Journal for the Education of Gifted Young Scientists, 10(3), 399-409, Sept 2022
e-ISSN: 2149- 360X
jegys.org
dergipark.org.tr/jegys

Young Wise Publishing
youngwisepub.com
gencbilgeyayincilik.com
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Research Article

Example of thematic learning in early childhood science education: seed

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Article Info

Received: 24 May 2022
Accepted: 20 July 2022
Available online: 30 Sept 2022

Keywords:
Conteptual change
Nature education
Preschool science education
Teaching concept

Abstract

The aims of the study are to prepare an instructional design that supports the development of children's basic scientific process skills for the seed theme and to examine the effectiveness of this design and to improve the awareness of preschool children about the concept of seed. In line with the purpose of the research, the changes in children's prior knowledge about seeds after implementing the activities that address the different skills in the acquisitions and indicators in the preschool curriculum were examined. The research was conducted with 198 preschool children attending a public preschool in the province of Izmir in the 2021-2022 academic year. The children's ages range from four to six years. During the research process, teachers were firstly given training about seed plants, flowering plants, fruit, seeds, and seed germination by academicians who are experts in the field of biology. The teachers who received this training also carried out eight activities with children about the topics of what the seed is, the importance of the seed, and the benefits of seed preservation. With the aim of determining the children's prior knowledge about seeds, open-ended structured questions developed by the researchers were asked to the children before the activities, and their answers were recorded. The same questions were asked after the activities were completed and the answers were recorded again. This study is a case study, one of the qualitative research methods. One-third of the children' answers were coded by two independent experts, and then preliminary codes were created. Afterward, all responses were evaluated with these codes. The results of the analysis determined that while the knowledge and awareness of the children about seeds were low at the beginning, this level increased after the study. The study is thought to contribute to teachers and researchers who develop activities on seed awareness and can be an example of how to develop thematic instructional designs science education in the preschool period.

To cite this article:

Ucuncu, G., Karakaya, F., Yilmaz, M., & Girengir, A. (2022). Example of thematic learning in early childhood science education: seed. *Journal for the Education of Gifted Young Scientists*, *10*(3), 399-409. DOI: http://dx.doi.org/10.17478/jegys.1135189

Introduction

Plants are in the first step of ecosystems' food chains in terrestrial and aquatic environments. Plant and other photosynthesizing creatures (producers) capture the energy entering an ecosystem as sunlight. These creatures absorb

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and transform the Sun's energy. Thereby, they store this energy in sugars and other complex molecules. These molecules then create food for a series of consumers, such as animals fed on by eating the producers (Urry et al., 2021; Cunningham & Cunningham, 2018; Mader & Windelspecht, 2018). About 326 thousand plant species have been defined so far in the world. 89 % (291 thousand) of these are seed plants (Urry et al., 2021; Bevanger, 2019). On the other hand, 290,000 of the seed plants consist of flowering plants, and very few of them are gymnosperm plants. Seed is the structure that enables reproduction in seed plants. It contains the embryo, which is a small outline of the plant. The seed consists of an embryo sack with a source of nutrients in a protective coat. When the seeds mature, they are separated from their parent plants by wind or other means. The seed can survive for days, months, or even years when released from the parent plant. Therefore, a seed can be described as a mobile model of a pregnant woman's uterus. Under proper conditions, the seed germinates. The embryo comes out of the seed coat as a sapling (young plant). Some seeds fall next to their parent plants, while others are carried far away by wind or animals. For seeds to germinate, proper temperature, water, air, and light changes are necessary. The fruit protects the encircled seed and helps attract seed-dispersing animals (Urry et al., 2021; Sadava et al., 2017). Seed plants have also had a tremendous impact on the human community. Around 12,000 years ago, humans began cultivating wheat, figs, corn, rice, and other wild seed plants. The domestication of seed plants, especially flowering plants (angiosperms), enabled the most important cultural change to reveal in human history. Gymnosperm plants typically bear ''naked'' seeds on the surface of the cone scales. The most crucial difference that distinguishes flowering plants from gymnosperm plants is that they have flowers and fruits (Urry et al., 2021; Freeman et al., 2020; Sadava et al., 2017; Simon et al., 2020). These different plant species can be distinguished from each other by the distinct characteristics of their organs (roots, stems, leaves, and flowers), such as morphological, anatomical, and molecular structures.

Various answers can be given to the question*, ''Why should biodiversity, including plants, be protected?''.* Our aesthetic values and the fact that they offer countless products to people are some of them. Undiscovered or unused plant species may be necessary for future uses such as food, medicine, vegetable fiber, fuel, rubber, and wood. Efforts should be made to educate individuals on the issues of nature, protection, and biodiversity from the youngest age they can academically comprehend. It is essential to instill love and respect for the aesthetic beauty of natural life, especially in children (Simpson, 2019; Belk & Maier, 2019; Simon et al., 2020*).* In this context, the Science Curriculum includes the acquisition of ''F.3.6.1.2. *The student presents the observation results of the life cycle of a plant''* (MoNE, 2018a, p.18). And the Secondary Education Biology Curriculum includes the acquisitions of ''9.3.2.1. *The student explains the realms used in the classification of living creatures and the general characteristics of these realms*. 12.3.3.2. *The student explains the fertilization and the formation of seeds and fruits in flowering plants.* 12.3.3.3. *The student designs experiments in which seed germination can be observed''* (MoNE, 2018b, p.18). When the basic characteristics of the preschool education curriculum are examined, it is seen that students' learning by discovery is a priority. In this context, the priority of learning by discovery is defined in the preschool education curriculum as follows:

> *"In learning by discovery method, it is important for the child to actively participate in the learning process, transfer what s/he has learned to different situations and use it in new situations. The program encourages the child to notice what is happening around him, to ask questions about the subjects s/he is curious about, to research, to discover, and to learn by playing. Thereby, meaningful learning takes place instead of rote-based learning (MoNE, 2013, p.16)."*

Starting from an early age, it is vital for a sustainable Earth to develop individuals' awareness of the environment and to understand the ecological importance of living creatures. From this point of view, the study aims to enable preschool children to comprehend the function of seeds in seed plants, the conditions of germination and embryo development, and to realize plant diversity.

Problem of Study

The main aim of this study is whether the seed theme-based teaching designed for the preschool period is effective or not. The following problem and sub-problem questions are determined.

Main Problem:

What's the effectiveness of seed theme-based teaching designed for the preschool period?

Sub-problems:

- What is the change in the knowledge about the concept of seed before and after the instructional design implementation?
- What is the change in the knowledge about the function of seed before and after the instructional design implementation?
- What is the change in the knowledge about the protection of seed before and after the instructional design implementation?

Method

Research Design

This research was conducted on the seed awareness of preschool children. The study was designed as a case study, one of the qualitative research methods. Case study is one of the qualitative research approaches in which one or more cases limited in time are examined in depth (Creswell, 2007). From this point of view, the study is consistent with case study as it evaluates the prior knowledge of pre-school children about seeds and follows the activities conducted during the two-month period and the new ideas they have developed about the seed.

Participants

The participants of the study consist of 198 children attending a public kindergarten in Izmir province in the 2021-2022 academic year. The ages of the participating children in the study range from 45 to 71 months. 48% (f=96) of the children are females; 52% (f=102) of them are males. Ethically, the study was conducted with the children who volunteered to participate in the study, and within the knowledge of their parents.

Study Process

This research was conducted in two different training stages. First of all, preschool teachers who would perform study on seeds with children received training from an academician who is an expert in the field of biology. Next, the teachers developed some activities appropriate for the developmental characteristics of preschool children. These activities were evaluated by field experts and organized in a way that would not allow scientific errors. Table 1 shows the developed activities below.

Table 1. Activities Developed for Research

Activity Name	Activity Type	Acquisition of the Activity	Indicators
Activity 1: What is seed?	Language Development	Comprehends what s/he listens/watches	* Fulfils verbal instructions. * Explains what s/he listens to/watches. * Comments about what s/he listens to/watches.
Activity 2: Revived seed	Cognitive Development	Predicts about the object/case/event	* Gives clues to the object/situation/event. * Predicts by combining the clues. * Examines the real situation. * Compares the estimated situation and the real situation.
Activity 3: What is inside the seed?	Cognitive Development	Observes objects or living creatures. Expresses what s/he listens to/watches in various ways.	*Tells the name of the object/living creature. *Tells the colour of the object/living creature. *Tells the shape of the object/living creature. * Tells the size of the object/living creature. * Tells the length of the object/living creature. * Exhibits what s/he listens to/watches through paintings.
Activity 4: Importance of seeds for plants	Language Development	Expresses what s/he listens to/watches in various ways.	* Exhibits what s/he listens to/watches through dramas. * Exhibits what s/he listens to/watches through stories.
Activity5: How	Cognitive	Establishes a cause-effect	* Tells possible causes of an event.

to reserve seeds?	Development	relationship.	*Tells the possible consequences of an event.
Activity 6: What do the seeds need?	Cognitive Development	Pays attention to the object/situation/event.	* Focuses on the object/situation/event that needs attention. * Asks questions about the object/situation/event that attracts her/his attention. * Describes the object/situation/event that attracts her/his attention in detail.
Activity 7: What plants are grown in our country?	Art Activity	Follows the directions about the location in the space. Prepares object graph.	* Places the object in the right place in accordance with the instruction. * Creates graphics using objects.
Activity 8: What if there were no seeds?	Language Development	Expresses what s/he listens to/watches in various ways.	* Exhibits what s/he listens to/watches through dramas.

After the activities were developed, pre-interviews were conducted with the children, and the data of these interviews were recorded. The activities designed were implemented for two months and every stages of them, from their implementation to the evaluation processes, were recorded. For example, children were asked to bring different seeds to the school in the first activity, and these seeds were examined as well as the seeds of cones and other plants discovered in the school garden. The visuals of this event are shown in Photo 1.

Photo 1. "What's Seed?" and "What's Inside Seed" Activities

As another example, in the fifth activity, the factors (temperature, humidity, light) that a seed needs in the process of becoming a plant were followed by experiment and observation. In Photo 2, there is an example of the data recorded by the students about their experiments.

Student data recordings about the development processes of the seed: The seed is at dark (upper left); it is unwatered and in a cold place (upper right); it is watered and in a cold place (lower left); it is at appropriate temperature, watered, and in a sunny place (bottom right)

Photo 2. An Example of Observation Form for "Revieved Seed" Activity

Photo 3 shows the visuals of the smart pots prepared by the students for the seeds to grow in the appropriate environment as a result of the observations made with the experiments.

Photo 3. Smart Pots Prepared by Students

Data Collection Tools

In the research, first of all, the answers of preschool children were recorded after they were interviewed by using semi-structured interview forms in order to reveal their prior knowledge about seeds. Then, the semi-structured interview form was evaluated by an expert in science and biology who studied a doctorate and a preschool teacher with a master's degree. Lastly, the research was started by common consent about its appropriateness for the age group. During the implementation of the activities, evaluation studies were carried out in accordance with the content of each activity while planning them, and students' progress was followed. Since these evaluations were performed for following the process, the results of these evaluations were not included in the findings. When all the activities were completed, it was aimed to determine whether there was a change in the prior knowledge of children about seeds by using a semi-structured interview form.

Data Analysis

For data analysis, the content analysis method was used. Content analysis is a detailed analysis method that follows the processes of coding the obtained qualitative data by independent coders, controlling the compatibility of the codes, and determining the themes created by the compatible codes. In this method, one-third of the data obtained from the semi-structured interview forms were analyzed by two independent coders, and preliminary codes were created. Miles and Huberman's (1994) percentage agreement between coders formula (the number of agreements/ the total number of codes x100) was applied for preliminary codes. Thus, the codes to be used to analyze all data were determined. For example, in the coding of the semi-structured interview form questions, the percentage agreement was 83% for the 1st and 6th questions; and 100% for the 2nd, 3rd, 4th and 7th questions.

Results

In this section, the answers given by the children to the semi-structured interview questions are presented in tables in the form of codes, themes, and sample opinions. To compare the preliminary knowledge and post-study situation, the pre-study and post-study opinions are given comparatively in the same table.

Conceptual Change for the Concept of Seed

For the findings in this category, the answers given to the questions of ''What is the seed?'', ''Is the seed alive?'' and ''What does the seed look like?'' were analyzed by combining them. The children's prior knowledge about the seed before the activities and the opinions they stated about the seed after the activities were coded and presented in Table 2.

Table 2. Pre-study and Post-study Opinions of Children on What a Seed is

Opinions	Theme	Codes	Sample Children Opinions
Pre-study	Vitality	Growing/developing/ living	*C-42: A seed is something that grows when planted. There is a plant in it. It is alive because it grows. C-17: It is alive because trees and flowers come out of it.
		Inactive/ nonliving	C-43: The seed is nonliving. It has no brain and no heart. C-34: The seed is nonliving because it does not speak to us.
	Image/ Visual	A fruit	C-40: Seeds allow trees to form fruits. They grow and become fruit.
		A flower	C-1: You plant the seed, it becomes a flower. A seed is something like a flower. C-44: Seed means flower.
		A core	C-38: A seed is a core. It is nonliving, it has no body. It cannot see. C-36: It is the core of an orange, an apple. The seed is nonliving. It is in the fruits.
		Circle	C-26: The seed is circular and black. A tree grows from seed. C-21: It is a red, earthy, circular thing.
		Small	C-41: The seed is something like the sand in the garden. It is tiny. But it grows, becomes a flower. C-15: The seed is small. It grows and develops, it provides plants to live.
Post-study	Vitality	Has cells/ alive	C-1: The seed is a sleeping baby. It has cells in it. It grows when watered and placed on the windowsill. C-17: The seed is alive. When you give water, it grows and develops. C-34: The seed cannot talk to us, but it is alive because it grows when we give water to it. C-43: It grows with water, so it is alive.

*C: Children

When Table 2 was examined, it was determined that the children had different opinions about the seed's being living and non-living before the study. Since they identify its livingness situation with themselves concretely, they regard the seed as nonliving; it is understood that some students claim that the seed can be living because it can grow. The children who inferred that the seed was a plant or part of a plant described it as a small, round-shaped structure that could be cultivated based on their observations. After the events, multidimensional perspectives and ideas were replaced by a more homogeneous definition. The seed is defined as a living structure that develops, grows, and sustains plant life under certain conditions.

Conceptual Change for Function of Seed

In this category, the answers to the questions of "What does a seed do?", and "What does the seed do for plants?" were analyzed by integrating. The codes created from the data obtained from the pre-study and post-study opinions according to the analysis results are given in Table 3.

Table 3. Children's Pre-Study and Post-Study Opinions on the Function of Seeds

Opinions	Theme	Codes	Sample of Children Opinions
Pre-study	Plant development	Growth of plants	*C-5: It provides plants to grow. C-58: It makes the plant grow.
		Flowering	C-2: It becomes a flower. If there is no seed, there will be no carrot, no watermelon, and no tomatoes.
	Benefit to humans	Forming a fruit/vegetable	C-15: Seeds grow plants. They form fruits and vegetables. C-42: It enables the plant to bear fruit.
		Healthy for humans	C-9: It keeps us healthy because we eat the seeds. C-40: It allows us to eat fruits and vegetables.
Post-study	Plant development	For plants to survive	C-2: It ensures for the plants grow and develop. C-15: Roots come out of the seeds of plants, the seed cracks, grows, and forms the plant. C-42: It makes the plant grow. C-58: Seed keeps the plant alive.

*C: Children

When Table 3 is examined, it is seen that the majority of children thought that the seed enables the plants to grow, enables them to bloom, and contributes to the creation of nutrients for humans before the study. However, after the activities were carried out, they started to think that the seed is a part of the plant's life cycle, and that the plant needs seeds to continue its life.

Conceptual Change for Protection of Seed

In this category, the answers to the questions of "Do you think it is beneficial to store seeds? Please explain why.", and "Do you think having our own seeds is beneficial in the future? Why?" were analyzed. The codes created from the data obtained from the pre-study and post-study opinions according to the analysis results are given in Table 4.

Table 4. Opinions on the Importance of Seed Collection and Storage

Opinions	Theme	Codes	Sample of Children Opinions
Pre-study	Benefit to humans	Becoming a tree/ blooming	C-12: A flower becomes a seed and a tree grows. To have a tree, we must store seeds. C-43: We make new flowers from seeds.
		Forming a fruit/vegetable	C-57: Yes, saving seeds is beneficial. Because they form fruits and vegetables. C-7: We must save the seeds, they will be food for us.
	Safety	Preventing it from being stolen	C-2: We must keep our seeds so that others cannot take our seeds. C-8: In order that our seeds are not stolen, we should keep them in the drawer. C-22: We must hide our seeds in a place where no one knows, so they do not take them.
	Negative opinions	It does not bloom/plant does not grow	C-1: Let's not hide the seeds, let them all bloom. They can't grow if we hide them. C-45: If we store the seeds, they will not grow. So storing is not a good thing.
Post-study	Sustainability of plant life	For plants to live	C-1: Storing seeds allows us to grow plants later. We plant seeds, we water them, and then we have plants. C-7: We will need stored seeds to grow plants. C-12: If we store our seeds, we use them to grow plants in case of fire in the future. We sow them, and they become trees.
	Benefit to humans	For nutrient production	C-21: We sow seeds later to grow tomatoes and carrots. C-10: We plant seeds in our garden to grow fruit and vegetables. That's why we need seeds.
		Giving strength	C-2: Storing our seeds gives us strength.

*C: Children

When Table 4 is examined, the children are seen to have negative opinions as well as positive opinions about seed preservation in the pre-study interview. Children have the idea that storing seeds will prevent plants from growing. In addition, the word ''storing'' formed a concrete meaning for children in this period, such as hiding, keeping it from thieves, and the children thought that it was necessary to hide the seeds for security reasons. The idea about the use of seed storage for later consumption as a nutrient was a common idea both in the pre-study interview and in the post-study interview. However, in the pre-study interview, it was determined that the children who stated the idea of seed's benefit to humans for growing fruit and vegetables changed their minds in the post-study interview. They emphasized the idea of its benefit to the plants as stating that the plants could continue to live because of seeds, and seeds contribute to the cultivation of new plants.

Discussion and Conclusion

This study aims to develop the awareness of preschool children about the concept of seeds. In line with the aim of the research, changes in the prior knowledge of children about seeds as a result of the activities carried out were examined. Furthermore, the prior knowledge of children about what a seed is and its function were also studied. In the study, it was found that children had prior knowledge that the seed is alive because it is a growing/developing structure, and nonliving because it is inactive. It has been observed that children resemble seeds to different parts of the plant (flowers and fruits) in shape and image.

Moreover, it has been determined that they have preliminary information about the growth of plants, flowering, forming a fruit/vegetable, and functions for humans. According to the results of the research, it can be said that there are scientific errors in children's prior knowledge of what the seed is (definition) and its function. It is thought that the lack of sufficient knowledge of preschool teachers about science concepts is a cause of this situation.

Önal and Kızılay (2021) emphasized that teachers should have high-level knowledge in order to teach preschool science concepts. On the other hand, Şimşek, and Çınar (2012) stated that for effective science education, preschool teachers should have knowledge about basic concepts (electricity, magnetism, acid, and base, etc.), especially about plants and the environment. However, studies in the literature have shown that preschool teachers do not have sufficient knowledge of science concepts (Cho, Kim, & Choi, 2003; Dağlı & Dağlıoğlu, 2020; Kallery, 2004; Yıldız & Tükel, 2018). For example, Dağlı and Dağlıoğlu (2020) determined in their study that teachers' lack of knowledge about science concepts was effective in not including scientific activities in pre-school education. Within the scope of this study, the children were determined to make different definitions from each other when describing the seed before the research. However, as a result of the activities carried out in the research, they made similar definitions of seeds. The children defined the seed as the structure that develops under certain conditions and enables the plant to survive. According to the study results, it can be said that children's participation in activities addressing different skills is effective in eliminating scientific errors in their prior knowledge about seeds. When the literature is examined, it has been seen that applied activities in which children directly participate are very effective in teaching science concepts to children in preschool education (Sadikoglu & Durmuş, 2022). As a matter of fact, according to Morgan et al. (2016), the implementation of science activities and the experiences will lead to an increase in the future science success of preschool children.

In the research, the children's opinions about the importance of collecting and storing seeds have been determined. Children stated that seeds should be stored in terms of benefit to human, safety, and flowering/plant growth. However, the children emphasized after the activities that the seeds should be protected for the plants to survive and for benefit to human. According to these results, it can be said that the developed activities helped children to build different understanding. Looking at the world with a scientific perspective, encountering natural and technological events, and taking part in processes such as decision-making and discussion have contributed to children (Stylianidou et al., 2014). Hereby, activities that preschool teachers will develop for different science concepts in early childhood are essential for sustainable education (Borg, Winberg, & Vinterek, 2017; Engdahl, 2015; Koca, Aydın, & Sert, 2022). In addition, offering different learning environments to children contributes to their cognitive, mental, and emotional development (Karakaya, Yılmaz & Bozkurt, 2022; Sadikoglu & Durmuş, 2022). When the literature is examined, it is seen that the implementation of activities involving science concepts in the preschool period allows children to gain curiosity, interest, and different perspectives towards concepts (Bosse, Jacobs, & Anderson, 2009; Durmuş, 2021). According to Alade et al. (2016), activity-oriented science education should be applied to develop the processes of problem-solving, creative thinking, and discovery in preschool children. Moreover, studies have also shown that it is essential for preschool teachers to implement activities that are fun, gain life experience, and include different skills for science education (Sağlam & Aral, 2015). These results support the findings of the study.

Within the scope of this research, the concepts of seed plants, flowers, seeds, and germination of seeds, which are expected to be learned in science and biology courses by students in primary, secondary, and high schools, were practically taught to preschool children. Similar studies can be planned for other concepts in science. It is thought that the reason for the successful results of this research is that the teachers' level of content knowledge about the subject was improved before the study. Teachers who firstly internalized the concepts were very successful in reducing the practices to the children's levels and gave scientifically correct answers to the children's questions. For this reason, conceptual knowledge of teachers, who are practitioners in science activities planned for children, are expected to be at sufficient level. The teachers found it very helpful to be informed by experts before the implementation process, and they stated that they had not received this knowledge during their undergraduate education. One of the most important outputs of this research is that children can easily learn the concepts that are taught. This is because a child can individually participate in all stages of the activities and interpret the results of the practices alone. It is thought that making similar plans and practices for other subjects in the program would be beneficial.

Recommendation

Recommendations for Further Applicant

In this study, seed-themed activities were developed for the preschool period to support the development of children's scientific process skills. In the studies to be carried out, different themes from this theme can be focused on. For example, a study can be carried out on the parts of plants that can be encountered in daily life and open to observational activities and their development. In this study, conceptual change was examined. Researchers can replicate this study by focusing on its effects on children's science process skills.

Limitations of the Study

This study is limited to the changes in the knowledge of preschool children about the concept of seed. In terms of the study group, it is limited to children age 4-6 years.

Acknowledgements

The authors would like to express their sincere thanks to the Cıglı Neriman Haşim Emirli Preschool's teachers and masters for allowing us to conduct this study. We also want to acknowledge the reviewers from JEGYS for their valuable comments. The authors declare that they have no conflict of interest.

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