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Bringing Science to Life in the Fifth-Grade Classroom Through Hands-On Learning

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Abstract

Science helps provide insight into the unknown and provides an outlet for exploration of living things. Children are innately curious about how thing work, and they are eager to ask questions. Science is the perfect outlook for students to fully engage in their inquisitiveness, but yet, many classrooms are skipping over science lessons or choosing to heavily focus on other subjects, such as reading and writing. Science is often taught as an elective, integrated with other subjects or it is only focused on for a short period of time. Unfortunately, when this subject does receive attention, lessons are heavily text-book based and fail to engage students in hands-on, inquiry-based learning. Many teachers struggle to create their own engaging science experiments, and to help find a solution to this problem, a hands-on, engaging science module for fifth-graders was created. This seven-lesson science unit focuses on life-science, and it covers the topics of photosynthesis and the role of producers, consumers and decomposers. It also connects to the Massachusetts Science Technology Engineering Curriculum Framework and Science Engineering Practices found in the Next Generation Science Standards. This module was designed so that it could act as an easily accessible science unit that teachers can look at and replicate in the classroom because the module is inexpensive and can be easily implemented into the classroom. This module will hopefully help make engaging, hands-on experiments and lessons become more accessible to teachers and students. Another purpose of this project was to test the effectiveness of an engaging life science module to examine if hands-on and inquiry based-learning can increase students’ knowledge and appreciation for science. The seven-lesson science unit was implemented into a fifth-grade classroom in Brockton, Massachusetts, and a pre- and post-assessment was administered and analyzed to examine the effectiveness of hands-on learning. The results show that hands-on learning may help students learn about science topics covered and taught in class, and it may help students maintain positive attitudes about gardening, plants and their importance in the environment and society.
Introduction

As Science, Technology, Engineering, and Mathematics (STEM) jobs are becoming more available and needed worldwide, the United States is experiencing a shortage in STEM workers. The global and American economy all have been experiencing great change over the past 20 decades and are all trending towards STEM fields. The need for STEM workers continues to grow, but the increase in professional workers in STEM fields in the United States is lagging in general and when compared to the dramatic growth of European and Asian global competitors (DeJarnette, 2012). Between 2010 and 2015, the ratio of STEM jobs posted online to unemployed STEM workers grew dramatically. In 2015, there were 17 STEM jobs posted online for every unemployed STEM worker. Some rural states are facing even more dramatic uneven ratios, such as North Dakota, Iowa, South Dakota and Nebraska. In these states, there were between 45 and 88 STEM jobs online for every unemployed STEM worker (“Sizing up the Gap in our Supply of STEM Workers”, 2017). It was also predicted that in 2018, about 2.4 million STEM jobs went unfilled in the US (“The STEM Imperative”, n.d.). The U.S. is failing to produce enough workers to meet the growing needs of STEM employers.

One question that researchers face is why there is a shortage of STEM workers if so many jobs are available. One of the reasons in the U.S. may be because of the lack of STEM education and pre-college preparation that our students receive, resulting in a continued decline in the number of students graduating college with a four-year STEM degree (Chen & Soldner, 2013). In the United States, about 78% of high school graduates do not meet the benchmark readiness for one or more college courses in mathematics or science (“The STEM Imperative”, n.d.). Many students are choosing not to pursue STEM careers when they get to college or switch out of STEM majors. In 2004, only 28% of bachelor students and 20% of associate students
entered STEM fields (Chen & Soldner, 2013). Over the last ten years, there has been a steady increase in student enrollment in STEM degree programs, but the rate of increase lags behind many other developed countries (DeJarnette, 2012).

Many students may have no interest in STEM fields or change their degree program because current STEM education practices in preschool to 12th grade settings are lacking to capture student interest in STEM content. There are many programs that exist for middle and high school students, but by the time students get to middle school, it may be too late to try to capture student interest in STEM fields. There are very few opportunities that exist currently to engage elementary students in STEM initiatives, but gaining student interest in STEM fields at a young age may be a very proactive approach to ensure that students are will succeed in STEM in middle and high school. In the 2018 National Survey of Science and Mathematics Education, only about 17% of teachers in grade K-3 and 35% of grade 4-6 teachers, reported teaching science all or most days every week. Only 43% of teachers in grades K-3 and 29% of grade 4-6 teachers taught science some weeks but not every week. In grades K-3, teachers typically spent only 18 minutes on science instruction and grades 4-6 teachers only spent 27 minutes a day (Banilower et al. 2018). Recent data is demonstrating that elementary students are getting very little exposure to science instruction. One way the U.S. can start to increase the number of students in STEM degree programs and increase the number of STEM workers, is by increasing science instructional time in elementary classrooms. Recent students and research has shown that the best time to create connection, awareness and interest in STEM fields would be in elementary schools (DeJarnette, 2012).

When science instruction does occur in the classroom, many science classes are heavily textbook-based and fail to engage students in hands-on, inquiry-based experiments. Schools need
to focus more on the STEM process rather than specific technical content to spark and prepare students for the world of science. The information that students are learning in American schools from teachers and textbooks are what is keeping students out of science. In many classrooms, students follow step-by-step science instructions, and focus heavily on content instead of the process of scientific learning (DeJarnette, 2016). Science instruction currently promotes learning about scientific definitions. In fact, 77% of elementary science teachers believe that at the beginning of instruction, students should be provided with new scientific vocabulary. Many other teachers focus heavily on learning content knowledge, and 56% of elementary teachers believe that hands-on/laboratory activities should be used primarily to reinforce a science idea that the students have already learned, and 33% of elementary teachers believe that teachers should explain an idea to students before having them consider evidence that relates to the idea (Banilower et al. 2018). Many science lessons are teacher-guided so that the teacher can make sure students complete a desirable end product, and this is done so that teachers can tightly monitor what is taught, and what students learn and are assessed on. Science instruction needs to focus on problem solving, critical thinking and open-ended inquiry. It should promote the process of scientific discovery and encourage students to learn about scientific concepts and vocabulary through their own inquisitiveness and experiments. This will help promote developing process skills rather than mastering content knowledge. Problem-based science activities promote scientific thinking and engage students in the act of practicing science. These type of science lessons need to be taught not only in middle and high school, but also elementary classrooms. Elementary aged students have the potential and cognitive capabilities to think critically and problem solve. By engaging them with science activities, these students will start to
build confidence and autonomy, which will benefit them in later science and mathematics courses throughout their academic careers (DeJarnette 2012).

Inquiry based learning one effective teaching method that can be used to teach science. Inquiry based learning is a form of active learning that places students’ questions and ideas at the center of learning. Students’ ideas are challenged, tested, redefined and seen as improvable. Students pursue investigations and problem-solving projects (“Capacity Building Series” 2013). However, many elementary science lessons are not following inquiry-based learning because this is not a common approach used in elementary science classrooms today (DeJarnette, 2012).

In fact, many teachers have an aversion to science because it is a difficult subject to teach and educators fear that they lack the necessary knowledge to teach science well (Alberts, 1991). In fact, science teachers at high-poverty schools are three times as likely to be credentialed in areas other than science when compared to science teachers at low-poverty schools (Hudley, 2013). According to the 2018 National Survey of Science and Mathematics Education, only 31% of elementary science teachers felt very well prepared to teach a science lesson, 17% of elementary teachers considered themselves very well prepared to develop students’ abilities to do science and 23% of elementary teachers considered themselves very well prepared to encourage student interest in science and engineering concepts (Banilower et al. 2018).

Clearly, elementary teachers do not feel prepared to teach science lessons or encourage a love for STEM. When teachers lack the pedagogical expertise in scientific inquiry, they will be less likely to try out new teaching techniques, such as inquiry-based learning. Many teachers lack the self-efficacy to incorporate these teaching techniques into lessons. One report actually showed that teachers who had low self-efficacy to engage students in inquiry-based learning
refrained from using a curriculum when teaching students and these teachers had lower student achievement (DeJarnette, 2012).

As a result, many teachers are lacking the knowledge to create interactive and hands-on science lessons and experiments. To generate exciting science investigations, teachers need to understand the material. The 2018 National Survey of Science and Mathematics Education shows that only 33% of elementary science teachers had attended a professional development program on science in the last year, and 43% of elementary teachers had participated in 0 hours of professional development for science in the last three years (DeJarnette, 2012). These estimates demonstrate that a lot of elementary science teachers may lack the needed knowledge to perform interactive experiments. They may let the inexperience intimidate them from trying to put together hands-on science activities.

Another reason why elementary teachers may not be designing interactive science lessons is because science experiments can sometimes require special equipment. As a result, if teachers lack sufficient funding or resources, they can become intimidated by trying to create experiments that they think will require special materials (Alberts, 1991).

Since many students may not be receiving quality science instruction, it is even more important to strive to start making science more creative and engaging. One way this can be done is by encouraging hands-on and outdoor learning. Engaging students with hands-on experiments with a particular focus on plants can help to increase their interest and motivation in science. Plant-based learning can help increase academic outcomes, environmental stewardship, soft skills (such as their communication skills, positive attitude, self-confidence and problem-solving skills) and overall wellness in students (Trundle, McCance & Shaheen, 2018). Unfortunately, children tend to have a limited understanding of the elements of nature. Little to no outdoor play
restricts children’s mobility in nature and limits their capacity to expand their environmental literacy. Lack of outdoor experiences can put children at a disadvantage when it comes to learning ecological concepts because students learn science best when abstract ideas are tied with prior knowledge (Eick, 2012).

Young children naturally have two essential components to their natural biological knowledge (the knowledge to identify biological entities and the phenomena and teleological and vitalistic causality). All children have active biological knowledge, which involves a set of devices that help enable children to make predictions and explanations about biological phenomena. Young children are able to identify between living and nonliving things, and they often explain biological phenomenon in relation to themselves as humans. This does not mean that they have an immature or limited view of science because this instead shows that children have adaptive and active minds. Children’s native biology is important because it serves as basis for their performance and learning in school. It provides educators an empirical base for designing instruction (Inagaki & Hatano, 2006). Children have innate knowledge of biology, and when directed by an adult, they can begin to obtain a better understanding of biology (Vlok, 2010). Childhood experiences in nature, when scaffolded by adults, can promote further interest in ecology and protecting the environment. When students are learning about the effects humans have on the environment, it can create a greater ethic of caring about nature and increase environmental activism. Nature-study is an effective way to teach science because it parallels current approaches to teaching science. It helps students focus on doing investigations, developing the ability to ask scientific questions, investigating the (natural) world, and reasoning through scientific data to draw conclusions. Students learn science best when abstract ideas are
tied with prior knowledge, and then students apply related contexts to these ideas, and test them concretely (Eick, 2012).

There are a number of studies that have found positive effects of nature-based learning. One study by Berezowitz, Yoder, and Schoeller (2015) compared learning outcomes in fourth and fifth grade students, where one group received an experiential school gardening curriculum, which replaced traditional classroom lessons. The other group experienced only the traditional classroom lessons. These interventions took place across twelve weeks. The researchers found significantly higher science achievement scores among student gardeners compared to non-gardeners. These gardening interventions showed that garden-based learning programs support academic performance, with the most evidence demonstrated by science test scores. School gardens may improve students’ attitudes about school overall because it involves experiential learning, which means that students learn through active participation. More engagement can also lead to improved academic outcomes. Gardening may also help students gain observational skills and allow students to incorporate a living lab into their academic schedule (Berezowitz, Yoder & Schoeller, 2015).

Another study by Bowker and Tearle (2007) focused on the views of students towards school gardens and plants from around the world. Students from England found their school garden as a place for pleasure, leisure, play and enjoyment and students from India and Kenya found the school garden as place of learning, community, security and peace. The children started to demonstrate awareness of global issues related to food distribution and food security after working with the garden. Children appreciated the flowers they grew and said that the flowers helped make the school look nice. Students also showed increased horticultural knowledge, shown through concept maps they drew where they could list words such as digging,
planting, watering, weeding and harvesting. They showed understanding of a basic knowledge of ecology, and an appreciation of food chains. Indian students were able to understand that caring for plants means helping care for the world. All students from Kenya, India and England showed positive attitudes about plants at the end of the gardening unit, and described taking care of plants as fun, and a nice way to get messy. This study showed that experiential learning can positively affect children’s learning, their attitudes about school, and their self-confidence and self-esteem. Their excitement, interest, sense of pride and self-esteem was shown through interviews and contextual observations. The findings from this study suggest that when children experience nature first hand, the promotion and encouragement of taking care of plants has the potential to create opportunities for learning (Bowker & Tearle 2007).

A case study by Eick in 2012 followed a third-grade teacher (Susan), who used an outdoor classroom for meeting state science and language art standards and used nature-study to bridge outdoor classroom experiences with state standards. This teacher brought students outside during lessons as much as possible and tied outdoor classroom experiences explicitly to her instruction in the classroom. Susan connected her teaching of writing skills to children’s experiences in the outdoor classroom. She found that connecting science and language arts to the outdoor classroom was a large motivator for lower achieving students because their self-esteem increased through the outdoor experiences. At the end of the year, she found that her class’s standardized reading test scores improved greatly. This study showed that outdoor learning not only helps to motivate learning, but it can benefit student learning in other areas such as reading and writing. (Eick 2012)

Outdoor and plant-based learning is great for students because children can bond and connect with the natural world, and this helps to build a foundation for interest, caring, and
potential social action to protect and preserve nature. Susan, the third-grade teacher, effectively linked her children’s outdoor learning with their indoor learning and found that the positive effects stretched far past increased standardized test scores. Students gained excitement and enthusiasm for the outdoors, and it led to further interest in science, persistence in learning and it increased interest in science related careers. The teacher also witnessed an increase in motivation to read, write and draw with students who struggled with literacy activities. Concept-oriented reading instruction in science led to significantly higher scores in reading comprehension, reading strategies and reading engagement compared to teaching reading using only basal readers. Students love to read about what they are learning and write narratives about their science experiences to help them reflect on and further process their learning. This also mirrors what actual environmental scientists do: researching (through reading), outdoor inquiry, and writing (Eick, 2012).

As a result of all of this research, a hands-on, engaging science module for fifth-graders was created. This module, which was implemented in a fifth-grade classroom in Brockton, Massachusetts, focuses on life-science, and learning about photosynthesis, the needs of plants and decomposers, and producers and consumers. The purpose of this research is to test the effectiveness of an engaging life science module to examine if hands-on and inquiry based-learning can increase students’ knowledge and appreciation for science. Another goal of this module is to create opportunities for hands-on learning opportunities which are exciting and connect to the Massachusetts Science Technology Engineering Curriculum Framework and Science Engineering Practices found in the Next Generation Science Standards. Lastly, this module was created so that it could become an easy accessible science unit that teachers can look at and replicate in the classroom because it is inexpensive and can be easily implemented into the
classroom. This module will hopefully help make engaging, hands-on experiments and lessons become more accessible to teachers and students.
Methods and Materials

Plant Material

Eight sunflower (*Helianthus annuus*) varieties (purchased from Johnny’s Selected Seeds): Sonja, Hybrid Sunflower, Chocolate, Soraya, Florenza, Ring of Fire, Valentine and Autumn Beauty *Asclepias syriaca* (common milkweed)

Science Lab Procedures

First, different sunflower varieties were grown in a lab setting in order to select an effective plant to use in a school setting. Different sunflower varieties were picked out from Johnny’s Selected Seeds website based on color, stem height and maturity length. The following sunflower varieties were chosen to test and grow: Sonja, Hybrid Sunflower, Chocolate, Soraya, Florenza, Ring of Fire, Valentine and Autumn Beauty. Three plants from each of these eight varieties were grown initially in the laboratory, and then moved out to Bridgewater State University’s greenhouse where they were repotted and grown to maturity. As the sunflowers were grown, color, height, germination rate and growth rate were observed.

After observing the growth properties of all eight sunflower varieties, Florenza was chosen because it withstood laboratory conditions, varying room temperatures when growing (the heat fluctuated in the building as it was growing which modeled realistic classroom conditions) and it had one of the shortest germination and growth rates. This sunflower was ideal for growth in classrooms because it would be able to withstand classroom conditions where the heat would be turned on and off throughout the week and day, and the sunflower would be able to germinate within a week, so students would be able to quickly start their experiments and collect data.

It was also determined that students would be growing and working with *Asclepias syriaca* (common milkweed), so seeds were grown and observed to determine how long it would
take for seeds to start to germinate and how long it would take the hypocotyl to emerge out of the soil. The milkweed took about one week as well before it started to emerge from the soil, which was ideal for students to start working with and testing.

Acetic acid, sodium chloride and light treatments

After selecting Florenza and milkweed, laboratory experiments were designed that could be implemented in the classroom. It was determined that students would be growing plants under various conditions, such as with different types of liquid and light. It was determined that students would be using acetic acid solutions and sodium chloride solutions to water their plants with, so Florenza plants were grown and tested with different concentrations of acetic acid and sodium chloride solutions to determine what solutions students should be using in class. These concentrations were determined by completing research on what acetic acid and sodium chloride levels started to inhibit plant growth (Haidarizad & Zarei, 2009) (Biswa, Khan, Yasmeen & Rahman, 2007).

Initially, six Florenza plants were grown with 2.50% acetic acid, but these plants died within a day, so the concentration of acetic acid was decreased so that students could observe gradual plant death. It was determined that 0.25% acetic acid solutions would be tested along with 150 mM and 300 mM of sodium chloride solutions.

After the solutions were created, Florenza seeds were taken and planted into plastic form pots. Each plastic form pot received about two Florenza seeds, this was to ensure that at least one of the two seeds would germinate (approximately one plant ended up sprouting for each of the plastic form pots used during the experiments). Then the form pots were brought together in groups of six. Each set of six plastic form pots received a different liquid treatment. The
treatments being tested were 0.25% acetic acid solution, 150 mM sodium chloride solution, 300 mM of sodium chloride solution and tap water. The sunflowers were all grown for seventeen days and received 100 mL of liquid every two to three days. The height of the sunflowers was taken on days one, three, eight, ten, twelve, fifteen and seventeen. The average height of the six sunflowers under each solution for each day measured were calculated and then graphed.

At the end of the seventeen days, it was determined that 0.25% acetic acid solutions and 150 mM and 300 mM solutions would be sufficient to use in a classroom setting for students to grow plants with.

**Educational Procedures**

Next, the 2016 Massachusetts Science and Technology/Engineering Curriculum Framework were examined to determine what scientific standards would work best and relate most to the experiments developed. It was determined that the ideal age to be working with these set of experiments would be fifth-graders, because the life-science standards that were identified related best to the sunflower and milkweed experiments. Two standards that were found related directly to photosynthesis and the role of plants in the environment. The two frameworks were:

**5-LS1-** 1. Ask testable questions about the process by which plants use air, water, and energy from sunlight to produce sugars and plant materials needed for growth and reproduction.

**5-LS2-** 1. Develop a model to describe the movement of matter among producers, consumers, decomposers, and the air, water, and soil in the environment to:

a. show that plants produce sugars and plant materials,

b. show that animals can eat plants and/or other animals for food,
c. show that some organisms, including fungi and bacteria, break down dead organisms and recycle some materials back to the air and soil.

After two standards were picked out, lessons and a pre- and post-assessment were developed and written that related both to the two life science standards and the sunflower and milkweed experiments developed. First, an assessment was developed so that student learning and attitudes could be measured and monitored before and after the implementation of this science unit. The assessment was developed and contained two different sections. The first section included multiple choice questions and a diagram, and this was designed in order to measure students’ understanding and mastery of the life-science topics and standards (Appendix). Then an attitude survey after this was developed in order to measure students’ feelings about science, gardening, plants and the environment (Appendix). The purpose of designing this assessment was to be able to measure students’ progress towards understanding these life-science topics and to see if their feelings about the outdoors and science changed at all after working through this science unit.

Next, in conjunction with the Teaching Science in Elementary School pre-practicum course, seven lessons were designed (six science and one engineering) as a part of an overarching photosynthesis and movement of matter unit. Each of these lessons were implemented in the classroom with fifth-grade students at the Oscar Raymond School in Brockton, Massachusetts, and a summary of each of the seven lessons can be found below.

**Lesson #1 - Effects of autumn on school garden plants**

During the first meeting, students were administered the pre-assessment. The purpose of the first lesson was to introduce students to plants and making observations. The overall goal of
this lesson was for students to examine the role of fall and how this season affects plant growth. The students were brought outside and given an observation sheet to fill out. The students walked around a school garden outside, and they observed signs of healthy and unhealthy plants, and they were asked to draw an example of both. Students then were asked to start thinking about how the season fall affects plants in their school garden, and how this season may be affecting plant growth. Students worked together in groups to develop a claim to the question: “How does the fall season affect plants in the Raymond School Garden?”

Lesson 2- What types of things affect plant growth?

During this second lesson, the overall goal for the lesson was for students to start to learn about the different variables that can affect plant growth. Students were asked to generate a list of different things they think affect plant growth, and they made a prediction of three different things that they think would affect plant growth. The students were then introduced to what variables they would be working with (sodium chloride, acetic acid and light) during their plant experiments, and that they would be observing how these variables affect plant growth. Students were asked to list different ways on how they could observe plant growth, and as a class, everyone settled that they would measure plant height in centimeters with a ruler, count leaves and look at leaf color, plant color and leaf shape.

Students then began to set up and plant their own milkweed and sunflower plants. Students worked in groups of 2-3, and they were each given either two milkweed plants or two sunflowers plants, and they were instructed on what variable they would be testing. For each group that tested sodium chloride and acetic acid, they received two plants. One planted was to receive water (to act as the control), and their other plants was to receive the sodium chloride or
acetic acid solution. The groups that were testing light would receive two plants, and one plant would grow in the light underneath a lamp set up in class and the second plant was to be grow in darkness in a cabinet inside the classroom. The variable that each group worked with was chosen randomly, and students were given a pre-generated data collecting sheet to use as they recorded observations every meeting (Appendix).

Students were given the chance to plant their own milkweed plants (these were pre-grown from the seed beforehand) or sunflower seeds and they were also able to fill up their pots with soil.

During the first meeting, students were instructed to only give their plants water, and that sodium chloride and acetic acid solutions would be created later on. Students who were testing their plants with light were told to start growing their plants in light initially. Students were asked to start by making initial observations of their plant or seeds. Groups working with milkweed plants had the chance to measure the initial height of the milkweed and observe different characteristics about the plant. Groups that planted sunflower seeds were asked to measure their seed and make observations about the characteristics of the seed.

Lesson #3: How does light affect plant growth?

The first thing students did when they came to class was grab their plants and they started making observations, and then the class moved into the lesson for the day. The lesson topic and goal for this lesson was for students to be able to understand that plants use energy and light from the sun to undergo photosynthesis, and for students to understand that plants need light to grow fully.
Students worked in groups to first make predictions about whether they thought sunlight was important for plant growth, and then they began investigating the role of sunlight on plant growth.

To do this, students worked in groups and they observed what the milkweed plants grown in class looked like when they were grown under sunlight, and then they looked at a picture of spinach seeds that was grown in darkness for a week. Students were able to observe in this picture that the spinach seed was able to germinate and sprout after a week, but the plant looked very yellow and not healthy on day seven. Students were given a worksheet to fill out as they walked through this process to help emphasis the role of sunlight on plants and seed growth. The class then discussed why seeds can start growing without sunlight. As a class after this discussion, a claim was developed stating that that initially plants do not need sunlight to start growing, but to continue to grow and to grow fully, plants need sunlight. Students started to relate the idea and importance of sunlight in photosynthesis because they thought about why plants are green, how they make food for themselves and what role sunlight plays in photosynthesis.

**Lesson 4- How does your variable (sodium chloride, acetic acid or light) affect plant growth?**

Before beginning the lesson, students took out their plants and made observations of their milkweed and sunflower plants. After this, the class moved into the main lesson for the day. The goal for this lesson was for students to learn that different variables affect plant growth, such as the idea that sodium chloride solutions, acetic acid solutions and darkness may have an effect on plant growth. This conclusion was reached by having students observe the pH level differences between their solutions and water by using pH strips.
Students first thought about the five basic things that plants need: water, air, sunlight, nutrients and space, and they then started to make their own sodium chloride and acetic acid solutions. Groups that were testing light were allowed to work with other groups to help make solutions. Students made their solutions by combining pre-made sodium chloride and salt solutions with about 100 mL of water. The students then mixed together their solution in a test tube. After making their solutions, students measured the pH of their solution using pH strips, and as a class, students learned about the basics of what pH measures, what the regular pH of water is, and they learned about acids and bases. Students were then asked to use this new knowledge of the pH of tap water, and to compare it to the pH of acetic acid and sodium chloride. Students used this information to think about how their variable would affect plant growth, and to make a prediction about how they think sodium chloride or acetic acid may affect plant growth.

Students who were working with light were asked to think about how they will be watering their plants with normal water, and they were asked to think about how watering a plant with normal water would affect a plant’s growth. These students then wrote a prediction about how they think normal water would affect a plant’s growth.

Students were then allowed to share their predictions with each other, and the entire class held a discussion about the role of water in plant growth. Then they were introduced to the role of water in photosynthesis, and how important water is in plant growth.

Lesson #5- How can we group organisms together based on similarities?

Students were required to measure and make observations about their plants prior to the lesson. After this, the class dove into the main lesson together, which took place over two days.
The lesson goals were for students to learn that there are functional relationships between consumers, producers and decomposers, and for students to learn that there are relationships with the transfer of matter between consumers, producers and decomposers. Students would also learn that there are different ways to group and classify organisms together based on similarities (between the ways that they obtain energy).

First, groups of students were given pictures of different organisms and things found in nature (pictures of a sun, stick, bear, grass, flower, etc.). Then students worked in groups to organize these pictures into any categories they wanted to as long as the categories were based on similarities between the organisms. Then students were asked to sort the pictures into groups based on what they think the organisms ate.

After this, students were asked to sort the pictures into three specific groups: organisms that produce their own food, organisms that eat other organisms for food and organisms that eat/consume dead matter for food. Students worked together in groups to do this, and the teacher walked around to give help and ask prompting questions.

The entire class then came together and talked about what organisms belonged where and why. The class was then introduced to the terms, producer, consumer and decomposer, and the class talked briefly about the role of these organisms in the environment. The class then wrote a claim together based off of how they can classify different organisms.

Lesson 6- The Role of Photosynthesis

At this point, students were not required to measure their plant’s growth, and the data collection process stopped after 43 days. Prior to the beginning of this lesson, the instructor put
together all of the student data, and graphed the average height of the milkweed and sunflower plants for each variable.

The main goal for this lesson was for students to learn that plants need carbon dioxide and water to start photosynthesis, and that plants use sunlight to convert these components into food and oxygen which is released as a byproduct. The second goal was also for students to understand that plants make food, so that they can use this to grow and reproduce.

Each group was given their line graph for their appropriate plant and variable. Students then looked through these charts and answered different questions about how the average plant heights compared between the control and the variable that they were testing (e.g., students compared the height between plants grown with sodium chloride and water, acetic acid and water, and light and darkness).

This then lead to a class discussion about photosynthesis, and how water and light are required for photosynthesis because they help a plant make food for itself, which gives the plant energy to grow and reproduce. Students then were introduced briefly to other components of photosynthesis, and what the basic formula looks like.

**Lesson 7- Engineering a Planting Tool**

The next lesson took place over two days, and students were given the chance to engineer a planter. The goal for this lesson was for students to learn that environmental engineers design, build and test tools to help plant a large volume of seeds quickly and efficiently, and for students to learn that they need to think critically about their tool in order to help make sure the seed being planted is receiving requirements needed to germinate and grow.
Students were introduced to different types of planters that farmers use to plant seeds, and then students were required to design and build a tool that was created out of everyday objects that plants a seed every 4 in (10 cm) over 3 ft (0.91 meters) without any help from a person’s hand touching the seed as it drops. Students were then provided with a sketch sheet, objects to build with, and then the students tested their designs together as class. At the end of each test, students were asked different questions as to how their tool could be improved and what they would design differently if they had the time. The goal of this lesson was for students to also learn about the different needs of seeds and plants, and to take these differences into consideration as they built their tools, but there was not enough to include this component into the lesson.

At the end of the seventh lesson and when students were done with their plants, the post-assessment was administered. Students completed this after they finished testing their planter.

Data Analysis

After the completion of all seven lessons, the post-assessment was administered. Students’ tests were graded, and students either answered a question correctly or incorrectly. The percentage of students who received each multiple-choice question correctly was graphed for questions one to nine.

Each individual assessment question was then analyzed as well, and for questions that had more than one correct answer, students had the opportunity to earn partial credit. For these questions, students had to circle three answers to receive full credit and to receive 1 full point. If students circled three of the correct answers with any combination of incorrect answers, they received 0.75 points. If students circled two correct answers with any combination of incorrect
answers, they received 0.5 points. If a student circled one correct answer with any combination of incorrect answers, they received 0.25 points. Then the results for each individual assessment question was graphed separately.

Question number ten was also analyzed, and this question required students to label the four parts of photosynthesis. Students were given 0.25 points if they labeled one part correctly, 0.5 points for two parts labeled correctly, 0.75 for three parts labeled correctly and 1 point for four parts labeled correctly. The percentage of students who received each of these points values was calculated, and then graphed.

For the attitude survey, each individual statement was assessed in order to analyze the average feeling. Circling a happy face was 3 points, circling a neutral face was 2 points and then circling a sad face was 1 point. The average score for each individual statement was calculated, and then a t-test scale was performed to analyze student performance on the assessment. The standard deviation and standard errors were also calculated for each statement. Then the average student attitude score for each statement was graphed.

After graphing each of these components of the assessment, the results were analyzed by looking at standard deviations, standard errors, the percentage of students who answered questions correctly and results from the attitude survey. Overall performance on certain topics was analyzed, and general student feelings towards certain topics on the attitude survey was analyzed.
Results

*Plant Physiology Lab Results*

**Figure 1 - The Growth of Sunflower Varieties.** Several different varieties of sunflowers were grown initially to determine which would work best in an elementary school setting. Some of the different varieties tested were: Sonja, Hybrid Sunflower, Chocolate, Soraya, Florenza, Ring of Fire, Valentine and Autumn Beauty. Florenza was chosen for further study.
Figure 2- Growth of Sunflowers Treated with Various Solutions Over 17 Days. The image shows the growth of six sunflower seedlings that were treated with water, 0.25% acetic acid, 150 mM NaCl or 300 mM NaCl. Their growth patterns were recorded seven times over 17 days.
Figure 3: Mean Height of Sunflowers Treated with Various Solutions Over 17 Days. Six sunflowers per treatment were grown and watered with 150 mM NaCl, 300 mM NaCl, 0.25% acetic acid solutions for seven days. There was also a control group which received normal water treatments. Over the course of over two weeks, the acetic acid and 300 mM NaCl solutions greatly inhibited sunflower growth or killed the plants altogether, and the 150 mM NaCl solutions slowed down sunflower growth. The error bars represent standard error. n=6
Sunflower varieties were tested in a classroom and greenhouse setting to identify the best variety for use in a fifth-grade classroom. Different varieties of sunflowers were grown, and it was determined that Florenza was able to germinate and grow the most quickly (Figure 1). The Florenza plants grew to become a suitable height, which was not too tall or too short, and it was able to withstand hardy conditions, such as being able to grow successfully despite not being watered for four to five days or even when the heat in the building was turned down or shut off over night or for the weekend.

When testing acetic acid and sodium chloride conditions, the control sunflowers (grown with just water) were able to increase their growth over seventeen days. The six sunflowers remained a healthy green color while growing for seventeen days and were standing up straight. Each plant had two to three green oval shaped leaves (Figure 2). On day one, the six sunflowers ranged in height from between 4 cm to 5.1 cm, and on day seventeen, they ranged between 5.5 cm and 5.8 cm. This shows that the sunflowers grown under water conditions increased their growth across seventeen days (Figure 3).

The six sunflowers grown with 150 mM NaCl had starting heights that ranged from 3.5 cm to 4.2 cm, and on day seventeen, they ranged from 3.9 cm to 5.1 cm. However, while quantitatively there were no statistical differences in these plant heights, qualitatively the sunflowers appear to have deteriorated in appearance. On day one, the sunflowers appeared green, healthy and standing upright. Across the seventeen days of the experiment, some of the sunflowers appeared to be yellowing and bending over (Figure 2).

The sunflowers grown with 300 mM NaCl ranged from 3.5 cm to 4.2 cm, and on day seventeen, ranged from 4.1 cm to 4.6 cm. However, while quantitatively there were no statistical differences in these plant heights, qualitatively the sunflowers started to become unhealthy and
die over the seventeen days. On day one, the sunflowers appeared to be upright, green and healthy. By day seventeen, all of the plants are no longer upright, and they were laying on top of the soil. The plants were losing their green color and appeared more yellow, and the leaves were shriveled up (Figure 2).

The sunflowers growth with 0.25% acetic acid only lasted for about eight days before dying, and the sunflowers one day one, ranged between 4.2 cm to 4.55 cm in height. On day three, the height increased to about 5.6 cm to 6.15 cm. This shows that overall the sunflowers were able to experience some growth at the beginning. By day eight, the sunflowers’ heights ranged from about 5.35 to 5.8 cm (Figure 3). Although statistically there was difference in sunflower height between days three to eight, qualitatively the sunflowers’ health deteriorated. On day one, the sunflowers were green and upright, and then by day three the sunflowers’ leaves are more wrinkled and the plants started to bend. By day eight, most of the sunflower plants were almost parallel to the top layer of the soil, and the remaining pictures show the sunflowers shriveled up and dead on top of the soil (Figure 2). However, after day eight, all of the sunflowers grown with acetic acid died.
**Assessment Data**

**Figure 4: Percentage of Questions Answered Correctly by Fifth Grade Students in Pre- and Post-Assessment.** Students were given a pre- and post-assessment before and after the science unit was taught to them. This diagram shows results from questions one to nine, which were multiple choice questions. Students received one point if they circled the correct answer(s) (some questions had multiple answers, “circle all that apply” style questions). The number of students who received the specific question correctly was calculated. For the pre-assessment, this number for the pre-assessment was divided out of 24 (this is the amount of students who took the pre-assessment). The chart shows the percentage of students who answered a question correctly for the pre- and post-assessment.
Figure 5: Percentage of Fifth Grade Students Scored for Question 10 on Pre- and Post-Assessments. Question ten was a diagram that required students label the four parts of photosynthesis (carbon dioxide, sunlight, oxygen and water). Students received 0 points if they could not label any parts correctly, 0.25 points if they labeled one part correctly, 0.5 points if they answered two parts correctly, 0.75 points if they labeled three parts correctly 1 point if they answered all four parts correctly. To calculate the percentage of students who received each point value was tallied and then divided by 24 (sample size) for the pre-assessment and 17 (sample size) for the post-assessment.
Figure 6: Average Score for Pre- and Post-Assessment Survey. Students were required to circle a happy, neutral or sad face for how they felt for eight different statements. The happy face received a score of 3, the neutral face 2 and the sad face 1. For each individual statement, the average score, standard deviation and standard error were calculated. Then a t-test was performed, and the standard error bars represent standard error.
Figure 7: Percentage of Students Point Totals for Question 3. Question 3 on the pre- and post-assessment had three total correct answers. Students were expected to be able to circle all three answers, and if they did, they received 1 point. If students circled two out of the three correct answers with any combination of incorrect answers, they received a 0.5 points. If students circled one of the correct answers with any combination of incorrect answers, they received 0.25 points, and if students did not circle any of the correct answers, they received 0 points. Students only received partial credit on this question for this individual analysis of question 3. The percentage of students who received each point total was calculated by for the pre-assessment, dividing by 24 and the post-assessment.
Figure 8: Percentage of Students Point Totals for Question 4. Question 4 on the pre- and post-assessment had three total correct answers. Students were expected to be able to circle all three answers, and if they did, they received 1 point. If students circled two out of the three correct answers with any combination of incorrect answers, they received a 0.5 points. If students circled one of the correct answers with any combination of incorrect answers, they received 0.25 points, and if students did not circle any of the correct answers, they received 0 points. Students only received partial credit on this question for this individual analysis of question 4. The percentage of students who received each point total was calculated by for the pre-assessment, dividing by 24 and the post-assessment, dividing by 17.
Figure 9: Percentage of Students Point Totals for Question 5. Question 5 on the pre- and post-assessment had three total correct answers. Students were expected to be able to circle all three answers, and if they did, they received 1 point. If students circled two out of the three correct answers with any combination of incorrect answers, they received a 0.5 points. If students circled one of the correct answers with any combination of incorrect answers, they received 0.25 points, and if students did not circle any of the correct answers, they received 0 points. Students only received partial credit on this question for this individual analysis of question 5. The percentage of students who received each point total was calculated by for the pre-assessment, dividing by 24 and the post-assessment, dividing by 17.
Figure 10: Percentage of Students Point Totals for Question 7. Question 7 on the pre- and post-assessment had three total correct answers. Students were expected to be able to circle all three answers, and if they did, they received 1 point. If students circled two out of the three correct answers with any combination of incorrect answers, they received a 0.5 points. If students circled one of the correct answers with any combination of incorrect answers, they received 0.25 points, and if students did not circle any of the correct answers, they received 0 points. Students only received partial credit on this question for this individual analysis of question 7. The percentage of students who received each point total was calculated by for the pre-assessment, dividing by 24 and the post-assessment, dividing by 17.
For the pre- and post-assessment on questions one through nine, each student could either answer a multiple-choice question correctly or incorrectly. In the data from Figure 4, students were not given partial credit for multiple choice questions (even if there was more than one correct answer given). The data from this table will be discussed first, and the individual question analysis will be given after.

There was an increase in the percentage of students who answered a specific question correctly for questions one, six and eight. For question six, “How do decomposers help plants live?”, initially 34.78% of students answered this question correctly, and by the post assessment, 64.70% of students answered it correctly. There was a 29.92% increase. For question number one, “What do plants need to live?”, 30.43% of students answered the question correctly, and for the post-assessment, 58.82% of students answered this question correctly. There was an increase by 28.39%. For question eight, “What can people do to help plants grow?”, initially, 69.97% of the class received this question correct, and on the post assessment, 88.24% of students answered this question correctly. There was an increase by 18.27% (Figure 4).

For questions two, three, four and nine, there was only a small percentage increase for students who answered the question correctly. For question two, “What is a composter?”, on the pre-assessment, 39.13% of students answered this question correctly, and on the post-assessment, 41.18% of students answered it correctly. There was a 2.05% increase. For question, three, “How do plants rely on consumers to live?”, 8.7% of students answered this correctly, and then on the post-assessment, 11.76% of students answered the question correctly. There was a 3.06% increase. For question four, “How do animals rely on plants to live?”, on the pre-assessment, 4.35% of students answered this correctly, and on the post-assessment, 11.76% of students answered it correctly. There was an increase by 7.41%. Lastly, on question nine, “If you
made a composter, what is the most important feature it would need?”, on the pre-assessment, 17.39% of students answered the question correctly, and on the post-assessment, 23.54% of students answered it correctly. There was an increase of 6.15%, but this topic was never taught as a part of the science unit, so this question was used as a control (Figure 4).

There were some questions, however, where the percentage of students who answered a question correctly, decreased from pre- to post-assessment (questions five and seven). For question five, “What do plants need in order to make food for themselves?”, on the pre-assessment, 8.7% of students answered this correctly, and on the post-assessment, 5.88% of students answered this correctly. On question seven, “How do plants help consumers live?”, on the pre-assessment, 8.7% of students answered this question correctly, and on the post-assessment, 5.88% of students answered this question correctly (Figure 4).

For question ten, “label the part of photosynthesis,” students were required to label the four parts of photosynthesis. Students received 0 points if they could not label any parts correctly, 0.25 points if they labeled one part correctly, 0.5 points if they answered two parts correctly, 0.75 points if they labeled three parts correctly, and 1 point if they answered all four parts correctly. Overall, student performance decreased from pre- to post-assessment.

For students that received 0 points, 41.66% received 0 points on the pre-assessment, and for the post-assessment this number increased to 52.94%. The percentage of students who received 0.25 points increased, on the post-assessment, but the percentage of students who received 0.5 and 0.75 points decreased from pre-assessment to post-assessment. For example, on the pre-assessment, 37.5% of students received 0.25 points and on the post-assessment, it increased to 41.77% of students. However, for 0.5 points on the pre-assessment, 12.5% of students received this point score, and this number decreased to 5.88% for the post-assessment.
For 0.75 points, 8.33% of students received this point score on the pre-assessment, and on the post-assessment, 5.88% of students received 0.75 points. On both the pre- and post-assessment, no one received a full 1 point (Figure 5).

Students were also given a pre- and post-assessment survey to fill out that asked them questions about their feelings towards science, nature, taking care of plants and outdoor learning. A t-test was done for each individual question, but none of the differences met the criteria for significance. There were no statistically significance changes for attitude survey scores for individual questions between pre- and post-assessments, except for statement number three, “Plants are an important part of our environment”. This means that for every statement except for question three, it cannot be concluded whether or not the students’ average attitude scores increased or decreased. However, one can observe where students’ scores tended to land near for each statement.

On question number three, “Plants are an important part of our environment,” on the pre-assessment, students’ scores ranged around 2.6 to 2.8, but on the post-assessment, students’ scores ranged from 2.9 to 3. This shows that there was an increase in the students’ attitude scores. Overall, for both the pre- and post-assessment, students felt happy about this statement.

For question number one, “I enjoy gardening and taking care of plants,” the score ranged from 2.4 to 2.65 for the pre- and post-assessment. So, for both before and after the science unit, students tended to feel neutral but slightly on the happier side about this statement. For question two, “I like to be outside while I learn,” the scores ranged between 2.4 to 2.7 on both the pre- and post-assessment. This means that students tended to feel neutral but slightly on the happier side about this statement. For question four, “I plan to start my own garden in the future,” students’ scores ranged from 1.8 to 2.3 for the pre- and post-assessment. So, the students felt neutral about
this statement. For question five, “I will need to know science to start a garden,” students’ score range was from 2.0 to 2.4 for the pre- and post-assessment. Overall, students felt neutral about this statement. For question six, “I want a job doing outdoor science,” the score for pre-assessment was 1.8 to 2.3 for pre-assessment, and 1.5 to 2 for the post-assessment. In general, students felt neutral about this statement as well. For question seven, “Plants play an everyday role in my life,” the score for pre- and post-assessment ranged from about 2.5 to 2.7. This shows that the students scored neutrally and on the slightly happier side. For question eight, “I think composters are gross,” on the pre-assessment, the score ranged between 2.1-2.4, and the post-assessment was 1.8 to 2.3. So, for both of these assessments, students scored neutrally towards this statement (Figure 6).

Several of the multiple choice questions that provided more than one correct answer were individually analyzed to see if students were able to at least circle one or two of the correct answers out of three. Students were expected to be able to circle all three answers, and if they did, they received 1 point. If students circled two out of the three correct answers, they received a 0.5 points. If students circled one of the correct answers, they received 0.25 points, and if students did not circle any of the correct answers, they received 0 points.

For question 3, “How do plants rely on consumers to live?”, a higher percentage of students were able to receive 0.25 points on the post-assessment. On the pre-assessment, 41.6% of students received this point total, whereas on the post-assessment, 76.47% of students received this point score. However, there was a decrease in the amount of students that received 0.5 points because 33.33% of students on the pre-assessment received this, and then this number dropped to 5.88% for the post-assessment. Overall, there was a 3.43% increase for the amount of students that received 1 full point when transitioning from pre- to post-assessment (Figure 7).
For question 4, “How do animals rely on plants to live?”, overall students performed better on this question for the post-assessment. There was a 7.11% percentage increase for the amount of students who received 0.25 points on the post-assessment (52.94% of students). Also, there was a slight increase for 0.5 points as well because there was a 4.38% increase (41.18% of students). Also no students received 0 points on the post-assessment, and there was only slight decrease for students who received 1 point total. There was a 2.45% decrease because only 5.88% of students received 1 point on the post-assessment (Figure 8).

For question number five, ‘What do plants need in order to make food for themselves?”, there was an increase in percentage of students for higher point totals. On the post-assessments, no students received 0 or 0.25 points. For 0.5 points, there was a 5.39% increase because 47.06% of students received this point total. For 0.75 points, there was a 12.74% increase because 29.41% of students received this point value. Lastly, for 1 point, there was a 11.03% increase because 23.53% of students received this point value (Figure 9).

For question seven, “How do plants help consumers live?”, students performed almost similarly on the pre- and post-assessment. On the pre-assessment, 8.33% of students received 0 points and 5.88% of students received a 0 for the post-assessment. For 0.25 points, 41.67% of students received this point value and 52.94% of students on the post-assessment received this point value. For 0.5 points, 41.67% of students received this point value for the pre-assessment, and 41.14% of students received this on the post-assessment. Lastly, no students were able to score 0.75 points on either the pre- or post-assessments, and no one scored 1 point on the post-assessment. However, 8.33% of students received 1 point on the pre-assessment (Figure 10).
Discussion

The purpose of this project was to test the effectiveness of an engaging life science module to examine if hands-on and inquiry based-learning can increase students’ knowledge and appreciation for science. Another goal of the project was to create lessons that incorporate hands-on learning, which are exciting and connect to the Massachusetts Science Technology Engineering Curriculum Framework and Science Engineering Practices found in the Next Generation Science Standards. The last goal was to create an inexpensive, easy to implement science module that teachers can use in their own classroom to help promote the incorporation of interactive and hands-on science learning.

Acetic Acid, Sodium Chloride and Light Treatment Experiments

To begin designing the science module, first, different sunflower varieties were tested to identify the best variety to use in a fifth-grade classroom, and the Florenza variety was chosen (Figure 1). Then different Florenza plants were grown and tested with 150 mM and 300 mM of NaCl solutions and 0.25% acetic acid solutions. This experiment was run to see what effects these solutions would have on plants, and to see if this experiment would be effective enough to use in a classroom setting. The plants grown with these concentrations showed signs of overall decreased healthiness because of photos that were taken throughout the experiment. The pictures show that the plants grown with these concentrations started off healthy and upright, and by the end of the seventeen days, the plants were yellow or bent over (Figure 2). The overall differences in data range for height in centimeters is inconclusive and insignificant (Figure 3). Quantitatively it cannot be concluded whether the height decreased or increased during the experiment, but qualitatively, there was a change in physical appearance in the plants (Figure 2). After
performing these experiments, it was determined that these concentrations would be appropriate for students to be working with in a classroom setting, and that they would be able to see the effects of using acetic acid and sodium chloride solutions on plants.

Pre- and Post-Assessment Results

After assembling these experiments, they were implemented into the classroom and both pre-and post-assessments were administered. After instructing and collecting assessments, the results were analyzed to determine the effectiveness of this unit on the students.

Overall, the use of hands-on and inquiry based-learning may have helped increase students’ knowledge and appreciation for science. The results from the post-assessment vary greatly from question to question. Overall, the percentage of students who answered questions correctly increased when it came to questions that covered topics that were explicitly covered in the science unit. However, the percentage of students who answered questions correctly decreased for the questions that covered topics that were not explicitly covered during the science unit.

Pre- and Post-Assessment Questions with an Increase for the Percentage of Students Who Answered Questions Correctly

Within teaching this science unit to students, the post-assessment shows that students increased their knowledge in certain topics more than others. Students showed increase in knowledge on the topics of: decomposers, needs of plants, what people can do to help plants grow, photosynthesis and how animals rely on plants. These topics were explicitly covered during the science unit, and this was shown by the increase in the percentage of students who answered questions one, (“What do plants need to live?”), six (“How do decomposers help plants
live?”) and eight (“What can people do to help plants grow?”) and question five (“What do plants need in order to make food for themselves?”), correctly, question four (“How do animals rely on plants to live?”) (Figure 4, 8 & 9).

Questions one (“What do plants need to live?) and eight (“What can people do to help plants grow?”) had an increase in the percentage of students who answered the question correctly from pre- to post-assessment. For question number one, on the post-assessment, 58.82% of students answered this question correctly, and there was an increase by 28.39%. For question eight, “What can people do to help plants grow?”, on the post assessment, 88.24% of students answered this question correctly, and there was an increase by 18.27% (Figure 4).

There may have been an increase in the percentage of students because these questions cover the topic of the needs of plant, and the hands-on science unit created heavily focused on this topic. For example, students were growing and taking care of their own plants, so they were getting to experience first-hand what their plants need in order to survive.

One lesson was dedicated solely to identifying what types of things affect plant growth, and the class was involved in whole class discussions about variables that could affect a plant as it grows. The class looked specifically at the role of sunlight, and they were engaged in a classroom experiment to determine “How does sunlight affect plant growth?”. Students were able to determine that for a plant to grow fully, it needs continuous sunlight, and students reached this claim by looking at their milkweed plants which were grown in light for a week and observing a picture of spinach seeds grown in the dark. They realized that their milkweed was green and standing tall with full green leaves whereas, the spinach seed was initially grown in the darkness, but when it became a plant, it was yellow and bent over.
During another lesson, students specifically looked at the five things that are needed for plant growth (space, soil, air, light, nutrients and water) by watching an educational video, and working as a class to generate a list on the board with different things that plants need. Students were encouraged to write down one thing that they think plants need to grow, and the class then organized these into categories on the board. For students that did not write a correct answer, the teacher left these sticky notes to the side, and then held a class discussion about whether or not those things were really needed for plant growth.

Students also completed their own experiments where they grew milkweed and sunflower plants with different types of liquids and light. At the end of the experiment, students looked at the average height of their plant as it grew with the control and test variable. For example, one group looked the mean height of a milkweed plant over 43 days, and they looked at two different lines, one for a milkweed grown with sodium chloride and one for milkweed grown with water (control). Students then made conclusions about their data and decided what type of light and liquid plants need to grow and they shared this with the class. The class as a whole after a large discussion decided that plants need full sunlight and regular water to grow and why this is needed. The students then were engaged in a series of scaffolding questions to learn about the role of water and sunlight in photosynthesis and plant growth and development.

Naturally, since this science model focused heavily on what plants need to grow and what people can do to help plants grow, the two questions on the post-assessment that relate to these concepts, had the highest percentage of growth and were a part of the top three questions that had the highest percentage of students that answered the question correctly. The data may support the idea that before the science unit, students may have had limited experience growing and taking care of plants, and after growing their own plants in class, students were able to experience
hands-on what they need to do help their plant grow and what their plant needs to receive to remain healthy.

For question number six, “How do decomposers help plants live?”, 64.70% of students answered this question correctly on the post-assessment, and there was a 29.92% increase (Figure 4). The question asked about the topic of decomposers, and this topic was directly covered in the science unit. Students were required to circle the correct answer for this question, which was, “decomposers help plants by breaking down dead matter and adding nutrients back to the soil”.

There may have been an increase in the percentage of students who answered this question correctly because this topic was heavily focused on during the science unit. Students during one lesson specifically organized pictures of different organisms into different groups based off of what they consumed for food. Students through a series of categorizing eventually ended up grouping organisms based off of organisms who “consumed other organisms for food, produced their own food, and consumed dead matter for food”. Students were most confused on organisms that consumed dead matter for food, so the instructor spent a significant amount of time going around to groups and encouraging them to think about how mushrooms and worms get food. This category was then discussed with the entire class, and students shared how they thought mushrooms and worms received food. Students were then given the vocabulary words for what these different types of organisms are called at the end of the lesson, which are consumers, producers and decomposers.

The data from the pre- and post-assessment for question six may support the idea that before the students had no hands-on and direct experience with the vocabulary term decomposer,
but after being exposed to an interactive lesson on categorizing organisms, they were able to gain information about this topic and answer the post-assessment question correctly.

On question five (“What do plants need in order to make food for themselves?”), initially, when examining this question on whether a student was able to circle all three correct answers or not, it appears that there a small decrease in the percentage of students who received this question entirely correctly. However, when examining the question and giving students partial credit for circling one or two of the correct answers, the results appear differently. Overall, there were no students who received 0 or 0.25 points, and there was also an increase for the number of students that received 0.5, 0.75 or 1 point. For 0.5 points, there was a 5.39% increase, for 0.75 points, there was a 12.74% increase, and for 1 point, there was a 11.03% increase (Figure 9). This shows that more students were able to circle more correct options for this question after the completion of the science unit.

This may be because at the end of the student experiments with milkweeds and sunflowers, students analyzed height growth and they were required to make conclusions about what plants need to grow. The class was then engaged in a discussion about how sunlight, water and oxygen are all required for plants to begin photosynthesis, and that in the end of photosynthesis, plants have themselves food. However, during this process, the class also learned and discussed the role of oxygen, and students may have gotten confused on the role of oxygen in photosynthesis and how plants make food for themselves. Students may have circled oxygen as an answer, and this may have skewed their assessment result for this question overall.

When examining question four (“How do animals rely on plants to live?”) on whether a student was able to circle all three correct answers or not, it appears that there is only a small increase in the percentage of students who received this question entirely correctly (7.41%)
(Figure 4). However, when examining the question and giving students partial credit for circling one or two of the correct answers, the results appear differently. Overall, students performed better on this question for the post-assessment. There was a higher percentage of students who received 0.25 and 0.5 points on the post-assessment than pre-assessment, and less students received 0 points on the post-assessment than pre-assessment. There was a 7.11% percentage increase for the amount of students who received 0.25 points on the post-assessment (52.94% of students). Also, there was a 4.38% increase for students who received 0.5 points, and no students received 0 points on the post-assessment. This supports the idea that there was some student progress in learning about how animals rely on plants to live (Figure 8).

To receive full credit on question four (“How do animals rely on plants to live?), students had to circle that animals rely on plants for protection, animals rely on plants for energy and food, and that animals rely on plants for a place to live. However, the science unit designed only ended up covering that animals rely on plants for energy and food. This was discussed and learned while students were sorting pictures or organisms into producer, consumer and decomposer categories. Students learned that consumers consume other organisms in order to receive food, and this is when students were exposed to the idea that animals rely on plants for energy and food either directly or indirectly. Initially, the module was going to be focused on how animals rely on plants for protection and a shelter, but due to some changing circumstances and the elimination of using a school garden, the science unit ended up shifting focus. However, students should have been able to circle option b: animals rely on plants for energy and food, and the results show, that on the post-assessment, the percentage of students who received 0.25 points increased, and this may be due to the fact that students were able to learn about this one option in class (Figure 8). If the science unit had focused more on the other two topics (how
animals rely on plants for protection and shelter), there may have been an increase in the percentage of students who received full or higher partial credit. This is because they would be exposed to these lesson topics, and would hopefully be able to answer an assessment question about these topics.

*Pre- and Post-Assessment Questions with Little or No Increase for the Percentage of Students Who Answered Questions Correctly*

When examining questions three ("How do plants rely on consumers to live?") and seven ("How do plants help consumers live?") overall and individually, there was little to no increase in the percentage of students who answered the questions correctly.

For question three ("How do plants rely on consumers to live?"), there was a 3.06% increase in the percentage of students who answered this question correctly (Figure 4). For question three, when giving students partial credit for each answer that was circled correctly, the highest percentage of students received only 0.25 points (76.47%) (Figure 7).

For question seven ("How do plants help consumers live?"), overall, there was a 2.82% decrease in the percentage of students who answered this question correctly (Figure 4). The highest percentages of students received 0.25 and 0.5 points. There was almost no difference between the percentage of students who received 0.25 and 0.5 points on the pre- and post-assessment because for 0.25 points, 41.67% of students received this point value on the pre-assessment and 52.94% of students on the post-assessment received this point value. For 0.5 points, 41.67% of students received this point value for the pre-assessment, and 41.14% of students received this on the post-assessment. Also, zero students were able to receive 1 point on the post-assessment (Figure 10).
One reason that these questions did not have any large growth or increase in the percentage of students who could answer them correctly overall or even partially is because these topics were not covered in the science unit. Relationships between plants and consumers was originally planned to be covered, but due to the cutting down of the school garden and time, discussion about the interrelationships between producers, consumers and decomposers was very limited.

For question ten, “label the part of photosynthesis,” students were required to label the four parts of photosynthesis. Overall, student performance decreased from pre- to post-assessment. For students that received 0 points, there was an 11.28% increase from pre- to post-assessment. The percentage of students who received 0.25 points increased, on the post-assessment, but the percentage of students who received 0.5 and 0.75 points decreased from pre-assessment to post-assessment. For students who received 0.5 points, there was a 5.88% decrease, and for students who received 0.75 points, there was a 2.45% decrease. On both the pre- and post-assessment, no one received a full 1 point. Overall, a higher percentage of students received 0 and 0.25 points on the post-assessment, and less percentage of students received 0.5 and 0.75 points (Figure 5).

This may be because students learned about the components of photosynthesis, but they were never directly taught how to label a diagram with these four parts. This may have caused some confusion when they had to label a diagram. The students may have had the knowledge, but they may have been unsure of how to express of it. Students were also confused and unsure of where each blank was referring to on the diagram and what part of photosynthesis it was referring to. In the future, a more detailed diagram may be provided, or students may be able to
just express their knowledge of the parts of photosynthesis through a multiple-choice question or fill-in-the-blank question.

Pre- and Post-Assessment Questions That Served as Control Questions

Originally, the science unit was designed to have students learn about and design composters, but these plans changed towards the middle and end of the implementation of the science unit. As a result, questions two (‘What is a composter?’), and nine (‘If you made a composter, what is the most important feature it would need?’), ended up serving as a control, so any percentages they may have increased or decreased can be compared to these control questions. The students during this science unit did not receive any instruction about composters.

For question two (‘What is a composter?’), and nine (‘If you made a composter, what is the most important feature it would need?’), there was very little change in the percentage of students who could answer these questions correctly. For question two, the pre-assessment shows that 39.13% of students answered this question correctly, and on the post-assessment, 41.18% of students answered it correctly. For question nine, on the pre-assessment, 17.39% of students answered the question correctly, and on the post-assessment, 23.54% of students answered it correctly (Figure 4).

The percentage of students who answered questions two and nine correctly increased by under 6.5%, which shows that overall there was no change in knowledge about a topic that was not taught before and after the implementation of this science unit. Any increase or decrease in percentage of students on assessment questions on topics that were actually taught can be compared to the control. Because these control assessments had almost no increase in the percentage of students who could answer this question correctly, any increase or decrease in
other assessment questions on topics covered in the science unit are mostly in result because of the instruction of the science unit.

*Pre- and Post-Assessment Attitude Survey Results*

Students answered a pre- and post-assessment attitude survey that analyzed their feelings towards life science, plants, taking care of plants and gardening. In general, students’ change in attitudes were not able to be measured because the data was insignificant except for question 3, “Plants are an important part of our environment”. Although most changes in the attitude surveys were insignificant, the student attitudes for each question were assessed.

Overall, 3 represented a smiley face or happiness towards the statement, 2 represented a neutral face and attitude about a question and 1 represented a sad face or unhappiness towards a statement. Overall, students felt happy about question one, “I enjoy gardening and taking care of plants”, question two, “I like to be outside while I learn,” question three, “Plants are an important part of our environment,” and question eight, “Plants play an important role in my everyday life”.

This is shown because all of the average attitude scores for these questions, the bottom range of the standard error bar started at or was higher than 2.4 (Figure 6). This shows that even before and after the science unit, students felt happy or potentially agreed with the statements that plants play an important in the environment, their every day lives, and that they enjoy outdoor learning and taking care of plants. This shows that even after the implementation of this science unit, students still enjoyed gardening, taking care of plants and they still understood and recognised the value of plants in the environment and their every day life.
Students felt overall neutral about the following statements, question four, “I plan to start my own garden in the future,” question five, “I will need to know science to start a garden,” question six, “I want a job doing outdoor science,” and question eight, “I think composters are gross”.

Students for these statements had a standard error bar range around the numbers 1.5 to 2.4. The average attitude score of 2 represented a “neutral” feeling towards a statement. The scores for these statements showed that the standard range of responses surrounded neutrality towards statements regarding gardening and composters. There was no significant change between student attitudes towards these statements both before and after the implementation of this science unit.

The reasons for this may be because originally this science unit was supposed to engage students in outdoor learning and gardening. A garden was started at the school for students to use, but before the implementation of the science unit, the garden was taken down for the remaining school year. There were no remaining plants in the garden for students to look at or grow, so students never got a chance to go outside and become more exposed to gardening. The implementation of this science unit also began in the fall, so there was no time for students to even start planting a garden due to the cold temperatures. Originally, students were going to have the opportunity to engage in outdoor learning more and they were going to be starting and taking care of their own garden. This is why the attitude survey contains statements about gardening and outdoor learning. However, because of changing circumstances, the objective and plans for the science unit were changed and the focus shifted to students just taking care of plants in the classroom. By the time the science unit switched focus, the fifth-grade students had already taken
the pre-assessment, so the questions on the survey could not be changed for the post-assessment survey.

Since the students never got a chance to garden or work more outside, it makes sense that there was no significant change in their attitudes towards question four, “I plan to start my own garden in the future,” question five, “I will need to know science to start a garden,” and question six, “I want a job doing outdoor science”.

Originally, students were going to be creating their own composters and working at decomposing snack materials. However, within the science unit, it was decided that students would not be creating a composter, and they created their own seed planters instead. There was no significant change in the average student attitude for this statement, and the attitude score ranged around a 2, which is neutral. This may be because students were never exposed to learning about composters or creating one.

**Overall Outcomes for the Science Unit**

Overall, the science unit may have been able to increase student knowledge and help students maintain a positive attitude on topics that were explicitly taught in class. This is shown because the percentage of students who answered assessment questions correctly increased for questions one, (“What do plants need to live?), six (“How do decomposers help plants live?”) and eight (“What can people do to help plants grow?”). There was also an increase for the percentage of students who received higher partial credit scores for question four, “How do animals rely on plants to live?”, and question five, “What do plants need in order to make food for themselves?”. Also, there as increase the average attitude score for the statement “Plants play an important role in the environment,” and students consistently kept positive attitudes
towards statements about topics that were taught in the science unit. For example, those statements were, question one, “I enjoy gardening and taking care of plants”, question two, “I like to be outside while I learn,” question three, “Plants are an important part of our environment,” and question eight, “Plants play an important role in my everyday life”.

The remaining assessment multiple-choice questions and diagrams that did not receive little to no increase in the percentage of students who answered the question correctly were questions two, “What is a composter,” three, “How do plants rely on consumers to live?”, seven, “How do plants help consumers live?”, nine “If you made a composter, what is the most important feature it would need?”, and ten “Label the parts of photosynthesis”. These assessment questions are all on topics that were not explicitly taught or covered in class. It was originally planned for these topics to be covered, but the science unit changed focus, and they were not. These percentages may not have increased because these topics were not explicitly taught or covered during the science unit.

The remaining attitude survey questions that received consistent neutral scores were statements five, “I will need to know science to start a garden,” six, “I want a job doing outdoor science,” and eight, “I think composters are gross”. This may be because these topics were not explicitly taught during the science unit. During the entire science unit, students did not get a chance to garden, experience outdoor learning (except for one lesson) or learn about composters. This may be why the mean student attitude score was neutral and why there was no significant difference between pre- and post-assessment average student attitude scores.
Effects of External Factors

One factor that may have affected assessment results is the method that was used to assess student learning and progress. Multiple choice questions that required students to circle several correct answers may have confused students, and this was one of their first experiences with multiple-choice questions like this. Students may have gotten overwhelmed with all of the multiple choice answers they could circle and may not have been sure how to express all of their knowledge. In the future, it is recommended to use multiple choice questions with only one answer to allow for students to be able to fully express their knowledge and to lessen confusion. It also would make for an easier and simpler data analysis.

Another factor that may have influenced student assessment results is that this science unit was not taught on a regular consistent basis. There were some weeks when the lessons were taught twice a week, and other times they were only taught once a week. Other times there were two or three weeks between when students met to be taught this science unit. If there was a regular, consistent meeting schedule for the science unit, then student assessment results may have been different.

Effects of Hands-On and Inquired-Based Learning

Overall, the implementation of the hands-on science unit may have helped to increase student knowledge on topics that were explicitly taught in the science unit and it may have helped to maintain positive attitudes towards topics that were explicitly covered in the science unit. Hands-on science experiments, lessons and units may help to increase student knowledge and increase or maintain positive attitudes towards topics and skills covered in class. Many researchers have been able to show positive results in the development of learners when they
learn through hands-on experiments. These studies have also shown that students have more interest in science when they are taught through this method. Experiments help to increase intrinsic motivation, which helps encourage students to take control of their own learning. (Dhanapal & Shan, 2014).

Hands-on learning can have many positive effects on students, but many teachers may not carry out hands-on experiments in their science lessons for numerous different reasons. One is because teachers believe it is too hard, expensive or takes too much time to design experiments. Many teachers may not see the reasons why STEM activities are beneficial to student learning and they believe that the teacher-centered approach is the only way for students to learn information and definitions. They also may believe that this teacher-centered approach is the only way to get students to achieve high test results (Dhanapal & Shan, 2014). However, the purpose of this module is to create inexpensive, accessible and easy to implement science experiments in the classroom for teachers. It is also to show that students can still learn classroom material and achieve high assessment results through hands-on learning. In fact, it helped to maintain positive student attitudes towards science and learning.

Hands-on experiments allow students to receive the opportunity to construct meaning in their learning through real-life experiences. They have the chance to be engaged in science projects and experiments that carry meaning, and they get to practice acting like real-life scientists by testing, analyzing, predicting and concluding. These laboratory experiences help students develop problem-solving and critical-thinking skills and become exposed to real-life laboratory experiments. Hands-on experiments help engage students in exciting material and knowledge, and spark interest in science. Students are able to construct their own meaning around topics and learn through discovery (Dhanapal & Shan, 2014).
Through hands-on learning, students rely more on evidence and data, and they develop autonomy when it comes to analyzing data and thinking independently and constructing their own meaning of this data. They become less dependent on authority to explain science concepts or ideas. Hands-on learning may even help to increase students’ motivation to learn and enhance their perception, creativity and logic. Hands-on learning allows students to construct real-life meaning out of science topics covered in class. It allows science learning to come to life and to expand beyond the limits of textbook learning (Dhanapal & Shan, 2014).

Hands-on learning allows students to construct positive attitudes towards science and experiments and may help to engage students in the subject. This overall may help to spark an interest and love for science at an early age that may carry over into their later life and encourage more students to pursue STEM careers (Dhanapal & Shan, 2014).

Further research on this study would include studying the effects of outdoor learning and garden activities on students. The goal would be to bring students outside more and to engage them in nature to help potentially increase their full understanding and appreciation for science. Another element that could be added into this study is a control group that does not receive hands-on instruction could be added. The results from this group could be used to compare to a classroom of students that did receive hands-on instruction. This study could also be done on a consistent schedule with simpler and more relatable assessment questions with more students. Further research could also examine the effects of hands-on and inquiry-learning on students and compare assessment results between different demographics of students.
Works Cited


Bowker, R., & Tearle, P. (2007). Gardening as a learning environment: A study of children’s perceptions and understanding of school gardens as part of an international project. Learning Environments Research, 10(2), 83-100. doi:10.1007/s10984-007-9025-0


Appendix

Name:___________________________ Date:_____________

Directions: Circle the best answer for each question. In some questions, it may require you to select multiple answers. If so, the directions will say.

1. What do plants need to live? Circle all that apply.

   A) Water
   B) Sunlight
   C) Air
   D) Vinegar
   E) Fertilizer

2. What is a composter?

   A) It is a gardening tool used to help plant seeds
   B) It is a natural pesticide used in gardens to help break down and kill insects
   C) It is a gardening tool used to help break up and dig soil
   D) It is a mixture of broken down natural waste that is used as a fertilizer for plants
3. How do plants rely on consumers to live? **Circle all that apply.**

   A) Consumers help plants by providing the soil with nutrients
   B) Consumers help plants live by spreading their seeds
   C) Consumers help protect plants
   D) Consumers give plants a place to live

4. How do animals rely on plants to live? **Circle all that apply.**

   A) Animals rely on plants for protection
   B) Animal rely on plants for energy and food
   C) Animals rely on plants for carbon dioxide
   D) Animals rely on plants for a place to live

5. What do plants need in order to make food for themselves? **Circle all that apply.**

   A) Oxygen
   B) Carbon dioxide
   C) Light
   D) Minerals
   E) Water
6. How do decomposers help plants live?

A) Decomposers help provide food for plants to eat
B) Decomposers help plants by breaking down dead matter and adding nutrients back to the soil
C) Decomposers help the roots of the plant stay down in the soil
D) Decomposers help plants get sunlight


A) Plants help provide food and nutrients to consumers
B) Plants help consumers live by releasing carbon dioxide
C) Plants give consumers shelter and places to live
D) Plants provide protection to consumers

8. What can people do to help plants grow? Circle all that apply.

A) Give plants lots of fruits and vegetables to eat
B) Make sure plants have plenty of sunlight
C) Plants give consumers shelter and places to live
D) Make sure plants have plenty of space to grow
9. If you made composter, what is the most important feature that it needs?

A) Light
B) Water
C) Animals
D) Decomposers
10. Label the diagram with the missing components of photosynthesis.
Direction: For the following statements, circle the faces that resembles your feelings.

1. I enjoy gardening and taking care of plants.

   ![Sad Face]
   ![Neutral Face]
   ![Happy Face]

2. I like to be outside while I learn.

   ![Sad Face]
   ![Neutral Face]
   ![Happy Face]
3. Plants are an important part of our environment.

4. I plan to start my own garden in the future.

5. I will need to know science to start a garden.
6. I want a job doing outdoor science.

7. Plants play a role in my everyday life.

8. I think composters are gross.
Directions: Circle the best answer for each question. In some questions, it may require you to select multiple answers. If so, the directions will say.

1. What do plants need to live? Circle all that apply.

A) Water

B) Sunlight

C) Air

D) Vinegar

E) Fertilizer

2. What is a composter?

A) It is a gardening tool used to help plant seeds

B) It is a natural pesticide used in gardens to help break down and kill insects

C) It is a gardening tool used to help break up and dig soil

D) It is a mixture of broken down natural waste that is used as a fertilizer for plants
3. How do plants rely on consumers to live? Circle all that apply.

   A) Consumers help plants by providing the soil with nutrients
   B) Consumers help plants live by spreading their seeds
   C) Consumers help protect plants
   D) Consumers give plants a place to live

4. How do animals rely on plants to live? Circle all that apply.

   A) Animals rely on plants for protection
   B) Animals rely on plants for energy and food
   C) Animals rely on plants for carbon dioxide
   D) Animals rely on plants for a place to live

5. What do plants need in order to make food for themselves? Circle all that apply.

   A) Oxygen
   B) Carbon dioxide
   C) Light
   D) Minerals
   E) Water
6. How do decomposers help plants live?

A) Decomposers help provide food for plants to eat
B) Decomposers help plants by breaking down dead matter and adding nutrients back to the soil
C) Decomposers help the roots of the plant stay down in the soil
D) Decomposers help plants get sunlight


A) Plants help provide food and nutrients to consumers
B) Plants help consumers live by releasing carbon dioxide
C) Plants give consumers shelter and places to live
D) Plants provide protection to consumers

8. What can people do to help plants grow? Circle all that apply.

A) Give plants lots of fruits and vegetables to eat
B) Make sure plants have plenty of sunlight
C) Plants give consumers shelter and places to live
D) Make sure plants have plenty of space to grow
9. If you made composter, what is the most important feature that it needs?

A) Light
B) Water
C) Animals
D) Decomposers
10. Label the diagram with the missing components of photosynthesis.
Lesson Plan - Effects of autumn on school garden plants

Day One - Fifth Grade Science at Raymond Elementary School

1. Explain to students that they will be going outside and making observations about plants they see outside
   a. Ask - What is an observation?
   b. Ask - What are types of things should we be looking at on the plant?
      i. Leaves, flowers, stem

2. Each student will get a clipboard and observation sheet (and everyone needs a pencil)
   a. Read over questions with students
   b. When you go outside, there will be able 4-5 people at each bed or "square of plants"
      i. Ask - "What are ways that we should be acting when we are outside?"
      ii. Ask - "How can we respect the plants we look at?"

3. Bring students outside to the garden
   a. Rotate around students as they are outside to ask them what types of things they notice about the garden and plants
   b. Ask if they are noticing any insects or bugs in the garden
      i. Check on the flowers, leaves or underneath the plant leaves near the ground
   c. Ask students if they see any weeds growing
      i. Introduce this term to them

4. Return to class, and have students discuss what they found in the garden
   a. Ask - Were the plants happy or sad? (or both?)
   b. Ask - How did they know this?

5. Next, have students answer this big essential investigable question
   a. How does the fall season affect plants in the Raymond School Garden?
      i. Write this on the board
   b. There are two ways to approach this:
      i. One is a guided discussion
         1. Ask students how they think different things are affecting plants
            a. The cold weather is causing some plants to die while others are still living
            b. All the rain may be helping some plants live while drowning other plants and causing them to die
            c. Different amounts of sunlight can be affecting plant growth
         2. Have students write their claim on the back of the paper
            a. Provide a sentence starter if students are struggling
            b. The plants in the garden look__________________.
            c. The season fall affects plants in the garden because
               ____________.
      ii. The next approach could be asking students to think about their response, and write it down
1. And then as a class, discuss their answers and use this information to assess their understanding of writing a claim and the class activity they just did
How does the season fall affect plants in the Raymond School Garden?

1. Do plants look happy (healthy) or sad (unhealthy)?

2. Draw one example of a happy (healthy) plant.

I know this plant looks happy (healthy) because….

.
3. Draw one example of a sad (unhealthy plant).

I know this plant looks sad (unhealthy) because…

___________________________________________________________________________________.
Lesson Plan 2- What types of things affect plant growth?

1. Students will be posed with the essential question, which they will be answering:
   a. What types of things affect plant growth?
      i. This question can be broken down to students as:
         1. What types of things affect how plants grow?
            a. Looking for general concepts, ideas or things that affect plant growth (this can be things that cause plants to grow or die)
            b. Students will try to list three things that affect the way plants grow.
            c. Examples of answers could be:
               i. Water
               ii. Sunlight
               iii. Air
               iv. Weather
               v. Temperature
               vi. Soil
      2. Students will be asked to predict three things that they think affect plant growth. A sentence starter that will be provided to the class is:
         a. I think __________, __________, and __________ affect the way plants grow because ________________.
            i. I think water, sunlight and air affect the way plants grow because without these things a plant would die.
   b. Students will be asked to turn and talk with a partner to discuss things that they think affect plant growth for about 2-3 minutes.
      i. After discussing with a partner, students will write down their prediction on their observation sheet.

2. Next, students will be walked through what they are going to be completing next.
   a. Students will be told they will be growing plants over the next several weeks. They will be testing different variables to see how they affect plant growth.
      i. Ask students: What is a variable?
         1. A variable is something that you test.
      ii. Tell students they will be testing the variables, sodium chloride (salt) and acetic acid (vinegar) solutions to see how they will affect plant growth. They also will be testing how light affects plant growth, and they will be growing plants both in the dark and light.
         1. Then ask students:
            a. What are different ways we can observe plant growth?
               i. We can measure plant height
               ii. We can observe how the plant looks
                  1. Count leaves
                  2. Look at leaf color
                  3. Look at overall plant color
4. Look at leaf shape
   iii. Students will each be broken up into different groups and testing different variables, which were already picked ahead of time.

b. The groups are going to be either growing sunflowers or milkweed.
   i. The group that is growing sunflowers will be planting seeds today, and the groups that are working with milkweed will be making observations about the milkweed plants because the instructor already started growing them.

c. Ask: “What are some general rules that we should follow while working with plants today to keep safe?”
   i. Don’t eat the seeds or plant
   ii. Don’t rip apart the plant
   iii. Keep the soil on the paper you are working on, and try not to spill it everywhere
      1. Soil should stay in cups, on trays on the paper and not thrown around
   iv. Students should listen to the teacher and directions given
   v. Share materials with your partner(s)
      1. Take turns and be patient
   vi. Work together
   vii. Be curious!
   viii. Rules for Scientists-
      1. Be nice
         a. Respect the people and materials we work with
         b. Be nice to the plants that we work with and be respectful in the way you treat them
         c. Treat your partner with kindness, share and take turns
      2. Be safe
         a. Be safe when we are working with materials
         b. Keep our bodies to ourselves
         c. Be kind to your partners, and work fairly with each other
         d. Use proper safety equipment
         e. Use materials appropriately
      3. Be curious
         a. Ask questions
         b. Try new things
         c. Be brave

3. Next, students will be split up into groups and should possibly rearrange seating so that they are sitting near people in their group.
   a. Group 1+2 will be testing acetic acid and water
   b. Groups 1, 2, 3, 4 pairs will be testing how acetic acid/sodium chloride affects plant growth, but they will also be growing plants with just water (in order to compare and have a control)
      i. Group 1- Growing milkweed and sunflowers with acetic acid and water
         1. Two ppl- Plant 2 sunflower seeds (1 with acetic acid and one w/o-for future)
2. Two ppl- Observe 2 milkweed plants (1 with acetic acid and one w/o- for future)
   a.
   b.

ii. Group 2- Growing milkweed and sunflowers with acetic acid and water
   1. Two ppl- Plant 2 sunflower seeds
      a.
      b.
   2. Two ppl- Observe 2 milkweed plants
      a.
      b.

c. Group 3+4 will be testing sodium chloride and water
   i. Group 3- Growing milkweed and sunflowers with sodium chloride and water
      1. Two ppl- Plant 2 sunflower seeds (1 with NaCl and 1 with water)
         a.
         b.
      2. Two ppl- Observe 2 milkweed plants (1 with NaCl and 1 with water)
         a.
         b.
   ii. Group 4-
      1. Two ppl- Plant 2 sunflower seeds
         a.
         b.
      2. Two ppl- observe 2 milkweed plants
         a.
         b.

d. Group 5+6 will be testing how light affects plant growth
   i. Group 5-
      1. Two ppl- plant 2 sunflower seeds (1 for light and 1 for dark)
         a.
         b.
      2. Two ppl- observe 2 milkweed plants (1 for light and 1 for dark)
         a.
         b.
   ii. Group 6-
      1. Two ppl- Plant 1 sunflower seed (1 for light and 1 for dark)
         a.
         b.
      2. Three ppl- Observe 2 milkweed plants (1 for light and 1 for dark)
         a.
b.

4. All of the sunflower plants will need to be kept in the dark for a week, and all milkweed plants will be left growing under the light.
   a. Students will just be watering the plants regularly this week and not adding any extra liquid variables to them this week.
5. Initial groups should be premade of what students are working in which groups. Then students should write down what variable they are testing at the top of their observation sheet, so they do not forget.
   a. Once this is completed, split this class into half and half.
      i. Half of the class will be observing milkweed plants and the other half will be planting sunflower seeds.
6. For students working with sunflower seeds:
   a. First students will take out their sunflower seed outside of their plastic bag. They will place it onto their desk and students will make observations about it. Groups will take out 2 sunflowers seeds to observe.
   b. On an anchor chart, things that students can look for in their observation will be listed and the steps to observing their sunflowers seeds and planting them will be listed.
      i. “What are things we can look for when making an observation?”
         1. Shape
         2. Color
         3. Size
         4. Texture
      ii. Students will be asked to draw a picture of their sunflower seed. They should be attempting to draw a real-life picture. They should try to make it look as close to real life as possible. They will do this on two different observations sheets for their two different seeds.
   c. Students will be informed that they will each receive a piece of butcher paper which they must keep on the desk with their partner.
   d. Next, they will use the plastic cup to fill up their pot with soil.
      i. Each table should have its own container of soil to work with.
   e. Students will be advised to try to keep their soil on their desk.
      i. Then students will be asked to use their plastic cup and fill it up with water which will be in a container on their desk.
         1. Students should wet the soil of their pot, so it is damp.
      ii. Then students will take out one sunflower seed, which will be provided on their desk on a plastic bag and they should dig about ½ inch down in the soil and then place the seed in and then cover it up with dirt.
      iii. Then students will take a piece of tape and write:
         1. Their names
         2. The name of the plant they are growing
         3. The variable they are testing
7. For students working with the milkweed:
   a. Students should be each given their milkweed plant, and they will begin to make observations about their plant. Students will be given two milkweed plants to work with.
      i. “What are things that we can observe about it?”
         1. Height
         2. Color
         3. Leaf shape
         4. Leaf size
         5. Leaf color
   b. Students will be asked to draw a picture of what the milkweed looks like and then to measure its height (in cm). Students will complete 2 observations on 2 different observation sheets.
      i. They will also record observations that they see about how the milkweed looks. They will write this on their observation sheet as well.

8. Students will then be asked to clean up all materials and place them back to where they belong.

9. Packets for students’ observations sheets will be created. Each will contain additional pages for students to work

10. Closing-
   a. Students will be asked at the end of class to share a few things that they learned about their plant or seed.
      i. What types of things did you notice about it?
         1. What does it look like? What color was it? How tall was it?
Scientist’s Name: ________________________________________________

**Observation Sheet**

**Type of Plant:** ______________________________________________

**Variable Being Tested:** ________________________________________

**Prediction:**
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

<table>
<thead>
<tr>
<th>Date</th>
<th>Plant Height (cm)</th>
<th>Observations</th>
<th>Drawing</th>
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Group Assignments

1. Acetic Acid Solutions Effects on Plant Growth
   a. Milkweed students
      i. Team 1-
         1. __________________________________
      2. __________________________________
      ii. Team 2-
          1. __________________________________
          2. __________________________________
   b. Sunflower students
      i. Team 1-
         1. __________________________________
         2. __________________________________
      ii. Team 2-
          1. __________________________________
          2. __________________________________

2. Sodium Chloride Solution Effects on Plant Growth
   a. Milkweed students
      i. Team 1-
         1. __________________________________
      2. __________________________________
      ii. Team 2-
          1. __________________________________
          2. __________________________________
   b. Sunflower students
      i. Team 1-
         1. __________________________________
         2. __________________________________
      ii. Team 2-
          1. __________________________________
          2. __________________________________
3. Light Effects on Plant Growth
   a. Milkweed students
      i. Team 1-
         1. ___________________________________________
         2. ___________________________________________
      ii. Team 2-
         1. ___________________________________________
         2. ___________________________________________
   b. Sunflower students
      i. Team 1-
         1. ___________________________________________
         2. ___________________________________________
      ii. Team 2-
         1. ___________________________________________
         2. ___________________________________________
Growing Plants

BY: MS. GATELY

ESSENTIAL QUESTION

What types of things affect plant growth?
Make a prediction!

What types of things affect plant growth?

- Try to list 3 things that you think affect plant growth.

- “I think __________, __________, and __________ affect plant growth because __________.”

Our Own Lab Experiment

Over the next few weeks, we will be growing our own plants. We will be testing different variables to see how they affect plant growth.

What is a variable?
What We Will Be Testing

Sodium Chloride Solutions  Acetic Acid Solutions  Light (Darkness versus light)

Observing Plants

What are different ways we can observe plant growth?
Plants We Are Growing

Milkweed

Sunflower (Florenza)

Rules for Scientists

Be nice

Be safe

Be curious
Be Nice

- Be kind to the people we work with and the materials we use
- Be nice to the plants that we work with and be respectful in the way you treat them
  - Don’t rip apart plants
- Treat your partner with kindness, share and take turns
- Work together.

Be Safe

- Be safe when we are working with materials
  - Do not eat seeds or plants we work with
  - Keep our bodies to ourselves
  - Be kind to your partners, and work fairly with each other
  - Use materials appropriately
    - Keep soil on the paper you are working on.
    - Soil should stay in cups or in pots
Be Curious

---

- Ask questions
- Try new things
- Be brave
Lesson Plan 3- How does light affect plant growth?

BSU Elementary & Early Childhood Education Department
Science Lesson Plan Template
created May 2018
Modified from MA DESE Model Curriculum Unit Lesson Plan Template
http://www.doe.mass.edu/candi/model/default.html
http://www.doe.mass.edu/candi/model/MCUtemplate.pdf

Teacher Name(s): Kelly Gately

Which Essential Question(s) does this lesson help to address?
(For science, state your how/what/which/where inquiry question that guides this lesson.)

How does light affect plant growth?

Lesson Topic: (For science, write the “Students will learn that...” goal.)
This topic is beginning to lay the groundwork for students to understand this goal:
1. Students will understand that plants use energy and light from the sun to undergo photosynthesis.
2. Students will understand that plants need light to grow fully.

Lesson Duration: (date and time)

October 25, 2018
1:05-2:15pm

Standard(s) to be addressed in this lesson: (For science, include the number and write out the full performance expectation.)

5-LS1-1. Ask testable questions about the process by which plants use air, water, and energy from sunlight to produce sugars and plant materials needed for growth and reproduction.
State Assessment Boundary:
• The chemical formula or molecular details about the process of photosynthesis are not expected in state assessment.

Learning Outcomes: (For example, “Given [materials], students will be able to [specific task] [measurable criteria].” This should be about your formative assessment at the end of the lesson.)
1. Students will be able to identify that plants need light to grow, and plants use light and energy from the sun to undergo photosynthesis.
2. Students will learn that photosynthesis is a unique process to plants and it helps support all life on Earth.
**Language Outcomes:** *(You will learn this in SEI class during student teaching. Leave blank during the Block.)*

1. Anything highlighted pink in the lesson plans means that I was not able to get to this section of my lesson while teaching.

*Note: Type in the white spaces. The gray spaces are the directions for what to include.*

**Assessments:** *(include all that are relevant for this lesson; formal and informal)*

| Pre-Assessment:  
*Happens in the engage to probe students’ ideas; e.g. predictions, brainstorming, graphic organizers, etc. You will not have a learning outcome for this.* | Formative Assessment:  
*What is the task students will do at the end of your lesson to show you they learned the science content and/or can accomplish the practice(s) in the standard? This should be a product you can collect as evidence of students’ mastery of the learning outcome. This is what the learning outcome is about.* | Summative Assessment:  
*This will only be in the last lesson of your unit. It should expect students to show their learning for the whole unit. This is what the learning outcome is about in your last lesson.* |
<table>
<thead>
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<tbody>
<tr>
<td>Students will be asked to turn and talk with a partner about the question “Do you think sunlight is important for plant growth? Why or why not?” As a class on chart paper, we will brainstorm whether they think sunlight is important for plant growth, and why or why not. I will write reasons under why or why not they think this, and I will inform students that today we will be investigating the role of sunlight in plant growth.</td>
<td>At the end of this lesson, students will fill out observations in their science journals and they will fill out a prediction worksheet. Students will make predictions about the effect they think light plays on plants. They will fill out an exit ticket before they leave about one thing that they learned.</td>
<td></td>
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</tbody>
</table>
Differentiation:

<table>
<thead>
<tr>
<th>Accommodations (from 504 Plans/IEPs)</th>
<th>Modifications for English Learners</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Students will be working with partners in groups, and on their observation sheet, they are provided with sentence starters. We also will be having lots of group discussions to go over answers and what they found. When we are developing a claim, the class will form one together and I will write it up on the board for everyone to see.</td>
</tr>
</tbody>
</table>
### Targeted Academic Language:

| Teacher Content Knowledge: Detailed science information to help you teach this lesson. Include additional relevant terms with grade-level appropriate definitions that may come up during the lesson but that you are not planning on explicitly teaching. |
| Lesson Vocabulary with Grade-Level Appropriate Definitions: Only include those words you are explicitly teaching during this lesson, or that you taught in a previous lesson and students are using and practicing again. |

Teachers need to understand the process of photosynthesis and how sunlight affects plant growth.

**Photosynthesis**-
- Plants actually make food for themselves using carbon dioxide, water and sunlight to form oxygen and glucose. This process is known as photosynthesis. Plants are also known as autotrophs because they use light to create food for themselves. Some people mistakenly think they are feeding plants when they pot it and water it, but this is completely false. The entire process of photosynthesis is the transfer of energy from the Sun to the plant. Other animals and organisms cannot make their own food, and they eat plants, so they indirectly rely on photosynthesis too.

**Sunlight**-
- Sunlight is needed for plants to grow and develop. It is needed to undergo photosynthesis and without sunlight, plants would not be able to get energy or grow, develop and reproduce.
- Seeds can grow initially without sunlight because they have nutrient reserves they can tap into. As soon as this runs out, their growth and development will be hindered, and they’ll die.

- **Photosynthesis** - The process by which plants and some other organisms make food
- **Light** - Energy and sunlight given off by the sun (or a lamp) that plants need to grow
**Scientist:** What type of scientist studies this topic? What does this type of scientist do?

Botanists study plants and work with this topic in science. They study plants, what they look like and what affects their growth. They study plants and try to see how they can be used in different ways, such as for medicine, clothing or food.

**What should students know and be able to do prior to starting this lesson?**

**Student Background Knowledge:** List the common misconceptions students may have for this concept. Describe the accurate concept that correlates. Be sure these ideas are described above in Teacher Content Knowledge. Also, take a look at your assessment data.

| Misconception: Plants cannot grow without light. Plants need humans to give them food and light in order to grow. | Accurate Conception: Plants get energy from the sun, and they produce their own food. Plants use light from the sun to go through photosynthesis which helps them to produce food and become a green color. Plants can actually grow for a little bit without sunlight by using nutrients in the soil and that they have stored up. Once these nutrients run out, then the plant will begin to die. Plants need water, light and air to live, but plants do not need humans to give this to them if they are growing outside. They get water from rain, they get light from the sun and they get nutrients from the soil. |
Based on the placement of your lesson in your unit, what should students come to your lesson already knowing?

Students should know that plants need sunlight to grow and live. They may not understand though that plants can grow for a little while without sunlight. Students may have a basic understanding of photosynthesis and that plants use sunlight to go through this process.

Based on formative assessment data from your previous lesson (or pre-assessment data if this lesson is first), what gaps in student knowledge can you identify?

For misconceptions that correlate to this topic, students had misconceptions about what plants need to grow because many students could not identify that plants need water, light and air. Some of these students did not circle that plants need sunlight to grow, so this may be problematic. Students also struggled with identifying what plants need to undergo photosynthesis and what they need to make food for themselves. They may struggle with understanding that light is needed for photosynthesis.

**Instructional Items:** *(explain in detail; attach extra items to the end of your lesson plan)*

<table>
<thead>
<tr>
<th><strong>Materials for Students and Teacher</strong></th>
<th><strong>Resources (such as texts, videos, websites, etc.)</strong></th>
<th><strong>Tools (such as anchor charts, scientific or mathematical equipment, etc.)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Projector</td>
<td>Projector</td>
<td>12 rulers</td>
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<tr>
<td>26 Science Journals</td>
<td>2 Videos</td>
<td>3 pieces of anchor chart paper</td>
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<td>26 exit tickets</td>
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<td>Milkweed and sunflower plants for each group</td>
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<td>27 observation papers</td>
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<td>26 pencils</td>
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Lesson Delivery

This is specific to the content area you are teaching, including an explanation of:

- Differentiation Strategies (highlight these in your steps below)
- Safe Learning Environment (include examples in your steps below)
- Step-by-Step Procedures (be specific below)

Lesson Opening:

**Engage:** How will you get students excited? How will you find out what they know about the current lesson? How will you review from previous lessons?

To engage students:
First, students will come in, and I will have them watch this video about what plants need to live.

https://www.youtube.com/watch?v=_RXVhiUnTA8

Students will be asked to turn and talk with a partner about the question “Do you think sunlight is important for plant growth? Why or why not?”

As a class on chart paper, we will brainstorm whether they think sunlight is important for plant growth, and why or why not. I will write reasons under why or why not they think this, and I will inform students that today we will be investigating the role of sunlight in plant growth.

**Essential/Inquiry Question:** What is your how/what/which/where inquiry question to guide this lesson? Include the steps for how you will communicate this to your students. Include scaffolds for making predictions, if relevant.

How does light affect the way plants grow?

1. After reviewing with students what plants need to grow, I will present them with the same question I did last class. We will be investigating how light affects the way plants grow.

2. Students will watch the video in the lesson opening and we will discuss what how they think light affects plant growth.

3. Students will then get into groups and observe their plants, and they will get together with partners to examine the differences between plants grown in the light and dark. Students growing sunflowers still need more time to wait for their seed to start growing since they were just planted. This will explained to students, and students who are growing sunflower seeds will actually be given a diagram of a spinach seed to look at and observe instead.

4. Through scaffolding, students will make a claim at the end of the lesson about how they think light affects the way plants grow.
During the Lesson: (A science lesson will usually have the explore/explain OR elaborate, not all.)

**Explore:** Write step-by-step directions for you and your students to conduct the explore. Include rules/safety reminders, transitions, grouping, material distribution, and how you will model what students will do.
1. Students will get into groups after they work together in partners and after we go through their chart paper.

2. Students will have one partner to go up and grab their two plants, and I will call students to come up and get their plants.
   1. This will be done by looking at students’ plants and calling of what names are listed on the label.

3. Students will work with their partners to make observations about their plant and its growth so far. Students working with milkweed will need measure its height, so each pair will need to receive a ruler.

4. They will need to measure milkweed or sunflower height (if they have begun to grow), and make observations about its color, numbers of petals, shape or stature. Students will also need to draw a picture of their plants.

5. Next, students who have sunflowers seeds need to be told the following:
   1. So, our sunflower seeds in class still need more time to grow. These seeds are taking a while to sprout or open up. We cannot use these seeds for our activity today. Instead, I am going to give our sunflower groups a piece of paper with pictures of spinach seeds. I want you to look over this piece of paper and talk about what you see happening with your partner.
      1. Go around and check to make sure that students understand that the spinach seed is being growing without light, and a tiny yellow, short seedling has sprouted within a week.

6. Students after working with their partner, will need to get together with another group. Students with milkweed will need to be paired with a sunflower group and vice versa. There should be about 6 groups of 4.
   1. In these groups, students will work together to make observations about each other’s plants. The sunflower groups will look at and observe the milkweed, and the milkweed groups will look at and observe the spinach seed diagram. Milkweed students can report to the sunflower pairs what they found, and sunflower students can report what they found about their plants.
   2. Students will be given about 2-3 minutes to make observations about each other’s plants before they all redirected back up at me.

7. Next, students will start to fill out the following worksheet questions.
   1. While working in groups, students will be directed to fill out the following two questions together. They will be encouraged to work together and discuss an answer.
      1. “When a plant had no sunlight, it looked like ___________________."
      2. “When a plant had sunlight, it looked like ___________________."
   2. Students will fill out what they observe about their plants when looking at them

8. Next, students will be asked to refocus, and then they will move on to answer the questions about scenarios.
   1. “I decided to grow a plant at home. I want to grow my plant in my dark cabinet where it will receive no light. What will my plant look like?”
   2. “I decided to grow a plant at home. I want to grow my plant near a sunny window where it will receive plenty of light. What will my plant look like?”

9. Students will be given 5 minutes to work through these problems, write their answers, and then they will be asked to share out when they are all done.
10. Next, students will put away their plants and head back to their seats. I will call up
groups 1 at a time to carry up their plants.
Explain: Include a detailed student and teacher explain, with scaffolds to help your learners develop a claim, evidence, and reasoning. Include the anticipated claim, evidence, and reasoning for the inquiry question. Connect your explanation to the explore and to other resources (books, videos, etc.).
1. The next section of this experiment will lead into a discussion about how students think sunlight affects plant growth.
2. Students will be asked to turn and talk to a partner about how they think light affects plant growth.
3. After 2-3 minutes, students will be asked to share out.
   1. I will advise students that no answers are right or wrong and I want to hear all of their ideas.
4. I will scaffold students through a series of questions so that we can develop a claim together as a class.
   1. “What did we observe when we looked at the spinach seeds in the dark? What did we see growing?”
      1. “We saw a yellow little stem starting to come out of the soil and start growing”
   2. “What did we observe when we looked at the milkweeds in the light? Did anyone’s milkweed change in height?”
      1. “Yes, maybe slightly”
   3. “What does it mean if we see an increase in height in a plant?”
      1. “It means its growing.”
   4. “So to me, it seems like we saw an increase in height in both the milkweed and spinach plants.” “What does this mean about the spinach plant? What has it been doing in the dark?”
      1. Growing
   5. “What does this mean if the spinach plant grew in the dark? Does this prove or disprove that a plant needs light to grow?”
      1. “It means that a plant can grow without light.”
   6. “How do you think the seed was able to grow even though it was not receiving any light?”
      1. Look for volunteers and various answers. Eventually steer students in the direction that seeds have nutrients packaged up that they can use to grow. They use energy from these nutrients packaged up to help grow.
   7. “What do you think happens though when the seed uses up all of its nutrients in the seed?”
      1. It will stop growing.
   8. So, we can conclude that plants initially can grow without sunlight, but once they run out of that stored energy, they will stop growing. This means that plants need sunlight to grow and develop fully.
   9. “How were the color of milkweed and the spinach plant different?”
      1. Milkweed is green
      2. The spinach was white/yellowish
   10. “Why do you think they were a different color?”
   11. “What makes a plant green?”
      1. Photosynthesis. Light is needed to undergo photosynthesis. Without light, the plant cannot undergo photosynthesis, which means that it will not be green.
      1. “Do you think the plants in the dark are undergoing photosynthesis? Why or why not?”
1. No, they are not because they are not green!

12. How do you think our sunflower seeds will be affected by the light then? Think about what we just talked about happened to the spinach plants.

1. Our sunflower plants will start growing initially in the dark, but they will be short and yellow.

5. We are going to watch a short video on the process of photosynthesis and how plants use light to grow.

1. https://www.youtube.com/watch?v=lln136cML4g

6. Together as class, I need help developing claim for our question “How does light affect plant growth?”

1. Light is not needed for the start of plant growth, but for a plant to grow fully it needs light. Plants need light because they use it during photosynthesis to make food for themselves. Plants use food to create energy so that they can grow.

2. Students will fill out their claim in the science journal. I will aim to have students write at least the first two sentences.
**Elaborate:** *This may include an inquiry question, investigation, and/or CER framework, or be another type of creative project or real-world situation. An elaborate is usually an entire lesson in itself, and after the Lesson Opening above should be explained entirely here.*

**Lesson Closing:** *(When and how will students do your end-of-lesson formative assessment? After this is finished, how will you conceptually wrap-up the lesson? Link this to your standard and goal. Preview for the next lesson, if relevant.)*

Before students go, they will turn and talk with a partner about how they think light affects plant growth. Students will complete an exit that measures whether they understand light and its role in photosynthesis and plant growth. Then they will be free to pack up and get ready for the end of the day.

**List of Lesson and Content Knowledge Resources: (use APA citation style)**


What do plants need to survive? (2018, March 02). Retrieved from
https://www.youtube.com/watch?v=_RXVhiUnTA8

https://ssec.si.edu/stemvisions-blog/what-photosynthesis
How does light affect plant growth?

1. Use two describing words to explain the following events.

When a plant had no sunlight, it looked ____________________________

and ____________________________.

When a plant had sunlight, it looked ____________________________ and

______________________________.

2. Describe what would happen in the following situations.

**Situation A:** Ms. Gately decided that she wanted to grow a plant at home. She put her plant in a completely dark cabinet where it receives no sunlight. Describe what her plant would look like.

Ms. Gately’s plant will look:

________________________________________________________________________
________________________________________________________________________

**Situation B:** Ms. Gately decided that she wanted to grow a different plant at home. She puts it near a window where it receives plenty of sunlight. Describe what her plant will look like.

Ms. Gately’s plant will look:

________________________________________________________________________
________________________________________________________________________
3. **Make a claim.**

**Question:** How does light affect plants growth?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Name: ___________________________ Date: ______________________

Circle the best answer:

1. What process do plants use light for?

   - Photosynthesis
   - Energy transfer
   - Reproduction

2. Can plants grow **fully** without light?

   - Yes
   - No
A spinach plant was planted and grown in this tray for one week **WITHOUT LIGHT**. It was grown in the dark for one week in a cabinet.

This is what the spinach **seed** looked like **before** being planted.

This is what the pot of spinach **looked** like on **Day 1** **WITHOUT SUNLIGHT**.

This is what the spinach **looked** like on **Day 7** **WITHOUT SUNLIGHT**.
How does light affect plant growth?

By: Ms. Gately

Watch this video.

- [https://www.youtube.com/watch?v=_RXVhiUnTA8](https://www.youtube.com/watch?v=_RXVhiUnTA8)
Do you think sunlight is important for plant growth? Why or why not?

- Turn and talk with a partner
- Share what you think.

Make observations about our plants.

---

- Grab your plants (sunflower or milkweed).
- Get together in your groups.
- Make observations about your plant!
  - Don’t forget to measure its height.
Then work with another group!

- Get together with another group. Milkweed and sunflower groups will get together.
- Look at each other’s plants, and talk about what you see. Milkweed plants will be looking at the spinach plants. Sunflowers look at the milkweed plants.

Next, work together to answer the following questions!

- Work together with your group to answer the following question:
  - When a plant had no sunlight, it looked __________________ and __________________.
  - When a plant had sunlight, it looked __________________ and __________________.
Next, work together through the next scenario!

---

- Next work together in your groups to answer the following question:
  - “Ms. Gately decided to grow a plant at home. She wants to grow her plants in my dark cabinet where it will receive no light. What will her plant look like?”
  - “Ms. Gately decided to grow a plant at home. She wants to grow my plant near a sunny window where it will receive plenty of light. What will her plant look like?”

---

Clean up!

---

- Next,
  - Clean up, put your plants back, and sit back at your normal seat.
Next, we will be working to answer:
How does light affect plant growth?

- What did we observe when we looked
  at the spinach in the dark? What
did we see growing?

- What did we observe when we looked
  at the milkweeds in the light? Did
anyone’s milkweed change in
height?

Next, we will be working to answer:
How does light affect plant growth?

- What does it mean if we see an
  increase in height in a plant?

- We saw an increase in height in
  both the milkweed and spinach
plants. What does this mean about
the spinach plant? What has it
been doing in the dark? ****
Next, we will be working to answer:
How does light affect plant growth?

- How do you think the seed was able to grow even though it was not receiving any light?***
Next, we will be working to answer:
How does light affect plant growth?

- Why do you think they were a different color?

- What makes a plant green?***

- Do you think the spinach plants in the dark are undergoing photosynthesis? Why or why not? ****
Next we will watch this video.

https://www.youtube.com/watch?v=lln136eMI4g
Lesson 4: How does your variable (sodium chloride, acetic acid or light) affect plant growth?

BSU Elementary & Early Childhood Education Department
Science Lesson Plan Template
created May 2018
Modified from MA DESE Model Curriculum Unit Lesson Plan Template
http://www.doe.mass.edu/candi/model/default.html
http://www.doe.mass.edu/candi/model/MCUtemplate.pdf

Teacher Name(s): Kelly Gately

Which Essential Question(s) does this lesson help to address?
(For science, state your how/what/which/where inquiry question that guides this lesson.)

What types of things affect plant growth?
How does your variable (sodium chloride solution, acetic acid solution or light) affect plant growth?

Lesson Topic: (For science, write the “Students will learn that…” goal.)
This topic is beginning to lay the groundwork for students to understand this goal:
1. Students will learn that different types of things affect plant growth, such as that sodium chloride solution, acetic acid solution and darkness may have an effect on plant growth. This conclusion will be reached by having students observe the pH level differences between their solutions and water.

Lesson Duration: (date and time)

November 8, 2018
1:05-2:15pm

Standard(s) to be addressed in this lesson: (For science, include the number and write out the full performance expectation.)

5-LS1-1. Ask testable questions about the process by which plants use air, water, and energy from sunlight to produce sugars and plant materials needed for growth and reproduction. State Assessment Boundary:
• The chemical formula or molecular details about the process of photosynthesis are not expected in state assessment.

Learning Outcomes: (For example, “Given [materials], students will be able to [specific task] [measurable criteria].” This should be about your formative assessment at the end of the lesson.)
1. Students will be able to identify different types of things are needed for plant growth.
2. Students will identify different types of things affect plant growth (such as chemicals or light).
**Language Outcomes:** (You will learn this in SEI class during student teaching. Leave blank during the Block.)

1.

*Note: Type in the white spaces. The gray spaces are the directions for what to include.

**Assessments:** (include all that are relevant for this lesson; formal and informal)

<table>
<thead>
<tr>
<th>Pre-Assessment:</th>
<th>Formative Assessment:</th>
<th>Summative Assessment:</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Happens in the engage to probe students’ ideas; e.g. predictions, brainstorming, graphic organizers, etc. You will not have a learning outcome for this.</em></td>
<td><em>What is the task students will do at the end of your lesson to show you they learned the science content and/or can accomplish the practice(s) in the standard? This should be a product you can collect as evidence of students’ mastery of the learning outcome. This is what the learning outcome is about.</em></td>
<td><em>This will only be in the last lesson of your unit. It should expect students to show their learning for the whole unit. This is what the learning outcome is about in your last lesson.</em></td>
</tr>
</tbody>
</table>

Students will be given a sticky note and they will write down 1-2 things that they think plants need to survive. Working as a class, we will work together to put these ideas underneath broad categories so that we can identify five basic things plants need: water, air, sunlight, nutrients and space. If students list things such fertilizer or chemicals, we can place this in another category or things we aren’t sure about. This will be a concept we revisit as we examine our plants growing over time.

At the end of this lesson, students will fill out observations in their science journals and they will fill out a prediction worksheet (for them to make predictions about their plant and variable). On this sheet, it will also ask students to list the things that plants absolutely need to live. Students will also be filling out an exit ticket where they will be filling out one thing that they think affects plant growth.

**Differentiation:**

<table>
<thead>
<tr>
<th>Accommodations (from 504 Plans/IEPs)</th>
<th>Modifications for English Learners</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Students will have opportunities to turn and talk, and they are working with partners, so they have support from other students.</td>
</tr>
</tbody>
</table>
They are also provided with several sentences on their worksheets to help them start to think about how they want to form their sentences. Students will also be given a pH chart with a chart drawn so they can visually see how pH levels are neutral, high or low.

Targeted Academic Language:

<table>
<thead>
<tr>
<th>Teacher Content Knowledge: Detailed science information to help you teach this lesson. Include additional relevant terms with grade-level appropriate definitions that may come up during the lesson but that you are not planning on explicitly teaching.</th>
<th>Lesson Vocabulary with Grade-Level Appropriate Definitions: Only include those words you are explicitly teaching during this lesson, or that you taught in a previous lesson and students are using and practicing again.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers need to be aware that plants absolutely need water, air, sunlight, nutrients and space to live. Plants would like to have fertilizer or additional nutrients, but these are things that they don’t absolutely need. These are important differences to understand. Teachers need to be aware that acetic acid solutions are vinegar and water mixed together, and that sodium chloride solutions are salt and water mixed together. Teachers should be aware of how to use pH strips, and how to instruct students to use them. pH measures the total potential hydrogen in a solution. Teachers need to be aware that water has a pH of 7, so this is very neutral or “normal.” Acetic acid or vinegar is very acidic, usually measures around 2.5. Since it is diluted, it will be a bit higher. Salt is neither an acid or a base, but its pH is right above 7. This may vary if it is diluted, so the pH may be near the pH of water. This will be interesting and fun to investigate with students if this occurs. Teachers should be aware of what a graduated cylinder is, and how to measure liquids in it. Teachers should be able to understand and explain what a control variable is an experiment and what dependent and independent variables are. <strong>Control variable</strong>- A control variable is the one element that is not changed throughout an experiment, because its unchanging state allows</td>
<td><strong>Sodium chloride solution</strong>- A solution that is salt mixed with water. <strong>Acetic acid solution</strong>- A solution that is vinegar and water mixed together. <strong>Acid</strong>- A solution with a low pH. <strong>Graduated cylinder</strong>- A container you use to measure liquids in <strong>Control variable</strong>- Something that is not changed in the experiment. We do not add sodium chloride or acetic acid solutions or grow it in darkness. We want this to grow in “normal” plant conditions so that we use this data to compare it to the plants that are not growing in normal situations.</td>
</tr>
</tbody>
</table>
the relationship between the other variables being tested to be better understood.

**Dependent variable** - What you measure in an experiment and what is being affected

**Independent variable** - The variable that is changed or controlled in a scientific experiment

<table>
<thead>
<tr>
<th>Scientist: What type of scientist studies this topic? What does this type of scientist do?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botanists study plants and work with this topic in science. They study plants, what they look like and what affects their growth. They study plants and try to see how they can be used in different ways, such as for medicine, clothing or food.</td>
</tr>
</tbody>
</table>

**What should students know and be able to do prior to starting this lesson?**

<table>
<thead>
<tr>
<th>Student Background Knowledge: List the common misconceptions students may have for this concept. Describe the accurate concept that correlates. Be sure these ideas are described above in Teacher Content Knowledge. Also, take a look at your assessment data.</th>
</tr>
</thead>
</table>
| **Misconception:**  
Fertilizer provides plants with food or energy.  
Plants are not alive.  
Plants need things provided by people (water, nutrients, light)  

**Accurate Conception:**  
Plants get energy from the sun, and they produce their own food. Fertilizer is not needed to grow, although plants like to have it because it provides additional nutrients.  
Plants are living organisms.  
Plants need water, light and air to live, but plants do not need humans to give this to them if they are growing outside. They get water from rain, they get light from the sun and they get nutrients from the soil. |

**Based on the placement of your lesson in your unit, what should students come to your lesson already knowing?**

Students should already know that plants are alive because we just went over what dead and alive plants look like. Students may still be confused about what exactly qualifies plants as dead and alive however.

**Based on formative assessment data from your previous lesson (or pre-assessment data if this lesson is first), what gaps in student knowledge can you identify?**

For misconceptions that correlate to this topic, students had misconceptions about what plants need to grow because many students could not identify that plants need water and light and air. Some of them could only identify a few of these components. Students also thought that fertilizer was needed for plants to grow.
**Instructional Items:** *(explain in detail; attach extra items to the end of your lesson plan)*

<table>
<thead>
<tr>
<th>Materials for Students and Teacher</th>
<th>Resources <em>(such as texts, videos, websites, etc.)</em></th>
<th>Tools <em>(such as anchor charts, scientific or mathematical equipment, etc.)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>26 sticky notes</td>
<td>Projector</td>
<td>15 pH strips</td>
</tr>
<tr>
<td>26 pencils</td>
<td>Screen</td>
<td>2 Anchor charts</td>
</tr>
<tr>
<td>1 Whiteboard marker</td>
<td></td>
<td>12 graduated cylinders (size unknown)</td>
</tr>
<tr>
<td>Projector</td>
<td></td>
<td>12 graduated cylinders (10 mL)</td>
</tr>
<tr>
<td>26 Science Journals</td>
<td></td>
<td>2 large containers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 rulers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 stirring rods</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 pH strip measurement scales</td>
</tr>
</tbody>
</table>

**Lesson Delivery**

*This is specific to the content area you are teaching, including an explanation of:*

- **Differentiation Strategies** *(highlight these in your steps below)*
- **Safe Learning Environment** *(include examples in your steps below)*
- **Step-by-Step Procedures** *(be specific below)*

**Lesson Opening:**

**Engage:** *How will you get students excited? How will you find out what they know about the current lesson? How will you review from previous lessons?*

To engage students:

First, I will start by reviewing what we learned so far. I will ask students what they remember from last class so that they can begin to recall from over time. Some brief points to review are that the we have learned:

- Light is not needed for initial growth, but it is important for a plant to grow fully.
  - Light is used in photosynthesis.
  - Light is needed for plants so that they can make food.
- Different variables affect the way plants grow.
  - Temperature, chemicals, weather, light, space, water, etc.
- The weather fall affects plants
  - Causes some plants to start to die but not all plants
    - Still investigating, why?

Students will be asked to:

"**Write down one thing plants need to grow.**"

On a sticky note: I will have students write one things plants need to live.

Then on the whiteboard, we will create general categories of what plants need to live and have students put their sticky note underneath here. Things plants to need to live are **space, soil, air, light, nutrients and water.**

To reach this conclusion, I will start by asking two student volunteers to share their sticky note. I will take each of their sticky notes and read them aloud. I will ask students what are the same and different about these two sticky notes. Then I will place these sticky notes on two different places on the board. I will then see who has something that they think could be in a different category, and I will read it aloud. Together we will decide on a category and make a
new spot on the board for it. I will then ask if anyone else has a new category that we could
add, and we will keep going till we do not have any more categories left.
If someone lists fertilizer, then we will go over some things plants would like to live but do
not absolutely need, such as fertilizer.

**Essential/Inquiry Question:** What is your how/what/which/where inquiry question to guide
this lesson? Include the steps for how you will communicate this to your students. Include
scaffolds for making predictions, if relevant.

What types of things affect plant growth?
1. After reviewing with students what things plants need to grow, I will present them with
the same question I did last class. We will be investigating what types of things affect
plant growth.

How does your variable (sodium chloride solution, acetic acid solution or light) affect plant
growth?
2. Students will be examining how to make their solutions (whether it be water, sodium
chloride or acetic acid), and they will look at how much salt and vinegar are being mixed with
water. They will measure pH levels of these solutions and compare them to water. Students
will also observe a diagram about the sun’s light and energy and its relationship to the Earth.
Students will use this information to make a prediction about how they think their variable
will affect plant growth.

**During the Lesson:** (A science lesson will usually have the explore/explain OR elaborate, not
all.)

**Explore:** Write step-by-step directions for you and your students to conduct the explore.
Include rules/safety reminders, transitions, grouping, material distribution, and how you will
model what students will do.

- First, students will be in a group with their partners they are working with.
- Then students will make observations about their two plants they started growing last
week. Students will make observations about their sunflowers and milkweed plants.
Hopefully the sunflowers have started to sprout. Students will be able to draw what
their plant looks like, make observations about what the color, shape and structure of it
are. They will also be measuring plant height.
- During this time period, students will be instructed that one plant is going to be grown
with water or in light. The other will be watered with sodium chloride or acetic acid
solution.
- Then, students will be able to make their solutions. Each pair of students will be
making a solution, and then they will pour it into one big jar at the end. Each pair of
students needs a beaker. For students growing plants in light and dark, they will use a
cup to fill up with water, and they will measure out 50 mL of water in their graduated
cylinder.
- Then, for students making acetic acid and sodium chloride solutions, they will have
salt and vinegar already measured out. Students will receive containers full of salt or a
container filled with vinegar already measured out. Then pairs will work together to
measure out their graduated cylinder with 50 mL of water, and then they will pour their
water into their container with salt or vinegar. They will then close their jar and shake
it to mix it. They will need to do this three more times.
Students then will each be receiving a pH strip so that they can measure the pH of their solutions. I will model how to use the pH strip by placing it in the water for a few seconds, and then pull it out and place it next to their pH scale and see what color it best matches. Whatever color it best matches indicates its pH number, so they look up to see what their pH level is. They will record what the pH of their solutions are on a worksheet provided to them.

Students will be asked to write down the pH of the solution on their prediction sheets. Students will then write their initials on top of their solutions with a marker (need enough markers for this), and then they will put each solution in their tray. After completing this, their trays will be stored somewhere in their class. Safety note—Vinegar solutions need to be kept underneath somewhere near a base cabinet.

Students will then clean up their supplies and place their plants in the correct location needed.

**Explain:** Include a detailed student and teacher explain, with scaffolds to help your learners develop a claim, evidence, and reasoning. Include the anticipated claim, evidence, and reasoning for the inquiry question. Connect your explanation to the explore and to other resources (books, videos, etc.).

**Students will be sitting with their partners, and they will work together to answer this question.**

“How do you think different types of water affect plant growth?”

I will be writing on an anchor chart their different pH levels and we will talk about the scale of pH. I will explain that 7 is a neutral or normal pH level, and that is what water is.

I will then ask students what the pH level of their solutions were and I will write them on the chart paper. We will notice that the pH level of the acetic acid is a lot lower than the pH of water, and this type of solution is called an acid. We will then notice that the pH of salt is slightly higher than that of water. Introduce this as a base; if it's not clear on the pH strip that it is different, then just teach them that the salt does not change the water enough to notice it on paper, but salt adds a new element to water. This makes the solution different from “pure” water or water that we found from the water bottles. Then continue on with the next question.

Students will turn and talk with a partner and be asked to think about how this different pH level will affect their plant’s growth. For students working with water, they discuss how having water with a normal pH would affect their plant’s growth.

They will be asked to write a prediction about how they think their variable will affect their plant’s growth, and then to write another prediction about how they think the water will affect their plant’s growth. Students will be able to turn and talk with their partners about their prediction, and then they will write it down on their worksheet provided.

**Coming together**

- Have students share what they thought (ask for 2 volunteers from each group).
- Next, have students think about why water is important.
  - Prompt students to think about why water is important in growth. If students say it helps plants live, ask how it helps plants live.
  - If students having a lot of trouble, ask how water relates to photosynthesis
Water is needed for photosynthesis because plants use water to make food for themselves. Food gives plants energy which they use to grow, develop and reproduce.

**Elaborate:** This may include an inquiry question, investigation, and/or CER framework, or be another type of creative project or real-world situation. An elaborate is usually an entire lesson in itself, and after the Lesson Opening above should be explained entirely here.

**Lesson Closing:** (When and how will students do your end-of-lesson formative assessment? After this is finished, how will you conceptually wrap-up the lesson? Link this to your standard and goal. Preview for the next lesson, if relevant.)

To wrap up the lesson, I will have students share some of their predictions. At the end of the lesson, students will be given an exit ticket that asks them to answer a multiple-choice question. This question will be from my pre-assessment survey.

**List of Lesson and Content Knowledge Resources:** (use APA citation style)
pH Levels

The pH level of sodium chloride (salt) solution is ________________.

The pH level of acetic acid (vinegar) solution is ________________.

The pH level of water is ________________.
Name: _______________________________ Date: ____________________

**Prediction:**

**Control:**

I think that *water* will affect plant growth by....

_____________________________________________________________________

_____________________________________________________________________

**What You are Testing**

I think that the *sodium chloride (salt) solution* will affect plant growth by....

_____________________________________________________________________

_____________________________________________________________________

Name:__________________________________________ Date:_________________

**Prediction:**

**Control:**

I think that **water** will affect plant growth by….

__________________________________________________________________________

__________________________________________________________________________.

**What You are Testing**

I think that **acetic acid (vinegar) solution** will affect plant growth by….

__________________________________________________________________________

__________________________________________________________________________
Prediction:

I think that **water** will affect plant growth by....

______________________________________

______________________________________
Name:_____________________________

**pH Levels**

The pH level of *sodium chloride (salt) solution* is _______________________.

The pH level of *acetic acid (vinegar) solution* is _______________________.

The pH level of water is _______________________.
Prediction:

Control:

1. I think that water will affect plant growth by….

Helping the plant grow and live .

Making the plant die

What You are Testing

2. I think that the sodium chloride (salt) solution will affect plant growth by….

Helping the plant grow and live .

Making the plant die
Prediction:

Control:

1. I think that **water** will affect plant growth by…

   or

   Helping the plant grow and live . Making the plant die

What You are Testing

2. I think that **acetic acid (vinegar) solution** will affect plant growth by…

   or

   Helping the plant grow and live . Making the plant die
Name:__________________________________________ Date:_________________

Prediction:

I think that water will affect plant growth by….  

<table>
<thead>
<tr>
<th>Helping the plant grow and live</th>
<th>Making the plant die</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.jpg" alt="Green plant" /></td>
<td><img src="image2.jpg" alt="Dead plant" /></td>
</tr>
</tbody>
</table>

or
Exit Ticket

1. What do plants need to live? **Circle all that apply.**

Water  Air  Sunlight

Vinegar  Fertilizer
2. What do plants need in order to make food for themselves? **Circle all that apply.**

- Oxygen
- Carbon dioxide
- Sunlight
- Minerals
- Water
Exit Ticket

1. What do plants need to live? **Circle all that apply.**

   A) Water  
   B) Sunlight  
   C) Air  
   D) Vinegar  
   E) Fertilizer

2. What do plants need in order to make food for themselves? **Circle all that apply.**

   a) Oxygen  
   b) Carbon dioxide  
   c) Light  
   d) Minerals  
   e) Water
Lesson Plan 5 - How can we group organisms together based on similarities?

BSU Elementary & Early Childhood Education Department
Science Lesson Plan Template
created May 2018
Modified from MA DESE Model Curriculum Unit Lesson Plan Template
http://www.doe.mass.edu/candi/model/default.html
http://www.doe.mass.edu/candi/model/MCUtemplate.pdf

Teacher Name(s):
Kelly Gately

Which Essential Question(s) does this lesson help to address?
(For science, state your how/what/which/where inquiry question that guides this lesson.)
How can we group organisms together?
What are similarities and differences between different organisms?

Lesson Topic: (For science, write the “Students will learn that...” goal.)
1. Students will learn that there are functional relationships between consumers, producers and decomposers.
   a. Students will learn that there are relationships with the transfer of matter between consumers, producers and decomposers.
2. Students will learn that there is a production and transfer of matter and energy from the sun to producers then to consumers and then to decomposers.
3. Students will learn that there are different ways to group and classify organisms together based on similarities (between the ways that they obtain energy).

Lesson Duration: (date and time)
Tuesday, November 12, 2018
1:05-2:15pm

Standard(s) to be addressed in this lesson: (For science, include the number and write out the full performance expectation.)
5-LS2-1: Ecosystems: Interactions, Energy and Dynamics: Develop a model to describe the movement of matter among producers, consumers, decomposers, and the air, water, and soil in the environment to (a) show that plants produce sugars and plant materials, (b) show that animals can eat plants and/or other animals for food, and (c) show that some organisms, including fungi and bacteria, break down dead organisms and recycle some materials back to the air and soil.
Learning Outcomes: (For example, “Given [materials], students will be able to [specific task] [measurable criteria].” This should be about your formative assessment at the end of the lesson.)

1. Given an exit ticket about classifying organisms based off of how they obtain energy, students will be able to circle 3 out of 5 correct answers total (out of all 3 questions).

Language Outcomes: (You will learn this in SEI class during student teaching. Leave blank during the Block.)

1.

*Note: Type in the white spaces. The gray spaces are the directions for what to include.

Anything highlighted in pink are sections that we did not get to
Highlighted in blue is my section of the outdoor activity of my lesson I kept in my lesson plan, but we did not get to this. We followed the rain day plan that I have.
Highlighted in green are things that I would add into my lesson if I could go back.

Assessments: (include all that are relevant for this lesson; formal and informal)

<table>
<thead>
<tr>
<th>Pre-Assessment: Happens in the engage to probe students’ ideas; e.g. predictions, brainstorming, graphic organizers, etc. You will not have a learning outcome for this.</th>
<th>Formative Assessment: What is the task students will do at the end of your lesson to show you they learned the science content and/or can accomplish the practice(s) in the standard? This should be a product you can collect as evidence of students’ mastery of the learning outcome. This is what the learning outcome is about.</th>
<th>Summative Assessment: This will only be in the last lesson of your unit. It should expect students to show their learning for the whole unit. This is what the learning outcome is about in your last lesson.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working with students, I will have them write down on a sticky note what they believe lions (animals), trees (plants) and fungi (decomposer) eat. This will help me measure students’ knowledge about decomposers, consumers and producers and what they eat. It will also help me to understand if students are realizing that plants do not eat food and that they actually make their own. This will also get students ready for an initial understanding of the</td>
<td>Students will develop a claim based off how they think organisms can be grouped together, and we will work together as a class during the explain to fill this out. This claim will be filled out in their science journals.</td>
<td>Students will fill out an exit ticket at the end of the lesson that has them group together organisms based off 3 different categories. The first questions</td>
</tr>
</tbody>
</table>
flow of energy and matter. We will then make a list on the board of what these organisms eat. 

|                         | ask students to circle organisms that make their own food, the second question asks students to circle organisms that eat other organisms, and the third question asks students to circle organisms that eat dead matter. We will be talking in class about how to group different organisms, and each of the pictures listed are organisms that we will cover in class. This will help to show if they have learned that there are different ways to classify organisms and if they understand the different groups we learned about in class. |

Differentiation:

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<thead>
<tr>
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<th>Modifications for English Learners</th>
</tr>
</thead>
<tbody>
<tr>
<td>For English Language Learners, I have students working in groups, so that they are able to talk with other students. This will help to deepen their understanding of the material and directions. The worksheets I provide are also very visual and include pictures on them. This is to help students who may be unfamiliar with certain words. I also provided a caption underneath every photo in case someone did not understand what the picture is supposed to show.</td>
<td></td>
</tr>
</tbody>
</table>
Targeted Academic Language:

**Teacher Content Knowledge:** Detailed science information to help you teach this lesson. Include additional relevant terms with grade-level appropriate definitions that may come up during the lesson but that you are not planning on explicitly teaching.

<table>
<thead>
<tr>
<th>Lesson Vocabulary with Grade-Level Appropriate Definitions:</th>
<th>Only include those words you are explicitly teaching during this lesson, or that you taught in a previous lesson and students are using and practicing again.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers should be familiar with milkweed and sunflower plants. They should be familiar with what these plants look like and how they grow. Teacher should also be familiar with the salt and vinegar solutions that the students made and understand how much water each plant needs to get (20 mL). The salt solutions are a combination of salt and water mixed together. The vinegar solutions are a combination of vinegar and water mixed together. Teachers need to understand how to classify living organisms into different categories. They also need to have basic knowledge about producers, consumers and decomposers. They should be aware of organisms that are producers, consumers and decomposers, and understand how these organisms obtain energy.</td>
<td><strong>Organism</strong>- An individual animal, plant, or single-celled life form. <strong>Classify</strong>- To arrange something into groups <strong>Group</strong>- To put things together based off of categories <strong>Similarities</strong>- To have something in common <strong>Bacteria</strong>- Tiny organisms that are so small we cannot see them. They are single-celled.</td>
</tr>
<tr>
<td><strong>Fungi</strong>- Any member of the kingdom of living things (such as mushrooms, molds, and rusts) that have no chlorophyll, must live in or on plants, animals, or decaying material, and were formerly considered plants <strong>Producer</strong>- An organism that creates their own food <strong>Consumer</strong>- An organism that eats other organisms to obtain food or energy <strong>Decomposer</strong>- An organism that breaks down dead matter for energy and recycles materials back into the soil</td>
<td>(These words will be taught next lesson, this is why they are not in the student knowledge section)</td>
</tr>
<tr>
<td><strong>Scientist:</strong> What type of scientist studies this topic? What does this type of scientist do? Biologists study living organisms, such as plants, animals and bacteria. They work in biology, which is the studying of living organisms.</td>
<td></td>
</tr>
</tbody>
</table>
What should students know and be able to do prior to starting this lesson?

<table>
<thead>
<tr>
<th>Student Background Knowledge: List the common misconceptions students may have for this concept. Describe the accurate concept that correlates. Be sure these ideas are described above in Teacher Content Knowledge. Also, take a look at your assessment data.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misconception: Students will think that decomposers or mushrooms make their own food. Students will think that all animals get food by eating other animals.</td>
</tr>
<tr>
<td>Accurate Conception: Decomposers, like mushrooms actually break down dead matter in order to gain energy. Animals can actually obtain food from eating different types of plants (and also other animals). Students will learn this by going through our discussion of what bears eat and how animals obtain food (by consuming other organisms- this can be plants or animals).</td>
</tr>
<tr>
<td>Based on the placement of your lesson in your unit, what should students come to your lesson already knowing?</td>
</tr>
<tr>
<td>Students should know that plants make their own food in order to get energy. Animals consume other organisms in order to obtain food and animals do not make their own food.</td>
</tr>
<tr>
<td>Based on formative assessment data from your previous lesson (or pre-assessment data if this lesson is first), what gaps in student knowledge can you identify?</td>
</tr>
<tr>
<td>My pre-assessment data shows that students are fairly unfamiliar with producers, consumers and decomposers. They were confused with how these organisms rely on one another and how they interact together. Most of the questions that ask about how plants/animals or producers/consumers rely on each other they got wrong.</td>
</tr>
</tbody>
</table>

Instructional Items: (explain in detail; attach extra items to the end of your lesson plan)

<table>
<thead>
<tr>
<th>Materials for Students and Teacher</th>
<th>Resources (such as texts, videos, websites, etc.)</th>
<th>Tools (such as anchor charts, scientific or mathematical equipment, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>78 sticky notes 1 whiteboard 1 whiteboard marker 1 PowerPoint slide with 3 pictures of animals on it (lion, tree and mushroom) 8 bags with pictures precut (these are the bags with the pictures of</td>
<td>Video “Feed Me: Classifying Organisms - Crash Course Kids #1.2”: <a href="https://www.youtube.com/watch?v=AHC0zc143Ec">https://www.youtube.com/watch?v=AHC0zc143Ec</a></td>
<td>10 rulers</td>
</tr>
</tbody>
</table>
organisms that students will be organizing
26 science journals
Milkweed plants
Sunflower plants
Acetic acid and vinegar solutions
3 bottles of water (to water plants with)

Lesson Delivery
This is specific to the content area you are teaching, including an explanation of:

• Differentiation Strategies (highlight these in your steps below)
• Safe Learning Environment (include examples in your steps below)
• Step-by-Step Procedures (be specific below)

Prior to the Opening:

• Students will each get into groups and take out their sunflower or milkweed.
  o They will make observations about their plant in their science journal.
• Students will then water their plants with either water (from water bottles) or the solutions that they made. Plants that are going into the dark will be placed in a dark cabinet to grow.
• Students will put away their plants and return to their seats to begin the lesson.

Lesson Opening:

Engage: How will you get students excited? How will you find out what they know about the current lesson? How will you review from previous lessons?

To begin working with students, I will want to engage them in this lesson and help them get excited. To start we will be starting a quick activity to have students start to get an idea of what producers, consumers and decomposers are.

Each student will get four sticky notes, and I will ask them to first, write or draw one thing that they ate for lunch.
Then on a Powerpoint, I will project three images. The bottom one will be a mushroom (fungi), the next one will be a plant (a tree), and the top picture will be any type of animal (such as a bear).
I will then ask students on the last three of their sticky notes to write down what each of these organisms eat. On one sticky note, they will write what mushrooms eat. On the next sticky note, they will write what trees eat, and then on the last sticky note, they will write what lions eat. They either write one word or draw a picture of what these organisms eat. The mushroom and tree may confuse some students, but the idea is to get them to start thinking.

Things these organisms eat:
Fungi - Dead matter (dead leaves, dead animals, dead wood)
Trees - Make their own food, need water, CO2, light
Lions - Antelope, zebras, hippos, elephants, mice, birds, lizards, etc.

Next, I will have students share out what they ate for lunch, and then what they think what each of these organisms eat. We will have a few students share out what each of the organisms eat, and I will write them on the board under a list. Then, I will emphasize that each of these organisms get their energy in different ways, and we will be learning more about how organisms obtain energy.

One way that I could change this opening to make it more fun, exciting, interesting and more relatable is by showing them the video, ‘The Circle of Life’ from The Lion King, [https://www.youtube.com/watch?v=8zLx_JtcQVI](https://www.youtube.com/watch?v=8zLx_JtcQVI)
I can ask students to identify what types of animals or plants that they saw. I can then ask students to write down on a sticky note one way that they think these organisms obtain food. This will help students connect animals or plants that they have seen in familiar movies and try to start thinking about ways that organisms get food.

**Essential/Inquiry Question:** What is your how/what/which/where inquiry question to guide this lesson? Include the steps for how you will communicate this to your students. Include scaffolds for making predictions, if relevant.

**How can we group organisms together?**
**What are similarities and differences between different organisms?**

**During the Lesson:** (A science lesson will usually have the explore/explain OR elaborate, not all.)

**Explore:** Write step-by-step directions for you and your students to conduct the explore. Include rules/safety reminders, transitions, grouping, material distribution, and how you will model what students will do.

**Rain Day Plan**
- Tell students that today we are going to be working to answer the question:
  - How can we group organisms together?
  - What are similarities and differences between different organisms?
    - To answer these questions will be organizing and categorizing pictures of different organisms. We will then have a conversation about how and why we organized organisms together.
- Students then while working in groups of four will be handed an envelope that has the following pictures in them:
  - Worm
  - Mushroom
  - Bear
  - Milkweed
  - Wolf
  - Bacteria
  - Yellow/red leaf
  - Tree
Student will be asked to sort these pictures into similar groups. They can use whatever criteria they would like to group similar organisms or things together.

- Scaffolds for how students could sort animals
  - Plant/Animal
  - Predator/Prey
  - Makes Own Food/Hunts for food

- Probing questions for students:
  - “What do all of these organisms have in common?”
  - “What organisms can you put together right away based on things that you know they have in common?”
  - “How can we group these extra left-over organisms together?”
  - “What can we call this category? What can we call this group?”

I will then have groups share out with the class how they grouped their organisms. Once students have done this, they will put their pictures back into their envelopes.

- Students will record how they initially grouped their pictures together
  - Then we will come together as a group and have them share why they chose these categories
    - After sorting these pictures, students will regroup again based on what they think these organisms eat
      - This will help get students closer to understanding how to group animals together based on similarities
        - And they get closer to understanding the terms consumers, producers and decomposers

- I will have each group share what categories they had and what organisms they sorted into each group (if time allows)
- Probing questions:
  - “How do plants get food?”
  - “How do animals get food?”
  - “Do bacteria or mushroom obtain food? How do they?”

Then I will have students sort organisms into 3 specific categories

- As a class, we will aim to have the categories
  - Organisms that produce their own food
  - Organisms that eat other organisms for food
  - Organisms that eat consume/eat dead matter for food

- I will give students a chance to try to sort out these pictures into these three groups
  - Answer:
    - Organisms that produce their own food
      - Milkweed, tree, flowers, grass
- Organisms that consume other organisms for food
  - Bear, wolf, squirrel, bird
- Organisms that consume dead matter for food
  - Mushrooms, bacteria, worms
- Probing questions for this section:
  - “Are mushrooms a plant or are they something else?”
  - “How do all plants obtain food?”
  - “How do all animals obtain food?”
  - “How do bacteria get energy?”
- Outliers that will not be sorted
  - Stick, leaf, sun
  - “Do these organisms need food?”

**Explain:** Include a detailed student and teacher explain, with scaffolds to help your learners develop a claim, evidence, and reasoning. Include the anticipated claim, evidence, and reasoning for the inquiry question. Connect your explanation to the explore and to other resources (books, videos, etc.).

- To sum up everything that we have done at the end of this lesson, I will talk to students about how all of these organisms obtain energy in different ways.
- First, I will ask students to share how we grouped organisms together today
  - I will allow students a chance to share the different ways that they grouped organisms together and why.
  - Then I will guide them towards: We grouped organisms into categories based on what they consume for food.
  - Then I will ask what are the 3 different categories we had at the end
    - We have groups that make their own food, that eat other organisms for food and that consume dead matter for food.
      - I will then share with the class that animals, plants, bacteria and fungi all get food in different ways
        - Which means they obtain energy in different ways
    - I will then explain that we can categorize all of these organisms in different ways, but we are going to be looking into the terms: producers, consumers and decomposers and how we can group organisms into these categories.
      - There are producers, consumers and decomposers all around us.
- Now, we will all work together as a class to answer the question, “How can we group organisms together?”
  - I will tell students that we will be working together to develop a claim on how we can group organisms together
    - I will ask students to list ways in which we grouped organisms together
• We did grouped animals together based on what they eat/consume for energy
  o I will ask students “Did we group organisms together based on similarities or differences?”
    ▪ “What similarities were we looking for among animals?”
  • What they ate
    o “What does food give you?”
      ▪ Energy
  o So...
    ▪ The claim we will develop as a class is
      • I can group organisms together based on similarities for how organisms obtain energy.
    ▪ Ask students to stop and think, and then share how we grouped organisms based on similarities for how they obtain energy
  • Show this ending video about producers, consumers and decomposers to have students starting thinking about, “How can we group organism together?”
    o Here is an example of one way that we can begin to group organisms
      ▪ https://www.youtube.com/watch?v=AHCOzc143Ec
  • To end, I will explain to students that there are many different wants to group organisms together based off of similarities
    o We specifically will be looking at how to group animals together based off of how they obtain energy

Elaborate: This may include an inquiry question, investigation, and/or CER framework, or be another type of creative project or real-world situation. An elaborate is usually an entire lesson in itself, and after the Lesson Opening above should be explained entirely here.

Lesson Closing: (When and how will students do your end-of-lesson formative assessment? After this is finished, how will you conceptually wrap-up the lesson? Link this to your standard and goal. Preview for the next lesson, if relevant.)

Students and I will have a brief review of the types of organisms we learned about today, and what methods we used to group them. Then each student will be handed an exit ticket, and they will each fill out their own exit ticket about classifying organisms together based on similarities on how they obtain energy. There will be three questions on the exit ticket. Each question will require students to circle pictures of organisms. The first question asks students to circle all of the organisms that make their own food, the second question asks students to circle all of the organisms that eat other organisms to get food/energy and the third question asks students to circle all of the organisms that consume dead matter in order to obtain energy. The pictures used in these questions are pictures from our picture sort that we did in class. Students received all of these pictures in class, and they were required to sort them into categories. Students should be familiar with these pictures and organisms. Using the same pictures will help to let me know if they are understanding how to group organisms together and if they understood what we were trying to do in class.
List of Lesson and Content Knowledge Resources: (use APA citation style)


Feed Me: Classifying Organisms - Crash Course Kids #1.2. (2015, March 05). Retrieved from https://www.youtube.com/watch?v=AHCOzc143Ec


The Lion King - The Circle Of Life (HD). (2011, March 31). Retrieved from https://www.youtube.com/watch?v=8zLx_JtcQVI
<table>
<thead>
<tr>
<th>Orange, yellow or red leaf</th>
<th>Bird</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flowers</td>
<td>Sun</td>
</tr>
<tr>
<td>Stick</td>
<td>Grass</td>
</tr>
<tr>
<td>Squirrel</td>
<td>Tree</td>
</tr>
<tr>
<td>----------</td>
<td>------</td>
</tr>
<tr>
<td>Worm</td>
<td>Mushroom</td>
</tr>
<tr>
<td>Bear</td>
<td>Milkweed</td>
</tr>
</tbody>
</table>
How can we group organisms together?
What are similarities and differences between different organisms?

Directions: Record how you first grouped your animals together.

1. Record how you first grouped the organisms together. If you used more groups, draw additional circles. If you used less than four groups, just leave the extra circle empty.

Group Name:____________________           Group Name:_______________________
Group Name:____________________           Group Name:______________________
Group Name:____________________           Group Name:______________________
2. Record how we as a class grouped our organisms together based on: organisms that consume other organisms, organisms that make their own food or organisms that consume dead matter.

Group Name: Organisms that Consume Other Organisms

Group Name: Organisms that Make Their Own Food

Group Name: Organisms that Consume Dead Matter
Name:________________________________________

How can we group organisms together?

Claim: I can group organisms together based on....

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________.
Name:________________________________________

How can we group organisms together?

Claim: I can group organisms together based on….

A) Similarities in what they look like

B) Differences in how they act

C) Differences in what they look like

D) Similarities in how organisms get energy
Exit Ticket

1. Circle the organism(s) that make their own food.

Bear
Squirrel
Tree

Grass
Mushroom
2. Circle the organism(s) that **eat other organisms** to get food.

Bear          Squirrel          Tree

Grass          Mushroom
3. Circle the organism(s) that **eat dead matter** to get food.

- Bear
- Squirrel
- Tree
- Grass
- Mushroom
Lesson Plan 6 - The Role of Photosynthesis

BSU Elementary & Early Childhood Education Department
Science Lesson Plan Template
created May 2018
Modified from MA DESE Model Curriculum Unit Lesson Plan Template
http://www.doe.mass.edu/candi/model/default.html
http://www.doe.mass.edu/candi/model/MCUtemplate.pdf

Teacher Name(s):
Kelly Gately

Which Essential Question(s) does this lesson help to address?
(For science, state your how/what/which/where inquiry question that guides this lesson.)

What things do plants need to complete photosynthesis?
What do plants use to start photosynthesis and what do they create in return?

Lesson Topic: (For science, write the “Students will learn that…” goal.)

Students will learn that plants need carbon dioxide and water to begin photosynthesis, and that plants use sunlight to convert these components into food (sugar) and oxygen, which is released as a by-product.
Students will learn that plants make food (or sugar) so that they can use this to grow and reproduce.

Lesson Duration: (date and time)

December 4, 2018
1:05-2:15p

Standard(s) to be addressed in this lesson: (For science, include the number and write out the full performance expectation.)

5-LS1-1. Ask testable questions about the process by which plants use air, water, and energy from sunlight to produce sugars and plant materials needed for growth and reproduction. State Assessment Boundary:
- The chemical formula or molecular details about the process of photosynthesis are not expected in state assessment.

Learning Outcomes: (For example, “Given [materials], students will be able to [specific task] [measurable criteria].” This should be about your formative assessment at the end of the lesson.)

1. Given a multiple-choice question about different components that plants need for photosynthesis and to grow, students will be able to circle 3 out of 5 total correct answers.
Language Outcomes: (You will learn this in SEI class during student teaching. Leave blank during the Block.)

1.

*Note: Type in the white spaces. The gray spaces are the directions for what to include.

Assessments: (include all that are relevant for this lesson; formal and informal)

<table>
<thead>
<tr>
<th>Pre-Assessment:</th>
<th>Formative Assessment:</th>
<th>Summative Assessment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happens in the engage to probe students’ ideas; e.g. predictions, brainstorming, graphic organizers, etc. You will not have a learning outcome for this.</td>
<td>What is the task students will do at the end of your lesson to show you they learned the science content and/or can accomplish the practice(s) in the standard? This should be a product you can collect as evidence of students’ mastery of the learning outcome. This is what the learning outcome is about.</td>
<td>This will only be in the last lesson of your unit. It should expect students to show their learning for the whole unit. This is what the learning outcome is about in your last lesson.</td>
</tr>
</tbody>
</table>

Students will write down on a sticky note why they think sunflowers are tracking the sun. This will help to measure if students understand that plants need to track the sun in order to get sunlight for photosynthesis. This will help me to assess if students understand the “larger picture,” which is that plants need sunlight to make food for themselves.

Exit Ticket- The exit ticket that students fill out at the end of the lesson will help to assess if students understand the process of photosynthesis, and that plants need water, carbon dioxide and light to begin photosynthesis. It will also help assess if students understand what type of water plants need to grow efficiently.

Differentiation:

<table>
<thead>
<tr>
<th>Accommodations (from 504 Plans/IEPs)</th>
<th>Modifications for English Learners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will be working in groups, so ELL students will be able to talk and ask their partner questions. I will be walking around and monitoring groups, so I can provide one-on-one instruction if needed. I will be providing visuals on the board and showing students how</td>
<td></td>
</tr>
</tbody>
</table>
to complete the worksheet with my own example. This will model to students how to complete their worksheet. I will also be showing a video that will show students visually the different components of photosynthesis. I will also design and create a special worksheet for ELL students to work on.

**Targeted Academic Language:**

<table>
<thead>
<tr>
<th>Teacher Content Knowledge: <strong>Detailed science information to help you teach this lesson. Include additional relevant terms with grade-level appropriate definitions that may come up during the lesson but that you are not planning on explicitly teaching.</strong></th>
<th>Lesson Vocabulary with Grade-Level Appropriate Definitions: <strong>Only include those words you are explicitly teaching during this lesson, or that you taught in a previous lesson and students are using and practicing again.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers need to understand the process of photosynthesis and how sunlight affects plant growth. Photosynthesis- Plants actually make food for themselves using carbon dioxide, water and sunlight to form oxygen and glucose. This process is known as photosynthesis. Plants are also known as autotrophs because they use light to create food for themselves. Some people mistakenly think they are feeding plants when they plant it in a pot and water it, but this is completely false. The entire process of photosynthesis is the transfer of energy from the sun to the plant. Other animals and organisms cannot make their own food, and they eat plants, so they indirectly rely on photosynthesis too. Sunlight- Sunlight is needed for plants to grow and develop. It is needed to undergo photosynthesis and without sunlight, plants would not be able to get energy or grow, develop and reproduce. Teachers should also be aware of the students’ experiments, and that plants have been being grown with darkness, light, water,</td>
<td><strong>Photosynthesis</strong>- The process by which plants and some other organisms make food. Plants use carbon dioxide and water to convert it into sugar and oxygen by light through photosynthesis. This is how plants make food for themselves, which gives them energy to grow and reproduce. Students should understand the role of the sun in photosynthesis, and how it helps plants obtain sunlight. Sunlight is key to converting water and carbon dioxide to sugar (food) and oxygen (as a by-product). <strong>Light</strong>- Energy and sunlight given off by the sun (or a lamp) that plants need to grow. <strong>Line graph</strong>- A type of graph that is used to plot data over a period of time. <strong>X-Axis</strong>- The line on the graph that runs horizontally. The x-axis is where the independent variable goes (time). <strong>Y-Axis</strong>- The line on the graph that runs vertically. This is where the dependent variable goes (plant height). <strong>Legend/Key</strong>- This is the part of the graph that explains what the different colored lines represent. Students should understand the role of the sun in photosynthesis, and how it helps plants obtain sunlight. Sunlight is key to converting water and carbon dioxide to sugar (food) and oxygen (as a by-product).</td>
</tr>
</tbody>
</table>
salt solutions and vinegar solutions. The teacher should understand how to read a line graph and understand what the x-axis and y-axis represent (definitions in column on the right). The teacher should also understand how to read a line graph with two variables. To do this, a teacher needs to look to the right at the legend/key. This will tell you what each colored line represents. Teachers should understand the role of the sun and sunlight in photosynthesis (which is in the column on the right), and that plants capture sunlight by using their leaves.

**Scientist:** What type of scientist studies this topic? What does this type of scientist do?

Botanists study plants and work with this topic in science. They study plants, what they look like and what affects their growth. They study plants and try to see how they can be used in different ways, such as for medicine, clothing or food.

**What should students know and be able to do prior to starting this lesson?**

<table>
<thead>
<tr>
<th>Student Background Knowledge: List the common misconceptions students may have for this concept. Describe the accurate concept that correlates. Be sure these ideas are described above in Teacher Content Knowledge. Also, take a look at your assessment data.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Misconception:</strong> Plants cannot grow without light.</td>
</tr>
<tr>
<td>Plants need humans to give them food and light in order to grow.</td>
</tr>
<tr>
<td>Plants take in all the substances they need to grow through their roots.</td>
</tr>
</tbody>
</table>
Based on the placement of your lesson in your unit, what should students come to your lesson already knowing?

Students should know by now that plants need water and sunlight to grow. They should also be aware that plants need space, soil and air to grow as well. Students are familiar with the idea that plants make their own food through photosynthesis, and food gives plants energy to grow, develop and reproduce.

Based on formative assessment data from your previous lesson (or pre-assessment data if this lesson is first), what gaps in student knowledge can you identify?

For misconceptions that correlate to this topic, students had misconceptions about what plants need to grow because many students could not identify that plants need water and light and air. Some of these students did not circle that plants need sunlight to grow, so this may be problematic. Students also struggled with identifying what plants need in order to undergo photosynthesis. They also struggled with understanding what plants need in order to make food for themselves. They may struggle with understanding that light is needed for photosynthesis. The previous experiments that we have done though should help with this. Students also were not able to label all of the parts of photosynthesis in the diagram, so according to the pre-assessment, they are unfamiliar with the parts of photosynthesis so far.

There aren’t any misconceptions from previous lessons that really relate to this lesson other than the fact that some students thought that mushrooms are plants. Students thought that mushrooms were photosynthetic, and so we had to have a conversation about why mushrooms are not plants.

**Instructional Items:** *(explain in detail; attach extra items to the end of your lesson plan)*
<table>
<thead>
<tr>
<th>Materials for Students and Teacher</th>
<th>Resources (such as texts, videos, websites, etc.)</th>
<th>Tools (such as anchor charts, scientific or mathematical equipment, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 Science Journals</td>
<td>1 Computer</td>
<td></td>
</tr>
<tr>
<td>26 Pencils</td>
<td>1 Projector</td>
<td></td>
</tr>
<tr>
<td>1 Marker</td>
<td>1 Video - 1 Computer</td>
<td>Richard Kent’s Fun Facts- Heliotropism (0:50-0:57)</td>
</tr>
<tr>
<td>1 Whiteboard</td>
<td>1 Projector</td>
<td><a href="https://www.youtube.com/watch?v=OG2DgFTGtj8">https://www.youtube.com/watch?v=OG2DgFTGtj8</a></td>
</tr>
<tr>
<td>26 Graphs for Each Students</td>
<td>1 Video</td>
<td>1 Video - Photosynthesis for Kids - How plants make food - Animation Science</td>
</tr>
<tr>
<td>26 Worksheet Questions for Each Students</td>
<td></td>
<td><a href="https://www.youtube.com/watch?v=_xeYNnzwpSE">https://www.youtube.com/watch?v=_xeYNnzwpSE</a></td>
</tr>
<tr>
<td>26 Claim Sheets</td>
<td></td>
<td></td>
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<tr>
<td>26 Exit Tickets</td>
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</tr>
</tbody>
</table>

**Lesson Delivery**

*This is specific to the content area you are teaching, including an explanation of:*

- **Differentiation Strategies** (highlight these in your steps below)
- **Safe Learning Environment** (include examples in your steps below)
- **Step-by-Step Procedures** (be specific below)

**Lesson Opening:**

**Engage:** *How will you get students excited? How will you find out what they know about the current lesson? How will you review from previous lessons?*

Students have been asking questions about the sunflowers they have been growing in class. They have loved learning as much as they can about these plants, and they keep asking what a “real sunflower” looks like. To work off of this energy and excitement, I will show students the following video of sunflowers. This is a field of full-grown sunflower that are tracking the sun throughout the day. In the video, students are actually able to see how the sunflower moves throughout the day. Students will be shown the following video:

https://www.youtube.com/watch?v=OG2DgFTGtj8

0:50-0:57

Following the video, I will ask students to turn and talk with a partner about what they think is happening in the video. They will be asked to think about why the sunflower is moving.

Then I will call on a few students, and we will discuss that the sunflowers are following the sun and tracking the movement of the sun throughout the day.
I will then ask students to write down on a sticky note why they think sunflowers need to track the sunlight. Then a few students will be called upon, and we will conclude that the sunflowers need to track the sun because they need sunlight for photosynthesis. I will tell students that today we are going to be exploring the question: What things do plants need for photosynthesis? What do plants use to start photosynthesis and what do they create in return?

**Essential/Inquiry Question:** What is your how/what/which/where inquiry question to guide this lesson? Include the steps for how you will communicate this to your students. Include scaffolds for making predictions, if relevant.

What things do plants need for photosynthesis to grow?
What do plants use to start photosynthesis and what do they create in return?

In this section, I am going to be working with students on these questions by having them work through their own data from the experiments that we have been running all semester. I will state this question out right at the end of the engage section, and we will continuously work on these questions all period. We will then have a discussion about these questions at the end of the lesson (the questions that I ask to scaffold students is included in the elaborate).

**During the Lesson:** (A science lesson will usually have the explore/explain OR elaborate, not all.)

**Explore:** Write step-by-step directions for you and your students to conduct the explore. Include rules/safety reminders, transitions, grouping, material distribution, and how you will model what students will do.

N/A

**Explain:** Include a detailed student and teacher explain, with scaffolds to help your learners develop a claim, evidence, and reasoning. Include the anticipated claim, evidence, and reasoning for the inquiry question. Connect your explanation to the explore and to other resources (books, videos, etc.).

N/A

**Elaborate:** This may include an inquiry question, investigation, and/or CER framework, or be another type of creative project or real-world situation. An elaborate is usually an entire lesson in itself, and after the Lesson Opening above should be explained entirely here.

- To begin, students will be observing their groups’ chart. I have created charts with all of the students’ data so that they can examine what has happened to their plants as they grew and treated them with different variables.
- The students that tested salt solutions will look at the charts for plants treated with salt solutions, groups that tested vinegar solutions will look at the charts for plants treated with vinegar, and groups that tested light will look at the charts for plants treated with darkness.
- Students will need to work on the worksheet that was designed to help them begin to analyze their data and to begin to understand what is happening.
- To start, students will look up at the board so that I can model how to look at and analyze a chart. I will have students watch as I explain how to look at it and read it.
• To start I will ask students where the x and y axis are and what they each represent.
  • The x-axis on my example is number of days, and the y-axis is the height of a rose.
• I will ask students what the orange line represents and what the blue line represents.
  • The blue line represents a rose grown with water, and the orange represents a rose grown with soda. I will ask students to look at the blue line, which is the rose grown with soda.
• I will then have students look at the blue line, which is the rose grown with water. I will ask students, “What was the height of the rose at day 1?”
  • The height was 5 cm
• Then I will ask students, “What was the height of the rose at day 9?”
  • The height was 10 cm
• Then I will ask students “What was the height of the rose at day 24?”
  • The height was 15 cm.
• Then I will ask students, “What was the height of the rose at day 43?”
  • The height was 20 cm
• I will then have students look at the orange line, which is the rose grown with soda. I will ask students, “What was the height of the rose at day 1?”
  • The height was 3 cm
• Then I will ask students, “What was the height of the rose at day 9?”
  • The height was 5 cm
• Then I will ask students “What was the height of the rose at day 24?”
  • The height was 5 cm.
• Then I will ask students, “What was the height of the rose at day 43?”
  • The height was 4 cm
• Then I will ask students, “What do you notice about the rose grown with water and the plant grown with soda?”
  • The rose grown with water grew to be 20 cm whereas the rose grown with water grew to 4 cm.
• “What happened to the rose grown with water?
  • The rose grew very tall
• “What happened to the rose grown with soda?”
  • It shrunk and die.
• “So, what can we conclude from this data?”
  • Roses grow better and taller with water, whereas roses do not grow well with soda and shrink.”
• So, now each group will be looking at the data for their own plant. They each will be filling out the worksheet with that corresponds to the variable students worked with. Each student will get a copy of their own graph, but they will work in groups to get through the data because it is a lot to understand.
• To start, I will have students fill in number 1 and 2.
  • They will be labeling what the x-axis and y-axis is.
  • They will be labeling what the orange and blue line are.
• I will ask student volunteers from each group to share what they got.
Next, I will ask students to fill in number 3-4.
- Students will be filling in what the height of their two plants are at day 1 and day 45.
  - I will ask students how can I look at where my data is on day 1 and day 45?
    - Show example with rose graph if needed
- Next, I will have a few students share out so I can check on their data and progress.

Next, students will work on questions 5-6. I will tell students to look at their data from days 1 to 45 and notice if their height went up or down.
- This will tell you whether your plant shrunk or grew.
- Ask students with my rose, it started at 5 cm and then grew to 20 cm, did it grow or shrink?
  - It grew!
- For my rose, the rose started at 3 cm, but then grew to 5 cm, and then shrunk to 4 cm. Did the rose grow or shrink?
  - Both!
- Have students work, and then call on students for answers once they finish.
- Now, have students move to number 7. “What can we conclude from our data?”
  - Ask students to look at my rose graph and ask what they can conclude from this data.
  - Ask guiding questions such as, “What did the rose grow more with, the water or soda?”
    - “Did the rose grow better with soda or water?”
      - Water!
- I would write, “I conclude that…roses grow better with water because it grew more with water than soda.”
- Have students work with their own data and go around to monitor students working. They may need a lot of guidance so use similar guiding questions as listed above to help students.
- Once students are done, have the groups share with the entire class what they concluded about their plant!
  - Write these claims on the board so all of the student can see.
- Next, I will have students start to look at what I have on the board.
- They will see that plants grow better with light and plain water.
  - I will ask students to look at all of the claims on the board and I will ask them to make a conclusion about what **plants need to grow**.
    - Students will realize that plants need **light and water**.
- I will then ask students, “How do plants grow? What do they need to make for themselves to grow?” (food), and “How do plants make food for themselves?” (Photosynthesis)
- I will then ask students, “Then what two things do we know that plants definitely need to complete photosynthesis?”
  - Light and water
• I will then inform students that there are actually a few more components to photosynthesis, and we are going to watch a video to find out more.
• Students will watch the video:
  https://www.youtube.com/watch?v=_xeYNnzwpSE
  • The purpose for watching the video is to examine what plants need to complete photosynthesis. I will remind students of our inquiry question.
    • What do plants need for photosynthesis?
    • What do plants use to start photosynthesis and what do they create in return?
    • I will ask the students these questions after watching.
• I will have students flip to the next page in their science journal where they will make a claim about the following question: “What do plants in photosynthesis to grow?”
  • Claim will be:
    • Plants need **carbon dioxide and water** which gets turned into **sugar and oxygen** by **light** through **photosynthesis**. If time allows discuss with students what the sugar gives the plant and how it helps it live:
      • The sugar gives the plant food, which it uses as energy to grow.
    • I will ask students to fill in the blanks for the words bolded.

**Lesson Closing:** *(When and how will students do your end-of-lesson formative assessment? After this is finished, how will you conceptually wrap-up the lesson? Link this to your standard and goal. Preview for the next lesson, if relevant.)*

To wrap up the lesson, I will have students fill out an exit ticket to assess what they have learned about photosynthesis, and what plants need to grow. I will pass out the exit ticket for students to fill out.

**List of Lesson and Content Knowledge Resources:** *(use APA citation style)*


  https://getbusygardening.com/growing-spinach-from-seed/


Sunflowers Grown with Salt and Water

![Graph showing the growth of sunflowers with and without salt over time.](image-url)
Milkweed Grown with and without Salt

Height of Milkweed Grown With and Without Salt

- Milkweed Grown with Salt
- Milkweed Grown with Water

Height of Milkweed in Centimeters

Day 1, Day 9, Day 24, Day 43

Number of Days
Sunflowers Grown with and without Vinegar

![Graph showing the growth of sunflowers with and without vinegar over time. The x-axis represents the number of days (Day 1, Day 9, Day 24, Day 43), and the y-axis represents the height of the sunflowers in centimeters. The graph compares the growth of sunflowers grown with vinegar and sunflowers grown with water.](image-url)
Milkweed Grown with and without Vinegar

![Graph showing milkweed growth with and without vinegar](image)

- **Milkweed Grown with Vinegar**
- **Milkweed Grown with Water**
Sunflowers Grown with and without Light

[Graph showing the growth of sunflowers in light vs. in dark over 43 days.]
Milkweed Grown with and without Light
Teacher Example

Roses Grown with Soda and Water

- Blue line: Roses Grown with Water
- Orange line: Roses Grown with Soda

<table>
<thead>
<tr>
<th>Height of Plants in Centimeters</th>
<th>Number of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>15</td>
<td>43</td>
</tr>
<tr>
<td>20</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

- X-axis: Number of Days
- Y-axis: Height of Plants in Centimeters
Directions: Answer the following questions that follow along with your line graph.

1. What does the x-axis represent? What does the y-axis represent?

2. What does the orange line represent? What does the blue line represent?

3. For the orange line: What is the height of the plant on day 1? What is the height of the plant on day 43?

4. For the blue line: What is the height of the plant on day 1? What is the height of the plant on day 43?
5. **For the orange line**: Did the plant grow or shrink?

6. **For the blue line**: Did the plant grow or shrink?

7. What can you conclude from your data?

*I conclude that….*
Name:________________________________________ Date:____________________

Directions: Make a claim about the following question:

What do plants in photosynthesis to grow?

Claim:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________.
Exit Ticket

1. What three things do plants at the beginning of photosynthesis to make food? **Circle all that apply.**

   A. Carbon Dioxide
   B. Water
   C. Light
   D. Oxygen
   E. Sugar

2. What type of water do plants need to grow?
   
   A. Plain water
   B. Salt water
   C. Vinegar water
   D. No water
Lesson Plan 7- Engineering a Plant Tool

BSU Elementary & Early Childhood Education Department
Engineering Lesson Plan Template
created May 2018
Modified from MA DESE Model Curriculum Unit Lesson Plan Template
http://www.doe.mass.edu/candi/model/default.html
http://www.doe.mass.edu/candi/model/MCUtemplate.pdf

Teacher Name(s):
Kelly Gately

Which Essential Question(s) does this lesson help to address?
(For engineering, state a how/what question that guides the problem students will solve.)

How can we design a tool using everyday objects to help plant seeds efficiently and quickly?
How can we design a tool to help plants seeds, so that they have access to water, air and sunlight to grow?

Lesson Topic: (For engineering, write a “Students will learn that…” goal.)

Students will learn that environmental engineers design, build and test tools to help plant a large volume of seeds quickly and efficiently.
Students will learn that they need to critically think about their tool in order to help make sure the seed being planted is receiving water, space and a correct temperature.

Lesson Duration: (date and time)
December 11, 2018
1:05-2:20

Standard(s) to be addressed in this lesson: (For science and engineering, include the number and write out the full performance expectation.)

5-LS1-1. Ask testable questions about the process by which plants use air, water, and energy from sunlight to produce sugars and plant materials needed for growth and reproduction. State Assessment Boundary:

- The chemical formula or molecular details about the process of photosynthesis are not expected in state assessment.

5.3-5-ETS3-2(MA). Use sketches or drawings to show how each part of a product or device relates to other parts in the product or device.*
Learning Outcomes: (For example, “Given [materials], students will be able to [specific task] [measurable criteria].” This should be about your formative assessment that finds out if students can use their science knowledge in relation to the engineering goal.)

1. Given the second page of the Engineering Design Packet from questions 3-5, students will be able to fill out 3 out of the 4 blanks correctly.

Language Outcomes: (You will learn this in SEI class. Leave blank if you have not taken SEI yet.)

1.

*Note: Type in the white spaces. The gray spaces are the directions for what to include.

Assessments: (include all that are relevant for this lesson; formal and informal)

<table>
<thead>
<tr>
<th>Pre-Assessment: Happens in the engage to probe students’ ideas; e.g. predictions, brainstorming, graphic organizers, etc. You will not have a learning outcome for this.</th>
<th>Formative Assessment: What is the task students will do during or at the end of your lesson to show you they know how to apply their science knowledge to the engineering goal? This should be a product you can collect as evidence of students’ mastery of the learning outcome. This is what the learning outcome is about.</th>
<th>Summative Assessment: This will only be in the last lesson of your unit. It should expect students to show their learning for the whole unit. This is what the learning outcome is about in your last lesson.</th>
</tr>
</thead>
<tbody>
<tr>
<td>To assess students’ knowledge beforehand, I will ask students to write down on a sticky note one tool that they think people use to plant seeds (examples of this could be, shovel, hoe, drill, hands, etc.).</td>
<td>After building, students will fill out the second page of their engineering design packet, and they will fill out three questions that require them to use their knowledge of photosynthesis and needs of seeds.</td>
<td></td>
</tr>
</tbody>
</table>
Differentiation:

<table>
<thead>
<tr>
<th>Accommodations (from 504 Plans/IEPs)</th>
<th>Modifications for English Learners</th>
</tr>
</thead>
<tbody>
<tr>
<td>One modification that I made for ELLs are students will be working in groups. This will help ELLs because if they have any questions or concerns, they can turn and talk to a partner to ask for advice. I will also require students to draw out their design and this will help ELLs because it will enable them to work with visuals instead of written words.</td>
<td></td>
</tr>
</tbody>
</table>

Targeted Academic Language:

**Teacher Content Knowledge:** *Detailed science and engineering information to help you teach this lesson. Include additional relevant terms with grade-level appropriate definitions that may come up during the lesson but that you are not planning on explicitly teaching.*

**Lesson Vocabulary with Grade-Level Appropriate Definitions:** *Only include those words you are explicitly teaching during this lesson, or that you taught in a previous lesson and students are using and practicing again.*

| Teachers need to be familiar with the Engineering Design Process: Ask, Imagine, Plan, Create, Improve and the definitions of each of these terms (see the category to the right). |
| Teachers should be aware what plants and seeds need. They should know the difference between what seeds and plants need (see descriptions for these in the next column). |
| Teachers should be aware of the different types of ways to plant a seed: seed drill, seed planter, shovel and who uses these tools (look to see information on the right). |

| I will be teaching students what the EDP process and definitions for each part of the process. |
| Ask- Ask a question you need to answer and find a solution for |
| Imagine- Think about what you want to design and create |
| Plan- Plan out the materials you want to use to create your tool and then draw what it will look like |
| Create- Build your tool using different materials and adjust your original design if necessary |
| Improve- Test your tool, and then think about what you can do to improve its design. Then go back and make necessary adjustments |

| Students should be aware that seeds need: space, water and a correct temperature to grow. |
| Students should be aware that plants need: soil, space, sunlight, carbon dioxide (air), water, and nutrients to grow. These are the 5 requirements for growth. Plants go through photosynthesis in order to make food for themselves. |
Students should understand the difference between plant and seed needs.
Plants need: sunlight, nutrients, soil, space, and carbon dioxide
Seeds need: water, space, a correct temperature (NO sunlight, soil or nutrients necessary)

Students should be aware of the different types of ways to plant a seed: seed drill, seed planter and shovel.
A seed drill and planter are pulled behind the tractor. They contain a bucket full of seeds, and the seed drill or planter spits out the seeds one at a time in straight rows. The main difference between a seed drill and planter is the amount of space that the tool spreads out the seeds from one another.
Farmers use seed drills and seed planters to plant their own crops (such as maize) on a farm.

**Engineer**: What type of engineer would work on this goal? What does this type of engineer do?

Environmental engineers would work to complete this goal. These types of engineers work to improve and maintain the environment for the protection of human health and ecosystems. They would work to design a tool that helps plant seeds efficiently and that does not harm the environment or other plants around.

**What should students know and be able to do prior to starting this lesson?**

**Student Background Knowledge**: List the common misconceptions students may have for this concept. Describe the accurate concept that correlates. Be sure these ideas are described above in Teacher Content Knowledge. Also, take a look at your assessment data.

<table>
<thead>
<tr>
<th>Misconception:</th>
<th>Accurate Conception:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeds are not alive.</td>
<td>Seed are in fact alive, and this is how they grow over time. They require things to live just like plants and animals do.</td>
</tr>
<tr>
<td>Seeds need sunlight, nutrients (from the soil) and soil to grow.</td>
<td>Seeds do not need sunlight or nutrients (from the soil) to grow because they do not undergo photosynthesis to make food to grow. Seeds already have nutrients packed inside that they use to create energy for themselves. Seeds also do not need soil in order to grow, but they do need enough space.</td>
</tr>
</tbody>
</table>
Based on the placement of your lesson in your unit, what should students come to your lesson already knowing?

Students should come in already knowing about photosynthesis and what three things are required at the beginning of photosynthesis. Based off the exit ticket, almost everyone got this question correct. They should also be aware of the five things that plants need to grow because we have reviewed this in previous lessons and made a list on the board of things plants need to grow. Students should also know that plants make food for themselves through photosynthesis. This was reviewed during our producer, consumer and decomposer lesson, and students were able to fill in different plants that were considered to be producers.

Based on formative assessment data from your previous lesson (or pre-assessment data if this lesson is first), what gaps in student knowledge can you identify?

Some students may be lacking in knowledge about the three things that plants require at the beginning of photosynthesis. Although the majority of the class was able to answer this question correctly, there were still some students that did not. This will need to be reviewed during our lesson, so students are clear on plant requirements for growth.

**Instructional Items:** *(explain in detail; attach extra items to the end of your lesson plan)*

<table>
<thead>
<tr>
<th>Materials for Students and Teacher</th>
<th>Resources <em>(such as texts, videos, websites, etc.)</em></th>
<th>Tools <em>(such as anchor charts, scientific or mathematical equipment, etc.)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Pot with soil- 3ft (0.91 cm)</td>
<td>1 Computer</td>
<td>15 Rulers</td>
</tr>
<tr>
<td>100 Sunflower seeds</td>
<td>1 Projector</td>
<td></td>
</tr>
<tr>
<td>30 worksheets</td>
<td>Mini Tractor Operated Fertilizer and Seed Drill by Sanap Agro Machinery, Nashik</td>
<td></td>
</tr>
<tr>
<td>30 Pencils</td>
<td><a href="https://www.youtube.com/watch?v=I1ocRfZ_Zis">https://www.youtube.com/watch?v=I1ocRfZ_Zis</a></td>
<td></td>
</tr>
<tr>
<td>30 Sticky notes</td>
<td>KUHN - SEEDFLEX <em>(Animation)</em></td>
<td></td>
</tr>
<tr>
<td>For Creating:</td>
<td><a href="https://www.youtube.com/watch?v=SXSsHBjlyzM&amp;list=PLYcAu6TTf3RuYsAt5m0tTpGKe44nCA8pc">https://www.youtube.com/watch?v=SXSsHBjlyzM&amp;list=PLYcAu6TTf3RuYsAt5m0tTpGKe44nCA8pc</a></td>
<td></td>
</tr>
<tr>
<td>15 Plastic cups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 plastic bowls,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 plastic spoons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 empty cans or bottles, 30 straws,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 rubber bands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 paper clips,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 rolls of tape,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>soda bottle,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 pieces of string,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 roll of foil,</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lesson Delivery

This is specific to the content area you are teaching, including an explanation of:

- Differentiation Strategies (highlight these in your steps below)
- Safe Learning Environment (include examples in your steps below)
- Step-by-Step Procedures (be specific below)

Lesson Opening:

**Engage:** How will you get students excited in relation to the engineering problem and goal? How will you find out what they know about the current lesson? How will you review from previous lessons?

I am going to present my students with an imaginary problem. I am going to tell them that Bridgewater State University needs to start a HUGE garden, but they have no idea how to start it. Their biggest issue is they have 100 seeds to plant, but they don’t have time to plant each one by hand. They asked me to contact Mr. T-Mac’s class to see if his fifth-grade class could help with this problem. Explain to the students that they need to design a tool that will hold all the seeds at once. The tool also needs to be able to drop a seed every 4 in (10 cm) over 3 ft (0.91 meters) without a hand touching it. It is up to the class to work together in small groups to come up with different tools that BSU can use to start their garden! (Possibly ask Dr. Glen to come if possible to present this problem to students to make it sound more realistic).

Handout a sticky note to each student. Have students write down one tool that they think real farmers or people use to plant seeds on a sticky note. Call on several students and make a list on the board of different tools people use to plant seeds.

**Show students a video of how farmers plant seeds. They use tools such as a planter and a driller.**

This is what a planter looks like:

https://www.youtube.com/watch?v=SXSsHBjlyzM&list=PLYcAu6TTf3RuYsAt5m0tTpGKe44nCA8pc

This is what a driller looks like:

https://www.youtube.com/watch?v=I1ocRfZ_Zis

Explain to students that a seed driller and planter are pulled behind the tractor. They contain a bucket full of seeds, and the seed driller or planter spits out the seeds one at a time in straight rows. The main difference between a seed driller and planter is the amount of space that the tool spreads out the seeds from one another. Encourage students to think about these when they design their own later on.
**Engineering Goal:** What is the engineering goal? Include the steps for how you will communicate this to your students.

The goal for our engineers is to:

Design, create and test a tool created out of everyday objects that plants a seed every 4 in (10 cm) over 3 ft (0.91 meters) without any help from a person’s hand touching the seed as it drops.

At the end of the engage, students will be presented with this engineering goal. I will project it on the screen for students to see. I will ask students to turn and talk with a partner about what this statement means.

Then I will call on student volunteers to answer different questions about the goal. “What does it mean to design, create and test a tool? What are ways we can do this?”

“What does it mean to create something out of everyday objects? What types of things would I use for this?”

“What does it mean when it says the tool must drop a seed every 4 in without the help from a person’s hand? What would this look like?”

I will then ask students “What types of steps can we take to reach this goal?” I will then allow students to share what they we should be doing to build and test this tool. I will then tell students that we will be following the Engineering Design Process to meet this goal.

**During the Lesson:**

**Engineering Design Process (EDP):** Write step-by-step directions for how you and your students are using the EDP, including the names of the steps of the EDP you are using, and the specific actions you and students will take during each step of the EDP. Include rules/safety reminders, transitions, grouping, materials distribution, and how you will model what students will do.

**Ask:**

Tell students that the first step of the EDP is ask. The question that we are asking today are:

How can we design a tool out of everyday materials to help plant seeds efficiently and quickly?

How can we design a tool to help plants seeds, so that they have access to water, and space to grow?

Have students turn and talk with a partner. They will discuss answers to this question, and then call on a few students to share what they think. Encourage students to come up with their own questions while they talk with a partner as well.

Tell students that they will be working in teams of 2-3 to design this tool.

Explain to students that before we begin building that we need to think about what types of things seeds need to grow. First, talk about what they know plants need to grow: carbon
dioxide, space, soil, water and nutrients. Encourage students to think back to our experiment where we looked at seeds that were grown in darkness. Did the seeds grow without light? Yes! We can conclude from this that seeds DO NOT need sunlight to grow. Talk and discuss with students that seeds do not require soil or nutrients either. Seeds actually have nutrients compacted inside of them that they need to grow.
So, seeds need: space, water and the right temperature to grow. Have students think about the difference between what plants need to grow and what seeds need to grow. Write on the board what each one needs when growing.

Imagine-

Students while working in groups will start to think and talk about what kind of tool they would want to create, and what they would want it to look like. I will advise students to start thinking about what materials they would want to use.

Design-

Next, students will create be advised to draw out the tool they want to make. The teacher will make a list on the board of all the materials that students will have available to use. Students will also need to label the materials they want to use on their drawing. They will need to justify to a teacher why they want to use them. (Guiding questions could be: Why did you choose to use a spoon? How will this help unload seeds?) Students will work with their partner to create a design together, and then they will need to get it approved by a teacher before they begin picking out materials to build it.

Create-

Then once students have been approved (full drawing with at least 3 materials listed that they want to use and why), they may go up to the front of the class to pick out their materials, and then they may go back to their seats. Students will be allowed to only take the materials that they plan to work with. Then as they begin to build, and if they realize they want different materials, then students will be allowed to go back and get different materials.

Improve-

Once students have a full proof tool that they have created, they will be allowed to test their tool. Students will be take their tool and fill it up with sunflowers, and they will bring it to the back of the room to test. They will be testing it with a long pot filled with soil that is about 3 ft (0.91 cm) long. One student will be allowed to test it while the other student watches and checks the seeds as they drop. Students will have to estimate if the seeds are far enough part as they work.

If time allows, students will be asked what they can improve on after they test. I will ask students about different things that they could change or add as they work. Then students will be encouraged to return to their tool and redesign it. They will then be allowed to retest if there is enough time.
Lesson Closing: (When and how will students do your end-of-lesson formative assessment? After this is finished, how will you conceptually wrap-up the lesson? Link this to your standard and goal. Preview for the next lesson, if relevant.)

Students will fill out the second half of their engineering design packet once everyone is finished testing their tool. Then as a class, we will discuss everyone’s designs and creations. We will also talk about what went right and what went wrong, and what students can improve on for next time. I will ask students what they would do differently if they could, and I will ask them how their tool could help Bridgewater State University with their garden.

List of Lesson and Content Knowledge Resources: (use APA citation style)


KUHN - SEEDFLEX (Animation)[Video file]. (2013, March 20). Retrieved December 15, 2018, from https://www.youtube.com/watch?v=SXSsHBjlyzM&list=PLYcAu6TTf3RuYsAt5m0tTpGKe44nCA8pc


Engineering Design Packet
1. Draw a design of what your planting tool looks like. Label what each part of your design will made with.

AFTER you create your FINAL design:

2. Describe how your planting tool works.

____________________________________________________________________

3. What needs of a sunflower will be met by making sure the seeds are 4 inches apart?

____________________________________________________________________
4. What are the differences between what plants need to grow and what seeds need to grow?

Plants need:

____________________________________________________________________

____________________________________________________________________

Whereas seeds need:

____________________________________________________________________

____________________________________________________________________

5. After you seed sprouts and turns into a plant, what process will your plant need to go through to make food for itself?