently implements education standards for science as described by the California Department of Education. Typically, seventh grade science contains content about life sciences such as the processes from molecules to organisms, ecosystems, heredity of traits, and biological evolution. Eighth grade level students study physical science including materials such as matter and its interactions, motion and stability, and energy (Preferred Integrated Standards, 2014). In order to satisfy the state standards, science teachers present some subject matter through laboratory activities.

The typical outline for lab activities include an abstract, key terms, general background information, a scenario, a question or problem to solve, materials and procedure steps, and concludes with a discussion or conclusion portion to check for the students' understanding of the activity (Rascoe, 2010). It is important to make laboratory activities clear and simple to ensure students remain focused and are able to complete the lab in a timely manner. Lab activities can range from in context depending on what California standards are being covered by the school, the availability of funding and resources, time allotment.

Importance of Agriculture

California has one of the largest agricultural industries in the nation. California is dependent upon the revenue generated from agricultural commodities to support the economy and provide thousands of jobs for its residents. In 2012, the state brought in over 44.7 billion dollars in revenue from agricultural products; making it the highest earning state in the United States. Some of the state's top grossing commodities include: dairy products, grapes, almonds (shelled), cattle, nursery products,

berries, hay, and lettuce (Tolomeo, 2012). Focusing in on the central coast and Santa Barbara county, agriculture can be seen as a large portion of revenue generated for those areas.

In the San Luis Obispo County, top commodities include: cattle, alfalfa hay, barley, avocados, wine grapes, cut flowers, and strawberries. According to the 2012 Agricultural Commissioner's report, the county generated $861,803,000 dollars in agricultural commodities which was a 17.7 percent increase from the previous year (Settevendemie, 2012). Increases in agricultural revenue can be seen in Monterey County and Santa Barbara County as well.

In 2013, Monterey County agricultural commissioner's report stated that $4.38 billion dollars were generated in local commodities. The county also experienced growth within the fiscal year by an increase of nine percent compared to 2012. The top grossing commodities for the country include: strawberries, lettuces, broccoli, nursery products, wine grapes, and celery (Lauritzen, 2013).

Santa Barbara's agricultural commissioner reported a production value of $1,436,651,418 dollars in the year 2013— the eighth year in a row that agriculture surpassed the one billion dollar benchmark. As stated in the 2013 Santa Barbara Crops Report, "Through the multiplier effect, agriculture contributes a total of $2.8 billion to the local economy and provides 25,370 jobs." Agriculture is the largest contributor to Santa Barbara County's economy (Fisher, 2013). These statistics validate the positive impact agriculture has on California's economy and the importance of the industry.

Since agriculture is a large portion of California's economy and culture, it is crucial that students be educated about the industry. Agricultural education is a special education model. It combines leadership education, hands-on classroom activities, and experiences which can easily be apply to "real-world" scenarios. This model of education also "provides the relevancy and concept reinforcement" that helps all varieties of students thrive. Agricultural education is composed of three integrated components—classroom, leadership and hands-on experience (or supervised agricultural experience at

the high school level). Each aspect of the components overlap and support the others leading to a well-developed template for learning (Fritsch, 2013).

The subjects agricultural education can cover are extensive. As new technology and practices evolve, learning about and understanding the agricultural industry progress with the developments. Currently California is facing a drought so knowledge regarding water and its effects on agriculture has never been more relevant. Today's students could be the individuals that help solve the water crisis so learning about the different facets of water usage and environmental impacts is something that educational systems should further explore.

Summary

Overall, California is utilizing its resources for implementing effective teaching methods and ways to measure students' knowledge. Some newer methods of teaching include mobile laboratories, such as the Ag in Motion trailer, to bring high quality labs to middle schools that could not otherwise afford the necessary materials. These types of lab environments are heavily based on hands-on experiences and applying scientific methods and processes to real-life situations mainly revolving around the agricultural industry. Since California is the number one ranked state for agricultural production, it is important students have knowledge about the industry and how it impacts society.

Chapter Three

Methodology

The first step for developing laboratory curriculum for Ag in Motion was to contact the director of the program in order to gather information about how the lab activities were currently being conducted. Gathering current lab curricula and information regarding time allotments lead to the specific layout of the new curriculum. The next step was to research California's educational standards for seventh and eighth grade sciences. It was important to develop an understanding of the state standards to ensure the laboratory curriculum encompassed the required criteria. Thirdly, research regarding water filtration and purification labs was conducted to develop a bettering understanding of the concept and its importance to society. Fourthly, information was gathered using all the resources available to create a new lab activity that would adhere to the current formation of Ag in Motion laboratories. The final step was to present the newly developed lab curriculum to the direct and staff of Ag in Motion to validate the usefulness of the lab.

Director of Ag in Motion Consultation

The author of the project contacted Michele Laverty, the director for Ag in Motion, to gather insight on the style of curriculum and lab activities currently being implemented. Laverty provided useful resources such as current lab objectives and student lab manuals (Laverty, 2014). Using the provided materials, a template for the new curriculum was developed. Laverty also provided key information such as the length of labs and which areas of the educational standards are lacking in their program.

California Educational Science Standards Research

In order to identify what standard the new laboratory curriculum encompassed, extensive research was conducted using the California Department of Education's Next Generation Science Standards (NGSS) for seventh and eighth grade sciences. The existing Ag in Motion curriculum is compliant with state standards. So it was important to develop the new lesson plan to fulfill the NGSS. After researching standards regarding water, the seventh grade science standard MS-LS2-5 was selected. This standard requires students to evaluate competing design solutions for maintaining biodiversity and ecosystem services. To fulfill this standard, the concept of a water purification system laboratory activity was created.

Water Purification and Filtration Laboratory Research

To gain a better understanding of laboratory activities sufficient for seventh graders, research was conducted regarding existing water filtration lesson plans. This research was critical in understanding the methods used to teach seventh grade students new material in a familiar form. After reviewing several filtration labs, the author of the project was able to adapt a water filtration activity from the United States Environmental Protection Agency's Office of Water to meet the chosen state standard. This activity was hands on and fit within the allotted time for Ag in Motion labs.

Curriculum Development

Knowing that students participating in Ag in Motion typically have thirty to forty minutes to conduct the laboratory activities, a short, yet hands on curriculum was developed. A similar curriculum rubric and lab manual outline to that of Ag in Motion's was used when developing the new laboratory

lesson. The curriculum rubric outlined the title of the lab, gave a brief background on the topic of filtration, and an overview of the activity. The lab manual consisted three simple sections. The manual began with a cover page where students wrote their names. The next section specified places to record observations made during the activity. Finally, a conclusion portion containing a summary with critical thinking questions was included to check for students' understandings. In addition to the rubric and manual, an instructor's information page was created. The information page contained the specific Next Generation Science Standard explored in the activity as well as the objectives and outcomes of the laboratory. The materials and procedures used in the lab activity were an adaptation from a previously published lab by the Environmental Protection Agency (EPA) in which directions were clarified and the selected state standard requirements were achieved.

Summary

A laboratory curriculum was developed by collecting background information about the Ag in Motion program and researching the current state standards. This curriculum can be used by the program's facilitators, teachers, and students who are interested in conducting a water filtration experiment. The curriculum was created through researching various seventh grade level lab activities and using the existing Ag in Motion curriculum as a reference. This project provides facilitators and students with an instructor's information page with a curriculum rubric, a detailed materials and procedures hand out (adapted from the EPA), and a laboratory research notebook to aid in the presentation of the activity.

Chapter Four

Results and Discussion

The following pages of this project contain the materials needed to facilitate and conduct a water filtration lab for the Ag in Motion program. Materials include: instructor information, a background and overview of the activity, the objective, materials needed, procedure steps, and a notebook for students to record their data and observations. The curriculum involved satisfies California's Next Generation Science Standard MS-LS2-5; regarding interdependent relationships in ecosystems. This laboratory activity is meant for seventh grade students participating in the Ag in Motion mobile lab program. After conducting the laboratory, students should have a better understanding of how water is purified for human consumption as well as the role water plays in society.

Fun with Water Filtration

An activity adapted from the EPA

Instructor Information

This lab activity is designed to show students the simplified steps that water treatment plants conduct when purifying water. Each group of students (4-5 students per group) will construct their own filtration system and observe a basic water treatment process. By the end of the lab, students should understand how contaminates are removed from water and observe differences between contaminated and purified water samples.

It is important to note the final step at water treatment facilities is the addition of disinfectants to kill any harmful organisms. Since disinfectants are dangerous to handle, they are not included in this lab. Thus meaning the water filtered in this lab is **not** safe for drinking and students should be informed **not** to consume any water used in this lab activity. California's Next Generation Science Standard MS-LS2-5 is covered in this laboratory activity for seventh grade students.

Activity Details:

Lab	**Background**	**Overview**	**Concepts Covered**
Fun with Water Filtration	The water we are used to seeing in lakes, ponds, or rivers often contain contaminates that make the water smell and look funky. These types of water sources are usually unfit for drinking. However, that is where the process of water purification comes in!	Each group of students will build their own water filtration system and observe changes in the "dirty water" during each purification step. Students will learn the importance of water treatment facilities and having access to safe water supplies.	-water purification -ecosystem services -changes in natural resources -observation -How to construct models/diagrams

The laboratory exercise begins in the ensuing pages.

Fun with Water Filtration

An activity adapted from the EPA

Objective, Materials, and Procedures

Objective

The objective of this laboratory activity is to demonstrate the steps water treatment facilities use when purifying the water we drink. This can be done in four steps: aeration, coagulation, sedimentation, and filtration.

Materials Required (on a per group basis):

- 5 liters of "dirty water" (add about 2 cups of dirt to 5 liters of water—prepared beforehand)
- 1 two liter plastic bottle with its cap
- 1 two liter plastic bottle with the bottom cut off
- 1 two liter plastic bottle with the top cut off
- 1 large beaker or another plastic bottle with the top cut off (this will hold the plastic bottle with the bottom cut off)
- 2 tablespoons of alum
- 1 ½ cups of fine sand
- 1 ½ cups of coarse multi-purpose sand
- 1 cup of pebbles, washed
- 1 coffee filter
- 1 rubber band
- 1 large spoon for stirring
- 1 tablespoon for measuring the alum
- 1 stopwatch

Procedure

1. Pour the “dirty water” mixture into the two liter plastic bottle with a cap. Observe and record the appearance of the water in your Laboratory Research Notebook.
2. The first step in the purification process is **Aeration**. Aeration lets trapped gases escape while adding oxygen to the water.
    a. In order to complete this step, place the cap on the bottle and shake the bottle for 30 seconds.
    b. Once time is up, further aerate the water by pouring it into a beaker, then pouring the water back into the bottle.
    c. Continuing pouring the water back and forth for about 10 minutes.
    d. Once the water is aerated, record your observations of the water. Are the bubbles gone? Why did this happen? Well what happened was the trapped gases are now gone and so no bubbles appear.
    e. Next, pour the water into the bottle with the top cut off.
3. The next step in the purification process is **coagulation**. This happens when dirt and other particles attach to each other in order to create bigger particles that are easier to remove from the water.
    a. To get the dirt and other particles to coagulate, add 2 tablespoons of alum to your aerated water.
    b. Stir the mixture slowly for 5 minutes. Record any new observations. Do you notice the particles getting bigger in size?
4. Once your water mixture has coagulated, the next step is **sedimentation**. Sedimentation is a process where particles sink to the bottom of a container due to gravity.

a. In order to observe the sedimentation process, let the water stand still in the bottle. Try not to move the bottle or water.
b. Using your stopwatch, observe the water every 5 minutes for 20 minutes. Record any observations you see. Does the water appear to look any different?
c. At water treatment facilities, sedimentation occurs in specialized beds, called “settling beds.” They remove all the large particles that float towards the bottom the water. This process is important because it allows the clear water to be collected at the top of the bed and further purified.

5. Now it is time to build your water filter! To do so:
    a. Take your empty plastic bottle with the bottom cut off.
    b. Attach a coffee filter to the outside neck of the bottle where the cap would be and secure the filter with a rubber band. Make sure the opening of the bottle is completely covered by the filter.
    c. Next, turn the bottle upside so the large, open end is up and place it in a beaker.
    d. Pour a layer of pebbles into the bottle, filling it less than ¼ of the way full. If your filter is secure, none of the pebbles should fall out.
    e. Then pour the coarse sand on top of the layer of pebbles until a little over half the bottle is filled.
    f. Next, pour the fine sand on top of the layer of coarse sand until there is about 1 inch of space left at the end of the bottle.
    g. Before pouring the “dirty water” into your filter, it is import to clean the filter! This is done by slowly and carefully pouring 1 liter of tap water through the filter. Try not to disrupt the top layer of sand too much as you pour the water.

h. Empty the filtered tap water in the beaker in the proper disposal location set up by your instructor.

6. You are now on to the final step in your purification process! This final step is known as **filtration**. By passing water through the different types of layers in your filter, most of the impurities are removed.
    a. Now that your "dirty water" has coagulated, carefully pour the top two-thirds of the dirty water through your filter.
    b. Collect the filtered dirty water in the beaker. Do not discard the water.
    c. In a separate, clear container, pour in the remaining unfiltered "dirty water."
    d. Compare and record your observations between the filtered and unfiltered water. What do the two samples look like? Do you see a big change in the "dirty water" after it passed through the filter?

    *Remember, this water is still **not** safe to drink! There is a final step done at water treatment plants where disinfectants are added to the filtered water to get rid of harmful bacteria and organisms. The disinfectants they use are dangerous which is why we did not do that final step!
7. Now that you have completed your lab experiment, fill out your research notebook!

Laboratory Research Notebook:

Summary:

Summarize the four steps we took to purify the "dirty water."

1._____

2._____

3._____

4._____

Fun with Water Filtration

Laboratory Research Notebook

Researcher Name:_____

Experiment Date:_____

My Observations:

Step Number:	Observations:
1	
2	
3	
4	
5	
6	

Filter Diagram:

Draw a sketch of what your filter looks like. Be sure to label what the different layers are made of!

Conclusion:

Why is it important to purify water before drinking it?

_____

_____

_____

How did the "dirty water" look before we filtered it? And after?

_____

_____

_____

Chapter Five

Summary, Recommendations, and Conclusions

The newly created lab activity for Ag in Motion will help to add curricula variety and educate students on the value of water. The Ag in Motion program will benefit from this water filtration lab since the curriculum uses the new Next Generation Science Standards for seventh grade. Currently, Ag in Motion does not have curricula specifically designed for NGSS. This lab activity is quick and hands-on, which fits with Ag in Motions existing lessons. It is important to teach students about water and its role it plays in agriculture and society as a whole as California's drought continues.

Recommendations

The following recommendations should be considered when conducting a similar project:

1. Research current state standards as they often change.
    - Recently the state of California implemented several changes in educational standards, including NGSS. It is important to gain an understanding of what standards are required, especially for science.
2. Ensure the designed curricula fulfills state educational standards.
    - Ag in Motion prides themselves on allowing teachers to utilize the mobile lab during the school day since the activities cover specified state standards. Therefore, it is imperative curricula developed meets current state science standards.
3. Presenting the new lesson plan to the Ag in Motion board for use in the labs.
    - It would be beneficial to present the new lesson plan and receive feedback on the developments. The Ag in Motion board could provide guidance and assistance with developing curricula.

4. Create another laboratory lesson plan for eighth grade sciences.
    - Having a similar lab activity, in this case it was water science, would have been helpful to present to the Ag in Motion program. Having a water lab activity for both seventh and eighth grade levels would have given instructors more options in choosing what lab activity to conduct.

Conclusions

The development of the laboratory curriculum for the Ag in Motion program was a success since it accomplished the objectives stated in Chapter One. The lab activity meets a standard within the new Next Generation Science Standards for seventh grade which establishes credibility and usefulness. Since the activity is based on water and its functions, Ag in Motion now has a new subject that can be added to their compiled curricula. The lab activity itself is simple, fun, and fast and allows students to conduct a hands-on agricultural experiment. A negative aspect of this project was trying to communicate with the directors of Ag in Motion. A great deal of time was lost while waiting for responses and requested materials. However, the requested materials were essential for the development of the new curriculum and were needed for progress on the project. Overall, the project was very successful and a great experience.

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