

# Preschoolers Explore Greenhouses by Visiting a Greenhouse, Making a Model, and Growing Plants

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### Key Words

NGSS, arts integration, 5E Learning Cycle, preschool lessons, greenhouses, plants.

### Abstract

This practical lesson on greenhouses implements standards of the Next Generation Science Standards (*K-2 ETS 1-2; K-LS1-1*) and the preschool objectives from the Teaching Strategies GOLD. Teaching Strategies GOLD is an assessment tool available online and in print that can be used with any developmentally appropriate early childhood curriculum. The lesson structure follows the 5E's Learning Cycle Constructivist Model for teaching and the project-based, hands-on approach to learning. The preschool-aged children went on a field trip to a working greenhouse and then collaborated in groups to produce a three-dimensional model of a greenhouse as arts integration into this science project. The children affixed photo stickers from their greenhouse visit onto a recycled plastic container to make the greenhouse building. They used clay, toothpicks, and colored paper leaves to recreate models of plants they had seen and then planted real seeds. The following lesson on plants and greenhouses serves as a successful example of positive arts-integrated science; the children worked together with enjoyment and took pride in their work while the teacher evaluated it as rewarding.

### Introduction

The need for greater literacy and science preparation has been an impetus for federal and state legislatures in recent years to impose standards and assessments with direct curriculum implications, such as No Child Left Behind Act (Public Law 1997-1007-110, 2001), Common Core State Standards (The Council of Chief State School Officers and the National Governors Association Center for Best Practices, 2009), and Every Student Succeeds Act (2015). There has been a trend to integrate engineering and technology into science education by teaching science disciplines at all levels and by giving core ideas of engineering and technology the same status as those in other major science disciplines (Next Generation Science Standards Lead States, 2013). This requires a substantial amount of time to actively engage students in scientific and engineering practices so they can develop deeper levels of scientific and engineering investigation and understanding (National Research Council, 2012).

In this context, the current paper explores how some of these initiatives can be supported in activities



engaging preschool-aged children. The Next Generation Science Standards (NGSS) are addressed by a project involving hands-on experiences, observation, and creation of greenhouses models by three and four-year-old children at a child development center supported by their teacher.

## Literature Review

### Knowledge and Interest in Plants

Exposure of students to nature in general and plants in particular is important because the more students know about plants, the more they appreciate them and would be likely to protect them (Lindemann-Matthies, 2005). Previous studies with prekindergarten through high school students show that students' knowledge and interest in plants and agricultural issues is moderate to little and lower than the interest in animals (Bebbington, 2005; Strgar, 2007). Some reasons may be that students do not usually have many opportunities to interact with plants and their growth / movement is less obvious than that of an animal. This situation may lead to students' ideas of plants as being inanimate or to disinterest in agricultural and environmental sciences. Surveys with primary school students (4-11 years old) showed that school and teachers are the predominant source of information about plants while the second largest source of information is parents (Jewell, 2002).

### Hands-on Projects

Hands-on activities involve manipulation of objects to gain knowledge and understanding by learning through experience (Haurly & Rillero, 1994). Hands-on activities are associated with a positive effect on students' knowledge (Bigler & Hanegan, 2011) because children under the age of eight enjoy such active exploration along with interaction with people (Stuber, 2007). Utilizing hands-on projects allows for active involvement in the learning process over a longer period of time. Different hands-on activities can take place at a school garden including planting seeds or plants, dissecting flowers, sorting seeds, and comparing real plant parts. These activities can positively affect students' knowledge of species and their appreciation of biodiversity. Students involved in hands-on botany lessons have been

found to develop greater interest in nature and to perform better on assessments (Cooper, 2008). Additionally, these hands-on projects may encourage group work and have the potential to promote cooperation, goal-focused behavior, and mutual pride of the outcomes (Cooper, 2008). Preschool children are found to learn best when they have positive relationships with adults and other children, when they receive guidance and assistance, and when they can safely explore their environment (National Association for the Education of Young Children, n.d). Therefore, incorporating hands-on activities in the curriculum may be highly beneficial to young children.

### Incorporating Visual Arts and Crafts

Incorporating arts in science lessons benefits students' cognitive development by providing opportunities to increase their divergent thinking alongside the convergent thinking traditionally promoted in science (Land, 2013). Through this utilization of art integration, students' inquiry and experiential based learning can be guided not only by logical, objective, and systematic thought processes but also by thinking through intuition, subjectivity, emotion, and imagination (Land, 2013).

Another benefit of the integrated approach to instruction is that science learning can be facilitated by skills fostered by arts and crafts, such as: observation, pattern identification, visual thinking, and manipulative ability (Root-Bernstein & Root-Bernstein, 2013). Moreover, similar processes can be found in the arts and in science, supporting an integrative approach. Defining a problem, researching information, brainstorming solutions, creating prototypes, and presenting to an audience are common for both engineering and some art forms (Bequette & Bequette, 2012).

Studies suggest that visual arts, music, and crafts enhance manipulative abilities, fine motor skills, and visual-spatial thinking skills, which are predictors of success in scientific subjects (Newcombe, 2010). One strategy for developing visual spatial thinking skills is development of vocabulary for spatial relationships and positional prepositions. This also promotes overall literacy and learning across domains through integrated instruction.

Lastly, arts are found to benefit student engagement and attitude toward school (Doyle, Hofstetter, Kendig, & Strick, 2014; Nevanen, Juvonen, & Ruismaki, 2014). Students involved in the arts tend to display increased social competence, motivation, listening skills, goal-oriented work, and involvement in evaluating progress as a result of working together on collaborative arts projects. The previously stated research has shown art integration offers a holistic approach to learning, contributing to school performance, science readiness, and developing skills for future novel, problem solving situations.

### Standards Addressed by the Lesson

The lesson described in this article implemented the Next Generation Science Standard (NGSS Lead States, 2013), *K-LS1-1: Use observations to describe patterns of what plants and animals (including humans) need to survive*. The children in this lesson learned that plants need warmth, sunlight, and water to grow and live. They also learned that a greenhouse is a building in which plants can grow, even when it is snowing outside. The children were also able to observe real seeds grow inside their own greenhouses.

Another NGSS standard implemented was *K-2 ETS 1-2: Develop a simple sketch, drawing or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem*. All of the children were able to draw plants, create clay plants, and decorate their greenhouse models with stickers by collaborating with a partner. They were able to see inside the transparent plastic model, made from a fresh salad greens container turned upside-down, to learn that a greenhouse has many clear walls and a clear roof to admit sunlight to help plants grow throughout all seasons.

Preschool objectives used in this lesson are from the Teaching Strategies GOLD Preschool Objectives for Development and Learning (Berke, Heroman, Tabors, Bickart, & Burts, 2010). Objective *2c: Interacts with peers* was used throughout the entire lesson from holding hands on the walk to visit the greenhouse and during the tour. The children also worked with a peer when they designed the bottom of their greenhouse and when they put on the stickers.

Objective *9a: Uses an expanding and expressive vocabulary* was observed when the children learned about how a greenhouse is different than a house they might live inside. New vocabulary such as clear, humid, thorn, and condensation were also discussed throughout the lesson.

Objective *24: Uses scientific inquiry skills* was implemented throughout the lesson when students offered ideas about what a greenhouse might be and what happens inside. After the visit to a working greenhouse, the children were able to reflect on what they had seen and learned while they viewed digital pictures of their trip. Models were also made depicting the plants they saw living in the greenhouses.

Objective *25: Demonstrates knowledge of the characteristics of living things* was observed when the children learned correct terminology with new vocabulary words and discussed how to care for living things. The rooms at the greenhouse were also categorized into different sections for the different plants related to their native environments.

Objective *33: Explores the visual arts* was displayed as the children used different materials to create a model of a greenhouse, such as markers, clay, stickers, and a plastic container to create a 3D model.

### Method

This lesson is for preschool children, ages three to five years, to create a model of a greenhouse with realistic pictures, models of plants, and to observe the sprouting of seeds.

### Participants

The children who participated in this lesson attended a child development center located on a university campus. The children in the classroom ranged in age from 3 years and 5 months to 4 years and 7 months. There were 16 children in the classroom with seven girls and nine boys, including five learning English as a second language. The children in the classroom come from many backgrounds. Eight of the children were Caucasian, five were Middle Eastern, one was Caucasian/Chinese, one was Caucasian/Taiwanese, and one was African American/Korean.

**Materials**

For the lesson, many different materials were used. The greenhouse structure itself was made with a clear plastic rectangular prism-shaped bin decorated with photographic stickers from the student’s trip to the working greenhouse. The digital photos were cropped and plants and animals were cut out digitally to make a page that was printed in color on whole-page label paper to make stickers depicting the exterior of the building and its contents. Figure 1 shows the sheet of stickers used by the authors of this lesson. Two parrots lived in the greenhouse, so they were included in the sticker set. The plant models were made of natural, air-dry clay with toothpicks cut into pieces for cactus spines or green leaves cut from colored paper. Lima bean seeds were placed in moistened cotton balls in small, clear plastic zippered bags like those sold for packing jewelry. These were taped to the inside wall of the greenhouse models so students could watch the seeds sprout.

The clear plastic rectangular prism shaped bins used in this lesson were actually packages in which refrigerated fresh salad greens were packaged for sale at a

supermarket. The dimensions of the bins are 6 x 10 inches or 15 ½ x 27 ½ centimeters. For the greenhouses, a clear plastic strawberry container with a lid or another large clear plastic container could be used. If whole-page label paper cannot be found, print the pictures and cover them in clear contact paper, cut them out, and tape them on the sides of the greenhouse. Prior to making greenhouses with the children, a guided tour to visit a local greenhouse is highly recommended. If a fieldtrip is not possible to learn names and facts about plants, gather books from a local library, watch videos on the internet, or research photos of various plants for more information. Taking photos of the plants and the exterior of the greenhouse might be done before the visit to the greenhouse, or accomplished while visiting, depending on the needs of children and the number of adult helpers.

Figure 2 shows a greenhouse made by a teacher using the set of stickers from Figure 1. Preschool children were not expected to produce a greenhouse like the one in Figure 2, but this image may be useful to teachers of older students who want to adapt this lesson to their students.



Figure 1. Greenhouse sticker page originally 8.5 x 11 inches or 21.6 x 28 centimeters.



Figure 2. An example greenhouse made by a teacher using the stickers

### 5E's Learning Cycle Lesson Procedures

This lesson follows the 5E's Learning Cycle Constructivist Model for teaching (Abruscato & DeRosa, 2010). This format of teaching allows the teacher to determine what students know, make connections to prior knowledge, and stimulate self-questioning to generate curiosity before explaining the concepts. After the greenhouse visit, making a model of a greenhouse allowed children to practice their new concepts through the artistic construction of a model greenhouse and plants.

**Engage:** Show children a photo of a greenhouse. Ask, "What is a greenhouse?" "What happens there?" Record ideas in a web format using large chart paper.

**Explore:** After listening to a few ideas, show more detailed pictures of a greenhouse including the inside and exterior. "How is it different from a house?" "What lives there?" Continue recording ideas on chart paper.

**Explain:** Visit a local greenhouse. After your visit record children's observations and conversations. Take photos during the visit and later print them. Ask the children what they saw and learned from the visit, while introducing vocabulary such as "humid," "dry," "condensation," "thorns," and "clear."

**Expansion:** Children may work individually or together in small groups to create their own models of a greenhouse. In this lesson, the children worked in pairs. Besides creating clay models of a cactus and leaf-bearing plant, children planted lima bean seeds in small zippered plastic bags that were taped to the interior walls of the greenhouse.

**Evaluate:** While the children are placing their stickers on their greenhouses, check for understanding by repeating questions from the beginning of the lesson.

**Cycling Back to the Explain Phase over Time:** Remind students of new vocabulary words and the names of the plants. Check the lima beans daily or a few times a week to observe any sprouting from the seeds inside the greenhouse. New vocabulary words can be addressed from the growing seeds.

### Results and Conclusion

#### Overall Observations

This lesson was a great learning experience for the teacher and for the students. The field trip to the

greenhouse was successful and students were able to recall the hot room in which cacti live and that the walls of the greenhouse were made from glass to ensure growth of plants through sunlight. Overall, the teacher was thrilled to see the children working together in pairs and helping each other collaborate during each stage of making the greenhouse models. Working with a hands-on activity proved to be successful as the students were engaged throughout every step from coloring the floor of the

greenhouse together to being photographed holding the completed model. Most of the students loved making a cactus and filling it with many spines. Not as many children chose to make a second clay plant with leaves, but instead elected to play at a different center that day. Putting the stickers all around and inside the greenhouse seemed to be the most fun for all of the students. See Figure 3 and Figure 4.



Figure 3. Children drawing the floor of the greenhouse (left) and peeling stickers to decorate the sides of the plastic container (right).



Figure 4. Children proudly display their model greenhouses.

### Teacher Strategies, Problems, and Solutions

The greenhouses needed to be assembled by children working in small groups because of the complexity of the handwork and lack of student familiarity with these crafts. The teacher had no more than two groups (four children) at a table with her at a time so she could assist them as needed. The difficulties encountered were that some of the stickers were small and it was difficult for children to peel off the paper backing. Another area that posed some difficulties for students was shaping the clay. Rolling clay in their hands to make a cactus shape, whether a ball or a taller cylinder was a challenge. When the activity was offered the next day to create a new plant but with leaves, many students chose not to participate and engaged at a different center. When children were making the clay plant with added green leaves, the teacher noticed she had

cut the green leaves too large. See Figure 5. As the teacher put the lids back on the greenhouses, often, the plants fell over. The teacher also found it difficult for some of the clay plants or cacti to stay upright in the model greenhouses as the plastic lid used as a base had a rim around the perimeter and some clay plants would become unbalanced and tip over. The teacher used sticky-tack to adhere some of the plants to the floor of the greenhouses so they would not topple over.

Visiting the local greenhouse and building a model was successful for the teacher and the students. It was a time consuming project but it was very rewarding watching the pride of students in their work. The teacher recommends other preschool teachers try this lesson with their students.



Figure 5. Children building a cactus with spines (left) and a green-leafed plant with too-large leaves.

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