

A Case Study on Preschool Children's Perceptions of Biomimicry

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ABSTRACT

The main purpose of this research is to examine the biomimicry perceptions of preschool children. A case study, one of the qualitative research models, was used in the research. This research was conducted with the participation of 11 girls and 10 boys, aged between 50-65 months, who were studying in an independent kindergarten affiliated with the Ministry of National Education in Gaziantep in Turkey in the 2023-2024 academic year. Photographs and observer notes were used as data collection tools in the research. In explaining the science of biomimicry, the book "I am Hezarfen" written by Müzeyyen Erkul Art and Science Center and Suat Turgut (2018) was used. Through the activities, children were given detailed information about the science of Biomimicry and presentations were made. Within the scope of our study, one-week activity plans were created using the 5E model. At the end of this planning process, the children were allowed to create product designs. Findings emerged that during the activities, children used problem solving, collaboration, communication, research-discovery and creative thinking skills, which are 21st century skills. As a result, it has been observed that the activities carried out with preschool children have positive effects on children's perceptions of biomimicry.

KEYWORDS

Biomimicry; biomimicry; preschool period; design.

INTRODUCTION

Nature contains endless and unique formations that people are trying to discover. Diversity in nature has inspired developments in many fields, from art to education, from architecture to engineering. People have often created new products and designs by imitating nature in technological development (Avcı, 2019). Hezarfen Ahmet Çelebi, who made his first flight with artificial wings as a result of his observations by watching the flights of birds, inspired by nature, designed the primitive form of today's aircraft (MGM, 2009). As in the past, nature will continue to be a source of inspiration for the challenges to be encountered in the future. Biomimicry is an elegant component of sustainability and innovation (Kennedy et al., 2015). Sustainability; It can be defined as being permanent. Biomimicry science has guiding effects in ensuring the sustainability of world resources (Eryılmaz, 2015; Shimomura, 2010).

There are many definitions of biomimicry. When we look at the definitions of biomimicry, it is stated as imitating nature and being inspired by nature while producing a solution to a problem. Following these stages, it is aimed to create a solution and overcome the problem. (Avcı, 2019; Çelikel & Uçar, 2020; Eryılmaz, 2015). The concept of Biomimicry, which investigates that wisdom should be learned not only from human genius but also from the genius of nature; It was first put forward by Janine Benyus in 1997 (Avcı, 2019; Dicks, 2023). According to Dicks (2023), there are 3 basic principles of biomimicry, which Janine Benyus focuses on:

- Nature as model
- Nature as measure
- Nature as mentor

Nature as a model: Finding solutions to people's problems by imitating nature. For example; There are many different examples such as the invention of fins based on whales to swim comfortably, the production of climbing shoes based on lizards, and the dragonfly's ability to use air flow effectively, inspiring helicopter designers.

Nature as a measure: Biomimicry determines whether it is good or bad by considering the ecological balance.

Nature as a mentor: Biomimicry is a new way of seeing and valuing nature, which is the principle of schools that teach in nature today, such as forest schools.

Biomimicry serves as a bridge with other sciences while utilizing the principles of nature (Shimomura, 2010). Within the framework of biomimicry science, each discipline is inspired by nature within its own borders. While it is an artistic resource for architects, it also serves as a model for engineers. While being inspired by nature, it is not right to just make observations; it is of great importance in its functioning (Genç, 2023). In summary, the science of biomimicry; It consists of two stages: making observations in nature and making a design after the observation; (Avcı, 2019).

Considering 21st century skills, biomimicry also comes to the fore in the field of education. Areas where biomimicry science is effective in children's 21st century skills: They are listed as innovation, scientific process skills, ecological literacy, interdisciplinary work, design

and production (Avcı, 2019; Sorlu, 2010; Yakışan & Velioğlu, 2019; Yıldırım, 2019; Sumrall, Sumrall and Robinson, 2018).

Biomimicry includes activities that enable children who have moved away from nature to reconnect with nature and discover the riches of nature (Avcı, 2019). Nature is not a place where you spend limited time. It is a need that must be touched every day during childhood. Children's curiosity and research instinct towards all living and non-living beings in nature can only be realized when they integrate with nature. In this sense, biomimicry offers these opportunities abundantly (Ergül, 2023). In addition, the science of Biomimicry offers children the opportunity for ecological literacy at an early age and raises awareness about nature. Ecological literacy is very important for a sustainable world (Collado-Ruano, 2015).

Preschool period is a period when children's curiosity is extremely high, they are ready to explore and can use their creativity to a great extent (Yaşar and Aral, 2010). In the preschool period, when children are actively involved in the process by asking questions, seeing, hearing, touching, their learning accelerates. Environments outside the classroom offer these opportunities to children. Nature; It is a unique resource waiting to be discovered for children and offering the opportunity to experience while exploring (Temiz and Karaaslan Semiz, 2019; Köşker, 2019). Activities related to nature will also enable children to know nature better and gain ecological awareness (Köşker, 2019).

Among the goals taken in the 2023 education vision, it is mentioned that design workshops will be created where children can work on thinking, designing and producing. Considering the steps in the educational vision and the contribution areas that biomimicry will provide to children, it is thought that planning design studies within the scope of biomimicry science for preschool children will be beneficial in terms of introducing children to biomimicry science at an early age (Meb, 2018).

METHOD

In this study, a biomimicry-containing training program prepared with the 5E learning model was applied by the researchers. 5E model; It is a learning model consisting of five stages, which ensures active participation of children at each stage and supports their own learning. During this model process, children reach new concepts and make sense of the concepts based on their previous knowledge and experiences (Ergin, 2009).

This study aimed to examine the effect of children's interest, learning and attitudes towards the science of biomimicry. For this purpose, the research was designed as a case study, which is a qualitative research model. The purpose of qualitative research is to reveal the depth of description and meaning (Büyüköztürk et al., 2022). In case studies, data may be collected differently. In this study, data was obtained from observation, observation notes, video and camera recordings. The stories and activities of the training program to be implemented were created by the researchers and expert opinions were received. The concepts, achievements and indicators used during the program were selected in accordance with the development levels

of the children, and the activities were planned and implemented to last 1-1.5 hours. As activity materials, slides related to biomimicry were prepared, videos were compiled, a story book was selected, and patterns appropriate to the story written by the researchers were created. One of the researchers in this study is also the classroom teacher, that is, the practitioner himself. For this reason, he participated in the activity with the children at every stage of the activity and provided the necessary guidance.

A weekly training flow suitable for the 5E training model to be carried out during the research process was planned and the application activities carried out for each day are presented in Table 1.

Table 1.

A Weekly Training Flow Plan Suitable for the 5E Training Model

DAYS	5E STEPS	CONTENTS
1st day	1E INTRODUCTION	<ul style="list-style-type: none"> Organizing a trip to Müzeyyen Erkul Art and Science Center Presentation of the “Hezarfen Ahmet Çelebi” model Reading a story book about “Hezarfen Ahmet Çelebi”
2nd day	2E EXPLORING	<ul style="list-style-type: none"> Promotion of Biomimicry Science with slides and videos (https://www.youtube.com/watch?v=eM0IDHAnL7A , https://www.youtube.com/watch?v=DuAbJSWEpk)
3rd day	3E DESCRIPTION	<ul style="list-style-type: none"> Poster presentation (Picture 1) and storytelling appropriate to the content of the story “Fashion Workshop for Children in the Forest” Introduction and experience of design patterns (Picture 2) Photographing the experiences
4th day	4E DEEPENING	<ul style="list-style-type: none"> Viewing and interpreting the photographed experiments as slides Introducing the materials to be used in the design and sharing them to the groups Application
5th day	5E EVALUATION	<ul style="list-style-type: none"> Placing the Finished Design Products on the model Exhibition



Picture 1. Event Poster



Picture 2. Design Patterns

Ethical issues

This research was approved by the Scientific Research and Publication Ethics Committee of Hasan Kalyoncu University on 12.12.2023 with the decision numbered E-97105791-050.01.01-47816. A meeting was held with the families of the children, the application was explained and a voluntary consent form was obtained from the families. The application to be done by the teacher was explained to the children in advance. The application was implemented by the teacher of the class, taking all security measures.

Working group

This study was carried out in the spring semester of the 2023-2024 academic year at Zeynep Gençten Kindergarten, affiliated with the Ministry of National Education in Gaziantep. The study group consists of 21 children aged 50-65 months.

Table 2.

Distribution of children by month and gender

Gender	50-54 months old	55-60 months old	61-65 months old	N	%
Girl	6	5	0	11	52
Boy	6	2	2	10	48
Total	12 (%57)	7(%33)	2(%10)	21	100

Looking at the results in Table 2; Of the 50-65-month-old preschool children participating in the research, 52% are girls and 48% are boys. 57% of the participants are 50-54 months old, 33% are 55-60 months old, and 10% are 61-65 months old.

Table 3.

Demographic information of the participants

Variables	Degrees	N	%
Mother's Educational Status	Primary school	1	5
	Middle school	1	5
	High school	1	5
	Associate degree	1	5
	Undergraduate	14	67
	Graduate	3	13
Father's Educational Status	Primary school	2	10
	High school	3	14
	Undergraduate	13	61
	Graduate	3	14
Mother's Profession	Housewife	9	43
	Architect-Engineer	2	10
	Teacher	6	28
	Other	4	19
Father's Profession	Tradesman	1	5
	Architect-Engineer	7	33
	Teacher	3	14
	Other	10	48
Income Status of Families	Average	7	33
	Good	12	57
	Very good	2	10
Number of siblings	0	3	13
	1	14	67
	2	2	10
	3	1	5
	4	-	-
	5	1	5
Birth order	1.	11	52
	2.	7	33
	3.	2	10
	4.	1	5

Looking at the results in Table 3; While 67% of the mothers have a bachelor's degree and 13% have a postgraduate degree; 61% of the fathers have a bachelor's degree and 14% have a postgraduate degree. 57% of mothers are working mothers. It is seen that the highest

percentage in the profession category of fathers is in the Architect-Engineering category (33%). Considering the income status of their families; It is seen that 33% have medium income, 57% have good income and 10% have very good income. When we look at the number of siblings of the children; It is seen that 13% have no siblings, 67% have one sibling, 10% have 2 siblings, 5% have 3 siblings and 5% have 5 siblings. The majority of children are first children (52%).

Event App

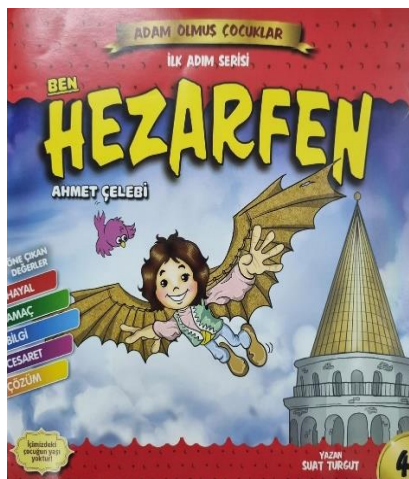
Abbreviations; O.N.; Observer Note

FIRST DAY

1E Introduction: During the trip to Müzeyyen Erkul Art and Science Center, children's attention was drawn to the scientist Hezarfen Ahmet Çelebi and explanations were made about who he was (Picture 3). After the trip, in the class conversation, short talks were made about other scientists they saw at the Science Center, and the children were allowed to express their knowledge and experiences by focusing more on the details that would emphasize the importance of Hezarfen Ahmet Çelebi. Then, the story book "I am Hezarfen" written by Suat Turgut was read (Figure 4-5) and intriguing questions were included at the end of the story, allowing the children to think and discuss the flying attempts in the story. It was stated that the flying experiments in the story were products influenced by nature and integrated with science, and that the name of it as a branch of science was "Biomimicry", thus helping children understand the relevant concept. Similarly; The words "Design, curiosity, imagination" in the story were discussed and the children were given the opportunity to share their thoughts and what they had learned with each other through various questions directed by the teacher.



Picture 3. Entrance Step
(Visiting the science center and
reading the story book)



Picture 4. "I am
Hezarfen" Story Book



Picture 5. "I am
Hezarfen" Story Book

Second-Day

2E Exploration: Using slides and videos containing various examples, the Science of Biomimicry was introduced in more detail with explanations that children could understand (Picture 6) and what the science of Biomimicry is was discussed.

O.N.; 1 *"While children called the pictures they saw at first "dress", they started to call them "dress design" at the end of the slides."*



Picture 6. Discovery Step (Introduction of Biomimicry Science)

Third-Day

3E Description; Before telling the story of "Fashion Workshop in the Forest", created by researchers to make it easier for children to understand the Science of Biomimicry and to help them use their imagination; The attention of the children was attracted with the poster prepared in accordance with the content of the story, and the storytelling was started by allowing them to express their thoughts about what they saw. After the problem situation that constitutes the essence of the story was defined by the children, pre-prepared design patterns that would help them produce solutions were introduced, children were left free to choose the patterns they wanted, and an explanation was given on how to use the patterns. On the same day, a trip to the market was organized to observe the fruits and vegetables mentioned in the story more closely, and the children were asked to experiment with the design cards given to them (Figure 7). After the trip; Slide presentations of the animals mentioned in the story were made in the classroom environment and they were allowed to try the design patterns on the screen reflections (Figure 9). Afterwards, the children were asked to go out to the garden and experiment by using the molds prepared for making crowns on the plants in the garden (Picture 8). Each experience was recorded by taking separate photographs.

O.N. 2 ; *"It is noteworthy that boys do not choose clothing styles. Only girls chose the dress patterns, only boys chose the shoe patterns, and both boys and girls chose the crown patterns."*

O.N. 3; *"The children were very excited and surprised at each try."*

Story: "Fashion Workshop in the Forest"

"Once upon a time, every forest had a queen. One day, a ball was organized in which all the forest queens in the world would attend. Unfortunately, the queen in one of the forests had no preparations for the ball. What can I do? He started to think. Then a very good idea came to his mind. She prepared illustrated posters on a huge piece of cardboard explaining that she wanted to go to the ball organized for the forest queens, and for this, she needed a dress that no one had ever seen before and that they would admire when they saw it, of course a pair of shoes, and most importantly a crown that they would not be able to take their eyes off of, and she hung them on all the trees in the forest. hung it. The Queen began to wait, confident that this would work and that her friends in the forest would prepare the most beautiful clothes for her. They examined these posters with pictures of animals, plants and fruits living in the forest with interest and decided to hold a meeting, saying that their own queen should be the most beautiful queen at the ball. At the meeting, the animals said, "We have feathers in different patterns. "We can make a very beautiful dress for our queen by using these," they said. They said, "We have many different colors of fruits and vegetables. We can use this to make a very different and stylish shoe for our queen. Maybe we can get help from the leaves of the trees while decorating the shoe." The majestic rocks in the forest, the stones shining brightly on the ground, leaves, flowers and even tree branches said, "We too will make the crown of our queen." They were all very happy and set to work as soon as possible to make the queen's dress, shoes and crown. The animals visited all the animals in the forest one by one and took pictures of the most beautiful patterns. They produced fabrics using these patterns and sewed a wonderful dress with these fabrics. They have prepared a wonderful pair of shoes using the most vibrant and impressive colors of fruits and vegetables. Of course, the most important thing was the crown the queen would wear on her head. The crown was supposed to be very eye-catching and the most beautiful crown ever seen. All the stones, leaves, flowers and tree branches in the forest came together. After good planning, they left the meeting having decided which ones to use. The day of the ball was getting closer and the Queen was waiting with curiosity to see what would happen, unaware of all these preparations. Then the preparations were finished. A giant mirror was set up in the forest and the queen was invited. The queen put on her dress, shoes and crown and stood in front of the mirror. When the queen saw herself in the mirror, she couldn't believe her eyes for a moment. The clothes he was wearing, his shoes and the sparkling crown on his head represented his friends in the forest. The Queen was very happy and thanked them all one by one and said, "I will go to the ball, but you will be there with me in my dress, shoes and crown." When the day of the ball came, they helped all the forest queens get ready and sent their queens off in a carriage pulled by deers. When the Queen arrived at the forest mansion where the ball would be held, she slowly got out of her car, walked to the door and entered. Suddenly, all eyes turned to the queen's magnificent dress, shoes and crown. The Queen became the most stylish queen of the prom. The Queen was very impressed

and very happy. When She returned to the forest, she told all her friends what happened, thanked them for their help and decided to open a forest fashion workshop together.”



Picture 7-8-9. Description Step: Trying Molds

Day 4

4E Deepening; The children's experiments using molds in different environments the previous day and photographed by the teacher were projected on the screen. One of the photographs belonging to each category is determined by voting, and the children; They were divided into 3 groups: one group to design a dress (Picture 10), one group to design a crown (Picture-11) and one group to design shoes (Picture-12). Using the patterns of their own groups, children will draw animal skin patterns on paper and use them as fabric patterns for dress design; They can use fruit and vegetable peels as shoe design and for crown design; It was explained that they could use stones, dry tree branches, leaves and flowers with different characteristics, and they were given free rein to create their designs, and teacher guidance was provided for necessary situations.

O.N. 4; “The children started talking about color harmony while experimenting.”



Picture 10. Deepening Step (Drawing Fabric Pattern for Dress Design)



Picture 11. Deepening Step (Crown Design) Picture 12. Deepening Step (Shoe Design)

Day 5

5E Evaluation; At this stage, the fabric patterns prepared by the children by drawing on paper were combined with the children's ideas and under the guidance of the teacher, and the queen's dress was completed (Pictures 13-14). Similarly, after the final version of the products designed for the queen's shoes and crown was evaluated with the children, the application ended by testing the created designs on a child (Picture 15).

O.N. 5; *"All of the girls stated that they felt like queens when they tried the designed products."*

O.N.6; *"When asked about the aspects of the activity that most interested them and what they liked, the children answered that it was the discovery and design part they made with cards in the garden." they preferred."*

O.N.7; *"Children preferred to use patterns that they were familiar with in daily life and saw more in their environment."*



Picture 13. Evaluation Step



Picture 14. Evaluation Step



Picture 15. Evaluation Step

RESULT AND DISCUSSION

In the study; The effect of the design activity developed in accordance with the 5E learning model on children's biomimicry perceptions was evaluated.

5E learning model; It consists of 5 stages that increase children's research-discovery curiosity, respond to their expectations, include skills and activities to focus on knowledge and understanding through an active research process, and also enable children's active participation in activities at each stage based on the preliminary information given and encourage them to create their own concepts. is a learning model. When we look at the studies in the field of education, it is emphasized that, based on the innovations in the constructivist approach and the developments in the field of psychology, people learn better by reconciling their personal experiences with the knowledge they have and believe in before (Martin, 1996). As a result of the study; It has been observed that with the training program prepared on the basis of the 5E learning model, children have access to detailed information about the science of Biomimicry, while they realize their knowledge and experience in the application phase of the study, they also actively participate by having fun, produce new designs and take a close interest in nature. According to the results of the study, it was concluded that the activities organized to recognize and understand the science of Biomimicry attracted the attention of children and that it was possible to implement the activities in the preschool period, as it was observed that they actively participated in every stage of the activities. Moreover; Based on the observer's note, only girls design with dress patterns, only boys design with shoe patterns, and both girls and boys design with crown molds. The gender of the children affects the material choices in the design process; It was observed as a remarkable situation in the study that the children in the dress design group were influenced by the animals they were familiar with in

daily life and saw more in their environment as fabric patterns, and that they preferred the patterns of these animals as fabric patterns and used them in their design works.

Considering scientific process skills, sustainability, innovation, ecological literacy, design and production in 21st century skills, the impact of biomimicry science on children is quite high (Avcı, 2019; Sorlu, 2010; Sumrall, Sumrall and Robinson, 2018; Yakışan and Velioğlu, 2019; Yıldırım, 2019).

In the updated Preschool Education Program; In order for children to be in touch with nature, outdoor play activities are determined as 1.5 hours a day. This information shows the importance of nature and the preschool period for exploration in nature. The program also prioritizes the development of creativity and learning through research and discovery (MEB, 2024). Since the science of biomimicry is a science based entirely on research and discovery, it is integrated with the new program. Early childhood years are years when creativity is very high because children have a lot of imagination (Quoted by: Çeliköz, 2017). Curiosity is an emotion that exists throughout life and initiates learning. Activities that nourish children's curiosity are important in terms of making sense of nature and the relationships in nature (Wendel, 2008). Due to children's natural curiosity, it is argued that design and construction activities are more suitable for children's nature than experimenting and researching. In addition, children have both the conceptual learning capacity and the basic process skills necessary for reasoning and reasoning during this period (National Council for Teacher Education [NRC], 2012). Activities that can be summarized as Design-Make-Explain can help children gain goal-oriented thinking skills by considering a difficult situation appropriate to their developmental level. A child who makes his own designs by imagining an interesting, different feature of a living thing must plan the process and convey it to those around him, even if he does this process only on paper (Ergül, 2023).

Through this study; By getting to know nature closely and learning its features through experience, it has been possible for children to discover the bridge between nature and science and nature and art. According to Collado-Ruano (2015); Biomimicry science provides children with the opportunity to meet nature at an early age and raises awareness of their knowledge and experiences. According to Temiz and Karaaslan Semiz (2019); Nature offers children an experimental, active learning environment. In this study; It has been observed that activities organized to understand biomimicry are very effective in providing children with opportunities to deeply examine the richness of nature, experience it and create interesting ideas.

Training organized to understand the science of biomimicry; It is suggested that all efforts, regardless of their age, should be evaluated in order to help children see the natural world, recognize its features, and understand that there is a different and new way to value nature. When planning age-appropriate biomimicry education and activities, determining the vocabulary appropriate to children's developmental levels to discuss the subject and selecting biomimicry examples with a level of complexity and which the target audience can connect with are among the main factors that should be taken into consideration (Biomimicry Institute, 2017-

2021). The selection of the activities and concepts frequently emphasized during the study process on the basis of this information has been one of the qualities that make the study unique in terms of its results. During the application process, children begin to make sense of and use the new words they learn; It has been revealed that the activity organized is effective in supporting children's language development and enriching their vocabulary. At the same time, observation findings regarding children talking among themselves about whether the colors they chose are compatible or not throughout the design process support that the study has a positive impact on the development of aesthetic perception in children. Supporting the colors, shapes, textures and similar or different features of living and non-living creatures in nature with biomimicry studies is very important in order to provide effective learning experiences that appeal to the senses. It is among the findings emphasized that children who actively use their senses with different stimuli can use their creativity more effectively, regardless of the type of activity (Ergül, 2023).

When the study process is evaluated in general terms, it can be seen that the topics and concepts included in the activities and the materials selected are appropriate for the age level of the children and that the activities provide the opportunity for children to use their creativity original and freely. Activities implemented at every stage of the study; It is aimed at children's interests and development levels, different achievements and skills are included in each activity, each child in the group makes decisions together by discussing and producing more than one idea for their designs in problem situations, testing and evaluating solution suggestions, as well as supporting the development of design-oriented thinking skills. has been remarkable.

It is thought that the application opportunities related to the science of biomimicry, which can be implemented at all ages and education levels, provide two basic benefits. First; Biomimicry activities, which use real-life experiences and concrete materials from nature, meaningfully support the developmental areas of preschool children, who have a high level of interest and curiosity towards living and non-living creatures in nature. The second is; Biomimicry activities make significant contributions to raising children who learn by directly interacting with nature and thus finding their place among living things, rather than raising children who learn by seeing or watching nature. Children who acquire and develop the need to establish a one-on-one connection with nature and the skills to use nature positively from an early age are likely to grow up with the awareness that they will make important contributions to creating the world of the future and become individuals who believe that they are a part of nature (Ergül, 2023). In line with this understanding, it is hoped that children who are supported from an early age will feel responsible for the world and the living things in it and strive to live in a system that can develop and change together.

Suggestions

This research can be applied to children in different age groups by using different education methods and changing the education period.

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