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Space Adventure for Little Explorers: Implementing the Engineering and Entrepreneurship Design Process in Preschool Education

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ABSTRACT

This study aimed to design, implement, and evaluate the feasibility of an activity titled "Space Adventure for Little Explorers", integrating the engineering and entrepreneurship design model within the STEM education framework into preschool education. The activity was structured in four stages: (1) Discovery with the Family, (2) Sharing My Discoveries, (3) Engineering and Entrepreneurship Design Process, and (4) Design Evaluation. The study was conducted with 20 kindergarten students (11 girls, 9 boys) aged five, attending a public primary school during the 2023–2024 academic year. Students with special needs were excluded. The "I Design My Own Rocket" activity was implemented over three days. A qualitative case study approach was employed, gathering data from preschool teachers, students, and their families. Findings indicated that considering students' readiness levels and employing various teaching techniques during phase transitions enhanced the activity's effectiveness. The integration of abstract concepts with real-life experiences facilitated students' conceptual understanding. Additionally, family-school collaboration and peer learning contributed significantly to the learning process. The activity provided students with hands-on experiences in problem-solving and engineering concepts, fostering creativity and engagement. It also improved their cooperation and communication skills. Students found the activity enjoyable and expressed a desire to participate again. Family involvement played a crucial role in enhancing learning motivation and self-confidence. It also supported students in developing information-seeking skills, reinforcing peer learning, and enriching the overall learning experience. In conclusion, integrating the engineering and entrepreneurship design model into preschool STEM education was found to be a feasible and effective approach.
Keywords: Preschool education, STEM education, engineering and entrepreneurship design model, space education.

Minik Kaşifler için Uzay Macerası: Okul Öncesi Eğitimde Mühendislik ve Girişimcilik Tasarım Süreci Uygulamaları

ÖZET

Bu çalışma, STEM eğitim yaklaşımı kapsamında mühendislik ve girişimcilik tasarım modelini okul öncesi eğitime entegre eden "Küçük Kâşifler için Uzay Macerası" adlı etkinliğin tasarlanması, uygulanması ve uygulanabilirliğinin değerlendirilmesini amaçlamaktadır. Etkinlik dört aşamada yapılandırılmıştır: (1) Aile ile Keşif, (2) Keşiflerimi Paylaşıyorum, (3) Mühendislik ve Girişimcilik Tasarım Süreci ve (4) Tasarım Değerlendirme. Çalışma, 2023–2024 akademik yılında bir devlet ilkokulunun anasınıfına devam eden, 5 yaşındaki 20 öğrenci (11 kız, 9 erkek) ile gerçekleştirilmiştir. "Kendi Roketimi Tasarlıyorum" etkinliği üç gün boyunca uygulanmıştır. Nitel araştırma desenlerinden biri olan durum çalışması kullanılmış ve veriler okul öncesi öğretmenleri, öğrenciler ve ailelerinden toplanmıştır. Bulgular, öğrencilerin hazırbulunuşluk düzeylerinin dikkate alınmasının ve aşamalar arasındaki geçişlerde çeşitli öğretim tekniklerinin kullanılmasının etkinliği daha etkili hale getirdiğini göstermektedir. Soyut kavramların günlük yaşamla ilişkilendirilmesi, öğrencilerin kavramsal anlamalarını kolaylaştırmıştır. Ayrıca, aile-okul iş birliği ve akran öğrenmesi öğrenme sürecine önemli katkılar sağlamıştır. Etkinlik, öğrencilerin problem çözme ve mühendislik kavramlarını uygulamalı olarak deneyimlemelerini sağlamış, yaratıcılıklarını ve katılımlarını artırmıştır. İş birliği ve iletişim becerileri gelişmiş, öğrenciler etkinliği eğlenceli bulmuş ve tekrar katılmak istediklerini belirtmişlerdir. Aile katılımı, öğrencilerin öğrenme motivasyonunu ve özgüvenini artırmış, bilgiye erişim becerilerini geliştirmiş, akran öğrenmesini desteklemiş ve öğrenme süreçlerini zenginleştirmiştir. Sonuç olarak, mühendislik ve girişimcilik tasarım modelinin okul öncesi STEM eğitimine entegrasyonu uygulanabilir ve etkili bir yaklaşım olarak değerlendirilmiştir.
Anahtar kelimeler: Okul öncesi eğitim, STEM eğitimi, mühendislik ve girişimcilik tasarım modeli, uzay eğitimi

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*The activity investigated in this study was designed and implemented as part of a master's thesis completed by the first author under the supervision of the second author

INTRODUCTION

In the contemporary era, often referred to as the "Space Age," concepts related to space science are among the topics frequently encountered by children. Preschool children must learn the concepts of the age in which they live and develop accordingly, as this lays the foundation for becoming scientifically literate individuals in the future. Concepts such as space, Earth, planets, and the Sun are included in the science curriculum for early childhood education. Integrating space science into early learning environments is considered a crucial factor in supporting the development of a scientific foundation among young learners. Teaching space science at an early age contributes to the development of children's scientific thinking skills and helps them make sense of the universe (Duran, 2023). Duran emphasizes that teaching space-related concepts during preschool significantly supports children's cognitive processes related to understanding the universe. Moreover, enhancing children's awareness of space enables them to gain new knowledge about astronauts, space vehicles, and the science of astronomy.

Space science fosters children's natural curiosity and contributes to the early development of fundamental scientific process skills such as questioning, observing, and hypothesizing. The vastness of space, the diversity of planets, and the requirements of being an astronaut offer academic knowledge and increase children's interest in STEM (Science, Technology, Engineering, and Mathematics), potentially influencing their future career orientations. In this context, the presence of aerospace engineers and space scientists in early childhood classrooms presents a valuable opportunity for raising career awareness among young learners (Duran, 2023).

Activities themed around space science naturally integrate the disciplines of science, technology, engineering, and mathematics. For instance, in space-related activities, children may explore planetary movements (science), design rockets (engineering), and use mathematical reasoning to understand rocket launch mechanisms. Hence, space science activities align closely with the STEM education approach. Designing such activities through a STEM lens is thought to provide students with an interdisciplinary perspective (Çetin et al., 2012).

Experiencing space science concepts at an early age in preschool learning environments contributes significantly to developing scientific thinking skills and enhances success in science-related learning (Çetin et al., 2012). Addressing abstract concepts such as space, planets, rockets, and astronauts as a core part of early science education helps children understand these topics and cultivates analytical and scientific thinking within the STEM framework. Research shows that implementing STEM practices in early childhood improves students' science and mathematics achievements while supporting the development of key 21st-century skills such as creativity, critical thinking, collaboration, and communication (Akgündüz & Akpınar, 2018).

Preschool children think and act like scientists and engineers by generating creative and innovative ideas. They are known for being inquisitive, curious, and exploratory, often asking questions to make sense of the causes and effects of everyday events (Gülden et al., 2023). Therefore, introducing STEM education at the preschool level is deemed appropriate. When children are provided with rich opportunities to explore their environment, solve problems, and think independently, these experiences contribute significantly to their cognitive development (Balat & Günşen, 2017).

For example, rocket design activities enable children to learn fundamental concepts in engineering and technology through hands-on experiences. During these activities, children learn about the structure of planets and the depths of space and gain awareness of scientific and engineering concepts. Furthermore, incorporating space-related themes into early childhood education has increased children's interest in scientific exploration and fostered their sense of wonder. Exploring astronauts' space missions, planetary differences, and rocket mechanics contributes to cognitive development and enhances inquiry, analysis, and synthesis skills.

Children are natural engineers; they enjoy designing, deconstructing objects, and discovering how things work (Cunningham, 2009). Studies indicate that children's capacity for engineering thinking is far more advanced than commonly assumed. They can consider multiple constraints, compare alternative designs, and articulate their reasoning from different perspectives (Cunningham, 2009).

In this regard, examining the feasibility of the activity "Designing My Rocket," which is based on the Engineering and Entrepreneurship Design Model, is crucial to understanding how early exposure to engineering education contributes to children's cognitive, social, emotional, and physical development. This study aims to gather the perspectives of preschool teachers, students, and parents regarding this activity. Additionally, the study seeks to offer solutions to challenges in teachers' knowledge and practices related to STEM and to propose a model for effectively integrating STEM education into early childhood settings.

Purpose and Significance of the Study

The primary aim of this study is to design activity plans in preschool education by integrating the STEM education approach with the engineering and entrepreneurship design model, to examine their applicability in classroom settings, and to evaluate the processes involved. Additionally, the study explores how incorporating family participation activities into STEM education can enrich preschoolers' learning processes and strengthen school-family collaboration—an essential aspect of early childhood education.

STEM education is widely recognized as an interdisciplinary approach crucial in equipping learners with 21st-century skills. However, the Turkish Ministry of National Education (MoNE, 2024) highlights that the current preschool education program does not address science, technology, engineering, and mathematics disciplines in a balanced and integrated manner. One of the most common shortcomings in implementing STEM education is the classroom application of product-oriented activities, which are often misinterpreted as genuine STEM practices. This emphasis on the final product overlooks the process-oriented nature of STEM and limits the effectiveness of the learning experience. Moreover, the lack of sufficient teacher knowledge in STEM education and the absence of structured guiding materials further complicate the implementation process.

Another significant gap is the scarcity of STEM activities in preschool education that are grounded explicitly in engineering and entrepreneurship design models. The lack of integration of the STEM approach in current early childhood curricula also poses a significant challenge to the practical and meaningful implementation of STEM education. This study aims to address these gaps by presenting a model that demonstrates how STEM education can be effectively integrated into preschool settings through engineering and entrepreneurship design processes. Additionally, it seeks to foster family engagement and promote a more cohesive application of STEM education at school and home. In this regard, the study is expected to offer significant theoretical and practical contributions.

While existing studies on STEM education tend to focus primarily on the products generated during activities, such a product-centered perspective does not fully reflect the core philosophy of STEM. STEM is a process-oriented educational approach aiming to develop students' problem-solving, critical thinking, and innovative design skills. To that end, the engineering and entrepreneurship design model—applied systematically and structured in this study—serves as a pedagogical tool to align with the essence of STEM education.

This model, based on the engineering and entrepreneurship design process, provides opportunities for students to design products and test and improve them, thereby aligning with the process-oriented nature of STEM education. In doing so, children engage in the full engineering cycle by analyzing problems, proposing creative solutions, and refining their designs. Therefore, the structured activity process developed in this study is a valuable example of how STEM education can be implemented effectively in preschool classrooms.

LESSON PLAN FOR THE ACTIVITY

In this study, an instructional plan was developed to integrate the "Designing My Rocket" activity into preschool education, based on the Engineering and Entrepreneurship Design Model. This model, proposed by Çakmakçı (in press), includes the iterative stages of Ask, Imagine, Plan, Create, Improve, and Market—Be Entrepreneurial, forming a structured and cyclical design process. The lesson plan was structured according to this model, emphasizing student-centered inquiry, creativity, and iterative design thinking within a STEM education framework. The phases of the Engineering and Entrepreneurship Design Model are illustrated in Figure 1.

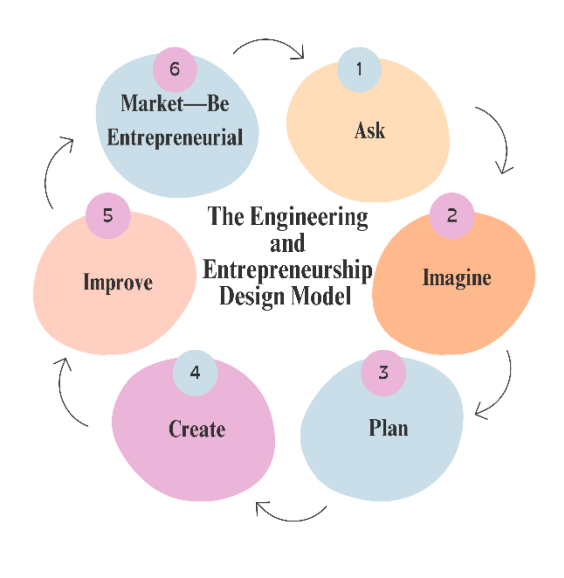

Figure 1. The Engineering and Entrepreneurship Design Model (Çakmakçı, in press)

Phases of the Engineering and Entrepreneurship Design Model

Ask:

In this phase, students are expected to identify the problem and define the constraints related to the problem situation. To attract students ' attention, the teacher may introduce current, real-life problems and innovations using news articles, videos, visuals, posters, or thought-provoking questions. These materials should serve as stimuli to activate students' imagination and creativity.

Imagine:

During this phase, students brainstorm to generate possible ideas, solutions, and design proposals. The process encourages students to develop innovative designs that respond to specific needs. Group work should be encouraged to support the generation of multiple ideas, and students should be guided to avoid judging each other's contributions. They are also encouraged to explain the rationale behind their ideas.

Plan:

At this stage, students select the most promising idea from their brainstorming list and begin planning the design process. They determine how to implement the chosen idea, identify the required materials, and create design sketches to visualize their plan.

Create:

In this phase, students construct and test a prototype of their design. The prototyping process enables them to evaluate the functionality of their product, identify necessary modifications, and enhance their designs. This phase supports the development of students' critical thinking, problem-solving, and design skills.

Improve:

Here, students revisit and refine their designs based on the results of the previous testing phase. They redesign and re-test their prototypes. The teacher is critical in prompting students to reflect on which ideas worked, what aspects require improvement, and how their designs can be enhanced. This cyclical process allows students to experience the iterative nature of design and to internalize the process-oriented essence of STEM education.

Market—Be Entrepreneurial:

In the final phase, each group prepares promotional materials—such as a name, logo, poster, and advertisement—for their design. Students are encouraged to discuss why their product should be preferred in a global market and how it differs from existing commercial alternatives (Ecevit, 2022).

Activity Implementation and Ethical Approval

The activity titled "Designing My Own Rocket", developed based on the Engineering and Entrepreneurship Design Model, received ethical approval from the Ethics Committee of Düzce University under decision number 2024/61, dated March 21, 2024. The activity was implemented with 20 preschool students enrolled in the kindergarten classroom of a public elementary school in the province of Düzce.

During the implementation process, students were divided into four groups, and each group was assigned tasks aligned with the designated stages of the model. The activity was facilitated by a graduate student who was both employed as a preschool teacher and possessed adequate knowledge of the STEM education approach and the engineering-entrepreneurship design model.

This activity aims to offer a model for integrating STEM education with engineering and entrepreneurship processes in early childhood education, providing significant contributions from both theoretical and practical perspectives.

Learning Objectives

The Ministry of National Education (MoNE, 2024) emphasizes that developing competencies in the field of science is critical for cultivating children's science capital. Although the science learning outcomes specified in the preschool education curriculum are implicitly distributed across various scientific disciplines, the overarching goals are structured to increase interest and curiosity in science, support children in discovering their potential, and provide a modern perspective on the nature of science through hands-on experiences with scientific processes.

Accordingly, the following learning objectives were identified in connection with the "Designing My Own Rocket" activity:

Scientific Process Skills:

Observing scientifically, classifying, making predictions based on scientific observation, making predictions based on scientific data, operationally defining variables, making scientific inferences, conducting experiments, developing scientific models, using evidence, and engaging in scientific inquiry.

Fundamental Knowledge and Skills Related to Science and Engineering Processes:

- Learns the fundamental concepts of science and engineering.
- Understands the nature of science and engineering.
- Recognizes the unique processes of science and engineering and applies them during scientific communication.
- Effectively uses scientific process skills such as measuring, estimating, interpreting, conducting experiments, recording data, and analyzing results.
- Develops interest in STEM (Science, Technology, Engineering, and Mathematics) fields and gains awareness of careers in these areas.

Basic Mathematical Skills:

Counting, creating mathematical representations, working with data, and making data-based decisions.

These learning objectives reflect the interdisciplinary nature of the STEM approach in early childhood education and support the development of children's foundational knowledge and skills in science, engineering, and mathematics. In doing so, students not only acquire scientific concepts, but also develop essential skills such as problem-solving, critical thinking, and innovation, along with increased awareness of STEM-related careers.

IMPLEMENTATION OF THE ACTIVITY

This activity was designed for five-year-old preschool children. It was implemented with 20 students—11 girls and 9 boys—who were attending a preschool institution and were newly introduced to scientific concepts. No students with special needs were included in the participant group. The activity was conducted in the classroom during the second semester of the academic year and followed a three-day instructional flow. Including family participation activities, the total implementation process was completed within one week.

Materials Used

The researcher provided the following materials during the implementation process:

- Paper cups
- Rubber bands
- Scissors, glue, tape
- Colored markers
- Colored foam sheets (EVA) and cardboard

Designing My Own Rocket" Activity

This activity was structured within the framework of the Engineering and Entrepreneurship Design Model, which is grounded in the STEM education approach. It includes a teacher-developed instructional plan aimed at introducing students to scientific and space-related concepts. The "Designing My Own Rocket" activity is implemented through four main stages:

Stage 1: "Exploring Rockets with My Family"

As part of the family involvement component, students were provided with the following materials:

- Family participation newsletter: Exploring Rockets with My Family
- Family participation worksheet: Exploring Rockets with My Family
- Worksheet: Rocket from Shapes

Prior to the activity, families were informed about these materials and received them through various communication channels. This ensured parental involvement in the learning process and encouraged students to participate in the activity with some pre-existing knowledge.

Stage 2: "Sharing What I Discovered about Rockets with My Family"

In this phase, the classroom was organized to support student presentations. The learning process unfolded as follows:

- Students presented the information they researched and discovered with their families to their classmates.
- The teacher facilitated the reflection and feedback process by asking guiding questions to help students evaluate both their own presentations and those of their peers.
- At the end of the presentation session, students were awarded certificates of achievement to enhance their motivation.

Stage 3: "Designing My Own Rocket"

During this stage, students followed the iterative steps of the Engineering and Entrepreneurship Design Model—Ask, Imagine, Plan, Create, Improve, and Market/Be Entrepreneurial—to develop their own rocket designs. The activity was conducted in groups and enabled students to enhance their skills in problem-solving, collaboration, and creative thinking.

Stage 4: "Evaluating My Rocket Design"

In this final stage, each student group evaluated their rocket design under the guidance of the teacher. The evaluation process involved the following:

- The teacher asked students guiding questions to help them critically assess their designs.
- Students not only reflected on their own designs but also analyzed and provided feedback on the designs created by other groups.

This phase supported the development of students' critical thinking skills and allowed them to actively experience the assessment component, which is a crucial element of STEM education.

The entire activity process offers a concrete example of how the Engineering and Entrepreneurship Design Model can be integrated into early childhood education within the STEM framework. Through this activity, students learned fundamental concepts in science while also developing essential 21st-century skills such as creative thinking, collaboration, and problem-solving through the hands-on design process.

The stages of the activity are illustrated in Figure 2.

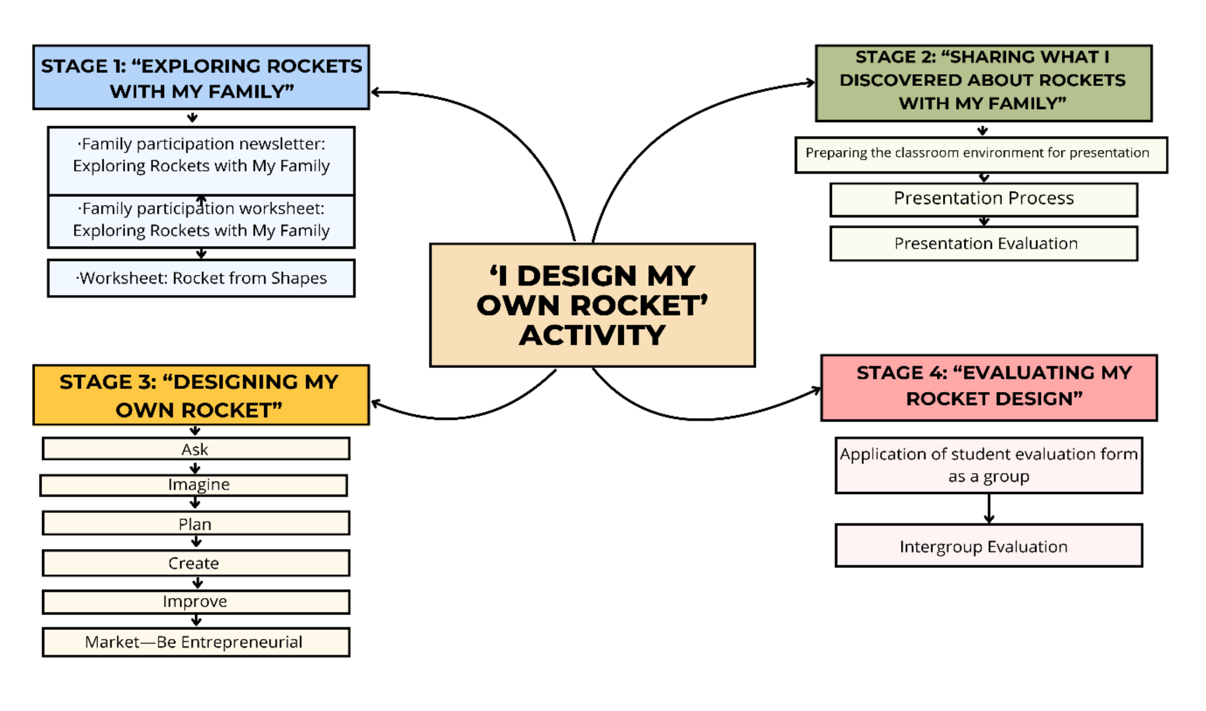

Figure 2. *Implementation Stages of the "Designing My Own Rocket" Activi*

Stage 1: Exploration with Family

Prior to the implementation of the activity, families were provided with informational letters and materials containing thought-provoking questions. This phase aimed to encourage families to prepare for the activity together with their children by conducting research on rockets and space, and by acquiring basic scientific knowledge.

As part of the family involvement activity, the following guiding questions were shared with families:

- "How do you think rockets fly?"
- "Can you imagine where rockets go?"

Posing such questions was considered crucial for stimulating children's thinking about space and rocket technologies, supporting their scientific discovery process, and enhancing their sense of curiosity. During this phase, families actively engaged in the learning process by reading, researching, and exploring space-related concepts together with their children.

Stage 2: Sharing My Discoveries

In this stage, the classroom environment was enriched with a space theme and arranged in a way that would capture the interest of young learners. Students shared the knowledge they had acquired through the research conducted with their families. The teacher facilitated the presentation process, guided students' explanations, and provided supportive feedback throughout.

To encourage student participation and motivation, certificates of achievement—prepared by the teacher—were presented to each student. During the presentations, the teacher posed reflective and guiding questions to assess the students' learning processes. Below are selected examples of student responses:

- "What did you like most about giving your presentation?"
  K11 (female): *"I liked the Earth. There were planets around the Sun. There was also the Moon. We call that the Solar System."*
- "Which topic did you enjoy the most?"
  E9 (male): *"I learned that Alper Gezer Avcı is our National Astronaut."*
  K2 (female): *"Getting the certificate."*
- "Which picture or shape did you like the most?"
  E5 (male): *"Gezer Avcı, the astronaut."*
- "What was the most interesting thing you learned about your presentation topic?"

K2 (female): *"The planet, the rocket, the Earth."*

- "What did you learn that was different from your friends?"
  K2 (female): *"Astronaut."*
  E5 (male): *"Spaceship, astronaut."*
  K9 (female): *"The Earth's colors—blue, green, white."*
  K11 (female): *"Space rocket."*

These responses indicate that students were able to articulate their understanding based on the knowledge they had gained through family engagement. The most engaging topics during the presentation phase included space stations, astronauts, and planets. Many students also highlighted learning about Turkey's first national astronaut and viewed receiving the certificate as a meaningful accomplishment. The arrangement of the classroom and the phases of this activity are illustrated in Figure 3.

Figure 3. *Classroom Preparation for the Activity*

Stage 3: Engineering and Entrepreneurship Design Process

Before initiating the engineering and entrepreneurship design phase, a preliminary activity was conducted to assess students' prior knowledge on the topic and to address potential misconceptions. In this context, a concept map was co-constructed with the students, systematically covering the key concepts related to rocket design.

During the development of the concept map, students made connections among fundamental concepts such as space, rockets, thrust, gravity, astronauts, and planets. This process supported the construction of their conceptual understanding while also aiming to help students relate these scientific concepts to everyday experiences and interpret them within an accurate scientific framework. The concept map created during this phase is presented in Figure 4.

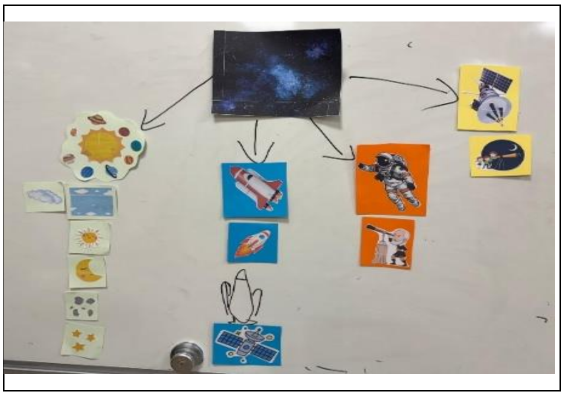

Figure 4. *Concept Map*

To foster students' awareness of the Solar System and the orbital sequence of the planets, several educational videos were shown under the guidance of the teacher. During this phase, students were encouraged to understand the arrangement of planets within the Solar System and to make connections with numerical sequencing. Following the video sessions, students completed a worksheet focused on the order of the planets in the Solar System. This activity was designed to enhance both astronomy-related understanding and mathematical sequencing skills. Additionally, a reverse counting game was played using a pre-prepared rocket model, involving a countdown from 10 to 1. This game aimed to help students focus their attention, reinforce the concept of numerical order, and support their cognitive development. Visual documentation of the implementation process is presented in Figure 5.

Figure 5. *Rocket Game Activity*

To reinforce students' knowledge about the Solar System, rockets, and astronauts—and to enhance their interest in these topics—several educational videos were shown. Throughout this process, students acquired information about the structure of space, the responsibilities of astronauts, and the working principles of rockets. The use of visual materials accompanying the videos helped students better conceptualize scientific ideas. Following the video sessions, a drama-based activity titled "Walking in Space" was implemented to provide students with a kinesthetic learning experience related to movement dynamics in space. In this activity, students imagined themselves as astronauts and dramatized how they would move in a zero-gravity environment by imitating the distinct walking patterns used in space. Through this embodied experience, students gained practical insights into the adaptations astronauts make to function in outer space and had the opportunity to explore scientific concepts through hands-on, experiential learning. Photographs of the classroom where the educational videos were shown are presented in Figure 6.

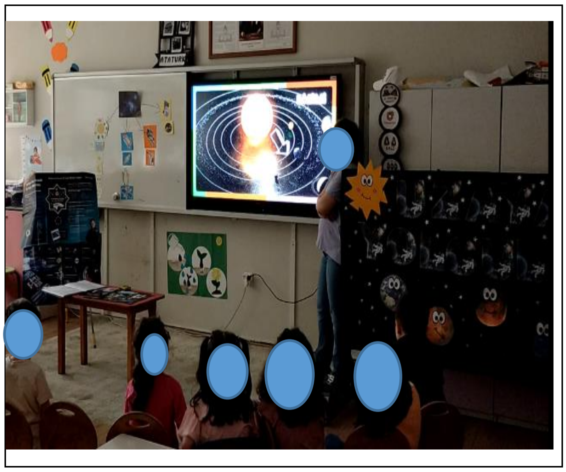

Figure 6. *Pre-Teaching Phase Using Educational Video on Planets and the Solar System*

To raise students' awareness about astronaut suits and rocket structures, an astronaut-themed worksheet activity was conducted. This activity aimed to increase students' interest in space exploration and rocket technologies. Following the worksheet activity, the teacher read aloud a story titled *"Space Travelers."* After the reading session, the teacher encouraged students to express their feelings and thoughts about the events in the story and to empathize with the characters. It was observed that students developed a stronger interest in the scientific discovery process by identifying with the story's protagonists. In the *"Space Travelers"* story, two characters, Berkay and Feray, embark on an exciting journey in a space shuttle. During their adventure, they encounter planets, stars, and meteors, and meet a robot who helps them explore the universe. Illustrations from the storybook are presented in Figure 7, and the book can be accessed via the following link:

Figure 7. *The visual materials are adapted from the storybook "Uzay Yolcuları" (Space Travelers), available at the Ministry of National Education's official platform: https://egitimdebirlikteyiz.meb.gov.tr/Materyaller/Medya/Cocuk_Oykuleri/Uzay_Yolculari*

Ask Phase

Before transitioning into the design process, a problem scenario was presented to the students, and discussions were held on how their existing knowledge could contribute to the design task. The teacher introduced the problem as follows: "Today, we are here to launch a rocket into space. Our goal is to make our rocket fly as high as possible and reach the farthest distance." To stimulate student thinking and prepare them for the design process, the teacher posed the following questions:

- *"What can we do to launch our rocket as high as possible?"*
- *"What materials can we use, and how can*

we design a rocket?"

Here are some of the students' responses:

- E6 (male): *"Fire mixture."*
- K7 (female): *"Something made of metal."*
- E9 (male): *"Exhaust."*
- K3 (female): *"Flames coming from the back."*
- K11 (female): *"Buttons."*

To explore and assess students' background knowledge related to vehicles and how engines work, additional questions were asked:

- *"How do we travel to another city?"* → *"By bus," "By car."*
- *"Where do buses depart from?"* → *"From bus stops."*
- *"How does a vehicle start moving?"* → *"With a key."*
- *"What powers a car or an airplane?"* → *"Engine," "Gasoline," "Wind."*

Students were also prompted to think about space travel by referring to Turkey's first astronaut, Alper Gezer Avcı:

- *"How did Alper Gezer Avcı travel to space?"* → *"With a space rocket."*
- *"Where did he go to space from?"* → *"From Earth."*
- *"How long did it take?"* → *"Half an hour," "48 hours."* (Varied responses were observed.)

These responses revealed that students viewed Alper Gezer Avcı as a heroic figure in space exploration and expressed great excitement about his journey. The teacher further explained the challenges of launching rockets from Turkey due to its geographical distance from the equator and densely populated regions. Visuals were used to show global rocket launch sites, and students were informed that space travel typically takes about one and a half days.

Imagine Phase

Students were divided into four groups, and each group was guided to plan their own rocket design. To begin the process, each group selected a team name and was asked to respond to the following questions:

- *"What type of rocket are you going to design?"*
- *"What features should your rocket have to reach the highest point?"*

The groups planned different designs using the same materials and determined which materials they would use during the design process. However, it was observed that the students lacked sufficient knowledge about the function of rubber bands. Therefore, an additional preparatory session was conducted to help them understand the concepts of stretching and propulsion forces.

The teacher used images and videos to explain how rubber bands are used in everyday life and engineering contexts. Following this, students conducted hands-on experiments with rubber bands to experience how force is applied through stretching. During this process, the student groups discussed key principles such as lightweight design, strong propulsion systems, and accurate launching techniques to ensure their rockets could reach the highest altitude. For instance, the following question was asked:

- *"How should we stretch the rubber band to launch the rocket as high as possible?"*

Sample student responses included:

- E6 (male): *"We'll put the rubber band here."* (Pointing to the open side of the cup.)
- K9 (female): *"We'll pull it like this and release it, and it will jump!"* (Demonstrating by launching a cup from inside another.)

All groups came to a common understanding that the stretching and releasing of the rubber band was directly related to how the rocket launches and reaches altitude. They began to recognize the effect of elastic energy and how propulsion works in their designs.

Plan Phase

In this phase, students were asked to determine the best possible rocket design and to plan their approach accordingly. To guide them in organizing their process systematically, they were encouraged to reflect on:

- Rocket construction steps
- Design details
- Task allocation within the group

Students developed sketch drawings of their planned rocket designs and collaborated to assign roles and responsibilities within their teams. The sketch drawings created by the student groups are presented in Figures 8, 9, 10, and 11.

Figure 8. *Rocket Design Sketch Worksheets from Group 4*

Figure 9. *Rocket Design Sketch Worksheet from Group 3*

Figure 10. *Rocket Design Sketch Worksheet from Group 2*

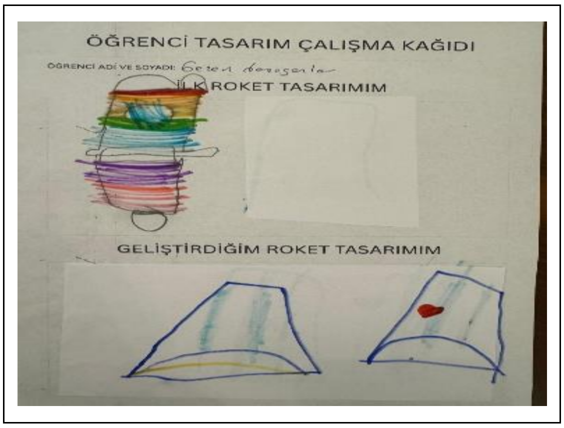

Figure 11. *Rocket Design Sketch Worksheet from Group 1*

Create Phase

Student groups began constructing their rocket designs using a variety of materials based on their initial plans. To support students in articulating the physical features of their rockets, analyzing encountered challenges, and making sense of their design process, the following guiding questions were asked:

- *"What features does your rocket design have?"*
- *"What are the physical characteristics of your rocket?"*
- *"What difficulties did you encounter during the construction phase?"*

Each group shared their design experiences:

- Group 4: *"We tied the rubber band and glued the cardboard. We decorated it. After tying the rubber band, it flies into the air like this."*
  → Group 4 successfully launched their rocket using rubber bands and paper cups.
- Group 3: *"We were going to glue the rubber band and flames like this, but we couldn't finish."*
  → Group 3 planned to add flame effects to their rocket but faced difficulties during execution.

Groups 2 and 4 completed their rocket designs successfully, while Groups 1 and 3 encountered some challenges.

The main problems observed during the production phase included:

- Rubber band breakage
- Improper cup orientation
- Difficulty in combining materials effectively

Students also discussed how to measure the height their rockets reached during the launch tests.

Key guiding questions and responses included:

- *"How will you measure how high your rocket flies?"* → *"We'll measure using the colored marks on the wall."*
- *"What kind of rubber band did you use, and how high did your rocket go?"* → Group 4: *"We put the rocket on top of the cup and launched it."*
- *"What could be the possible errors during the launch?"* → Most groups responded: *"Holding the cup upside down."*

Rocket Testing and Height Measurement Process

To measure the rockets' flight distance, students created a visual measurement system on the classroom wall using colored tape. They counted the blocks on the wall and marked different height levels with colored cardboard strips:

- 5 blocks (Red): Represents the lowest height
- 7 blocks (Yellow): Represents medium height
- 10 blocks (Green): Represents the highest height

Each group tested the flight of their rockets using these indicators and evaluated the accuracy of their launch method. Furthermore, they reflected on the factors that influenced the rocket's flight distance and identified potential errors during the launch.

The visual reference for the measurement system is presented in Figure 12.

Figure 12. *Visual Measurement Criteria for Rocket Testing*

During the testing phase, the heights reached by the rockets varied. Some groups were able to successfully launch their rockets to higher levels, while others were unable to launch their rockets at all. Students recorded the height measurements of their rockets on a graph worksheet during the test process. Based on the resulting graphs, each group identified which rocket reached the highest altitude. This activity contributed to the development of students' skills in data collection, graph construction, and data analysis. An example of the student graph worksheet is presented in Figure 13.

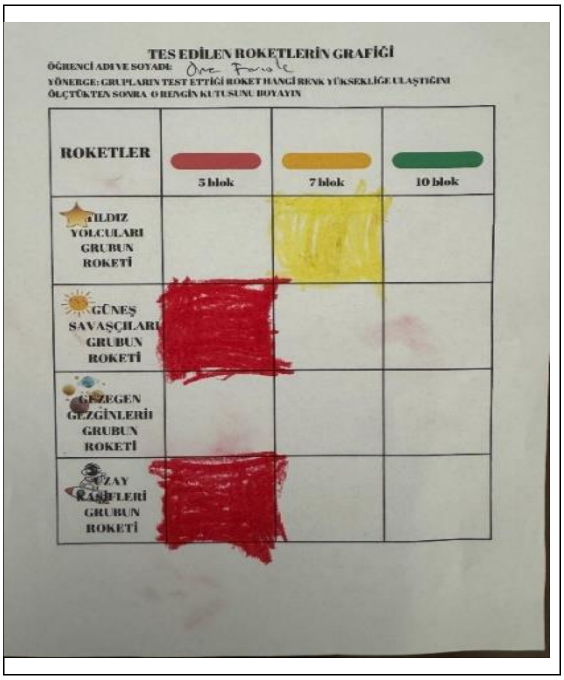

Figure 13. *Student Graph Worksheet on Rocket Test Results*

Improve Phase

In this phase, students were asked to analyze how they could improve their existing rocket designs and what changes they needed to implement in their revised models. The teacher guided students' critical thinking and problem-solving processes by posing the following reflective questions:

- *"What features need to be changed to make your rocket fly higher?"* → Group 2: *"Only the rubber band. Ours was too thin. It was really hard to make."*
- *"Which features of your rocket design worked well, and which didn't?"* → Group 1: *"It didn't work because the rubber band broke."*

→ Group 1: *“We couldn’t stick the rubber band at first because the tape didn’t hold.”*

- *“How can you improve your rocket design?”*

  → Group 2: *“We’ll use a thicker rubber band. It’ll be stronger.”*

- *“What features will your new rocket design have? What changes will you apply?”*

  → Group 3: *“We’ll remove the tape from the attached cups and add the rubber band properly.”*

Each group evaluated the difficulties they encountered in their initial designs and identified modifications to help their rockets achieve greater launch heights. Some of the changes included:

- Using thicker and more durable rubber bands
- Modifying tape and attachment techniques
- Redesigning the rocket body to be lighter or more balanced

Photographs of the improved rocket designs are presented in Figures 14 through 19.

Figure 14. *Group 4’s Initial Rocket Design*

Figure 15. *Group 4’s Improved Rocket Design*

Figure 16. *Group 1’s Initial Rocket Design*

Figure 17. *Group 1’s Improved Rocket Design*

Figure 18. *Group 3's Initial Rocket Design*

Figure 19. *Group 3's Improved Rocket Design*

Market / Be Entrepreneurial Phase

In this phase, students engaged in a series of creative activities designed to develop their entrepreneurial skills. The objective was to raise awareness of marketing, promotion, and brand identity in relation to their rocket designs.

First, each group was asked to create a unique name to represent their rocket design. Students came up with creative group names that reflected the essence of their designs:

- *"Star Travelers"*
- *"Sun Warriors"*
- *"Space Explorers"*
- *"Wandering Planets"*

Next, each group designed and visualized a logo that represented their rocket identity. Students selected symbols that reflected the character of their designs:

- Star Travelers → Logo with a star symbol
- Space Explorers → Space-themed logo
- Sun Warriors → Logo featuring a warrior girl and sun motif
- Wandering Planets → Logo with a planetary symbol

In addition, each group developed slogans to highlight the unique features and functions of their rocket designs. Examples include:

- *"Sun Warrior Girl Rocket"* (Sun Warriors)
- *"Rocket Roaming in Space"* (Space Explorers)

To help students promote their designs to a broader audience, they were asked to create advertisement posters. These posters described their rockets, emphasized key features, and incorporated their logos. The poster activity supported students in developing communication and presentation skills.

Logo visuals from the rocket designs are presented in Figures 20, 22, and 24, while poster visuals are provided in Figures 21, 23, and 25.

Figure 20. *Logo of the "Star Travelers" Team (Group 4)*

Figure 21. *Advertisement Poster of the "Star Travelers" Team (Group 4)*

Figure 22. *Logo of the "Wandering Planets" Team (Group 1)*

Figure 23. *Advertisement Poster of the "Wandering Planets" Team (Group 1)*

Figure 24. *Logo of the "Space Explorers" Team (Group 2)*

Figure 25. *Advertisement Poster of the "Space Explorers" Team (Group 2)*

Stage 4: Design Evaluation Phase

In this phase, the students' reflections on their rocket design processes, peer observations, preferences, and feedback exchanges were examined. Using unstructured evaluation questions, the aim was to encourage students to:

- Observe and evaluate other groups' designs
- Compare their own designs with those of their peers
- Reflect on collaboration and communication within their own groups

Student responses indicated awareness of features they appreciated in others' designs and differences they noticed in their own. For example:

- Group 1: *"I liked Group 3's rocket. Theirs was really nice."*
- Another student from Group 1: *"I really liked how E6 added rubber bands and made wings—it was like a kite!"*
- Group 1: *"Our rocket had different rubber band placements."*

Students also commented on how they experienced teamwork and collaboration during the design process:

- Group 1: *"We helped each other and made our rocket together."*

In terms of aesthetic evaluation, students highlighted the visual and attention-grabbing features of the rockets:

- Group 2: *"I liked how flames came out from the bottom of Group 3's rocket."*

These reflections demonstrated that students not only considered technical elements of the rocket designs but also paid attention to visual and aesthetic aspects, revealing a more holistic engagement with the design and evaluation process.

Teacher Observation Notes: "Designing My Own Rocket" Activity

Students brought to school the projects they had prepared with their families based on research about space and rockets. It was observed that when families were informed in advance about the lessons to be conducted that day, the topic of space and rockets naturally became a shared point of discussion during drop-off at the school entrance. Compared to days when families were not aware of upcoming classroom activities, this awareness seemed to strengthen their sense of belonging to the school community.

Upon entering the classroom, students showed interest in the thematic bulletin board and posters. Each student examined the visual displays. Most students gave presentations to share what they had learned with their classmates. During the presentations, it was observed that some students confused the names of airplanes and rockets. The teacher recorded the presentations and awarded each presenter with a pre-prepared, rocket-themed certificate of achievement.

During the presentations, most students stated that astronauts travel to space by rocket and conduct experiments related to water and illness. They also described how rockets are launched with fire coming from the bottom. Using reflective questions, students evaluated their own presentations and those of their peers. This peer interaction supported knowledge sharing, particularly of content learned with their families, and revealed the effectiveness of peer learning from the teacher's perspective.

A concept map on space was created collaboratively with the students, using visuals to categorize key concepts. The teacher read the story *"Space Travelers"* aloud, and asked questions about the events in the story, encouraging students to share their thoughts and feelings. It was observed that students empathized with the characters and offered creative solutions to the challenges described. However, during a slide presentation about Alper Gezer Avcı, some of the content was perceived as abstract by the students.

The rocket-themed reverse countdown game (from 10 to 1) attracted strong engagement from students. Those who completed the activity worksheets proceeded to the "Ask" phase. Although students were curious, it was noted that their prior knowledge about how rubber bands function was limited. As a result, the teacher planned a supplementary session for the next day focusing on rubber bands' structure and uses, supported by visuals.

In this follow-up session, students were shown a visual presentation about the flexibility and mechanical function of rubber bands, particularly how tension generates force. Students then experimented with stretching rubber bands to experience the principle of elasticity firsthand.

During the design phase, groups initially envisioned rockets by connecting the rims of two paper cups. To support the iterative design process, students were asked:

- *"If we use a rubber band on the cup, what kind of rocket could we create?"*
- *"How should we stretch the rubber band on the cup?"*

Each group engaged in hands-on exploration:

- One group attached the rubber band to the open end of the cup.
- Another cut and glued it to the closed bottom of the cup.
- A third group attached it in reverse.

Students tested their rockets, using a classroom measurement system that proved reliable. After each launch, students recorded the results on their worksheets and created bar graphs to visualize the outcomes.

During the improvement phase, groups modified their designs:

- One group used two rubber bands for added power.
- Another preferred a single band for simplicity.
- A different group changed the rocket's shape.
- One group reinforced the structure by adding a second band.

For the entrepreneurial phase, each group designed a logo for their rocket and illustrated it with colored pencils. Based on their rocket's performance and challenges during the building phase, students developed different marketing strategies:

- One group humorously said, *"Don't buy our rocket—it keeps losing the rubber band!"*
- Another proudly advertised, *"Our rocket works. It's a strong rocket."*
- A popular slogan was, *"The rocket that launches the highest."*

Finally, students successfully measured their rockets' altitude using the designated color-coded height indicators and reflected on the launch errors encountered during testing.

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

This study aimed to evaluate the feasibility and effectiveness of the activity "Designing My Own Rocket," developed based on the Engineering and Entrepreneurial Design Model within the context of STEM education in early childhood. The analysis of teacher observation notes, activity evaluation forms, and visual documentation of student products was used to assess the contribution of the activity to students' learning processes.

Findings indicate that the activity effectively fostered students' creative problem-solving, engineering design thinking, collaboration, and entrepreneurial skills. These results are consistent with findings from existing literature. Akgündüz and Akpınar (2018) emphasize the positive effects of STEM education on preschool children's creative thinking and problem-solving abilities. Similarly, Öztürk and Çınar (2022) reported that engineering-based STEM education supports problem-solving skills in young children. Yalçın and Çakır (2022) highlighted that the engineering design process improves higher-order thinking, scientific process skills, curiosity, and motivation for designing products. The findings of the current study align with these previous studies.

Contributions of the Engineering and Entrepreneurial Design Process to Learning

The activity provided students with concrete experiences that supported their understanding of creative thinking, problem-solving, and basic engineering concepts. As emphasized by Şahin (2016), abstract concepts can be difficult for preschool children to grasp. In this regard, engineering activities grounded in STEM education help concretize abstract ideas and enhance conceptual understanding. The "Designing My Own Rocket" activity contributed to students' ability to make sense of such concepts through experiential learning.

Important findings also emerged regarding the development of entrepreneurial skills. Throughout the activity, students designed logos and promotional posters for their rockets, working collaboratively and using creativity to promote their designs. This aligns with findings by Aral and Arslan Kılıçoğlu (2022), who emphasized the importance of encouraging entrepreneurship in early childhood, as such activities help individuals discover and express their creativity. Therefore, the rocket activity is considered an effective model for supporting entrepreneurial development.

Students' Readiness and Its Impact on the Learning Process

During the activity, it was observed that differences in students' readiness levels and challenges in understanding abstract concepts influenced the learning experience. Harman and Çeliker (2012) and Senemoğlu (2009) emphasize that readiness plays a critical role in cognitive learning. Without preparatory support, children may struggle to grasp new concepts. Ültay et al. (2016) also highlight the need to concretize concepts in STEM activities for preschoolers. In light of these findings, this study underscores the importance of assessing students' prior knowledge and offering supportive materials (e.g., visuals, concrete objects, guiding questions) before such activities begin.

Attention Spanand Motivation

It was noted that the extended duration of the activity occasionally led to decreased attention spans among students. Bartan (2019) suggested that strategies such as rhymes, riddles, finger plays, puppets, and music can help maintain young children's attention. Therefore, incorporating short, engaging transition activities during STEM lessons is recommended to sustain motivation and focus.

Impact of Family Involvement on the Activity

Family participation emerged as a powerful learning tool throughout the process. Students who collaborated with their families to conduct preliminary research displayed increased confidence and motivation. Çamlıbel Çakmak (2010) emphasized that active family involvement helps children become more consciously engaged in their education. Similarly, Balat and Günşen (2017) found that family support plays a vital role in reinforcing school-based learning at home.

Feedback from families indicated that the first stage of the activity, *"Discovering Rockets with My Family,"* enhanced students' curiosity, confidence, and scientific thinking. These findings support the work of Çetin et al. (2012), which demonstrated that early exposure to scientific concepts plays a critical role in developing scientific reasoning. However, some families expressed challenges in integrating the activity into daily routines, although most welcomed the opportunity for future participation. Güler and Akman (2006) reported that children's science learning is significantly influenced by environmental factors and adult support—underscoring the importance of sustaining family engagement in educational practices.

Conclusion and Recommendations

The "Designing My Own Rocket" activity offers an effective model for fostering engineering and entrepreneurial skills among preschool children within the scope of STEM education. The findings indicate that students made gains in creative thinking, problem-solving, engineering understanding, and entrepreneurship.

Based on the outcomes of this study, the following recommendations are proposed for future practice:

- Prepare informative content in advance to account for students' varying levels of readiness.
- Include short, motivational transition activities to maintain attention throughout the activity.
- Develop more structured and flexible family engagement strategies to ensure meaningful participation.

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APPENDIX

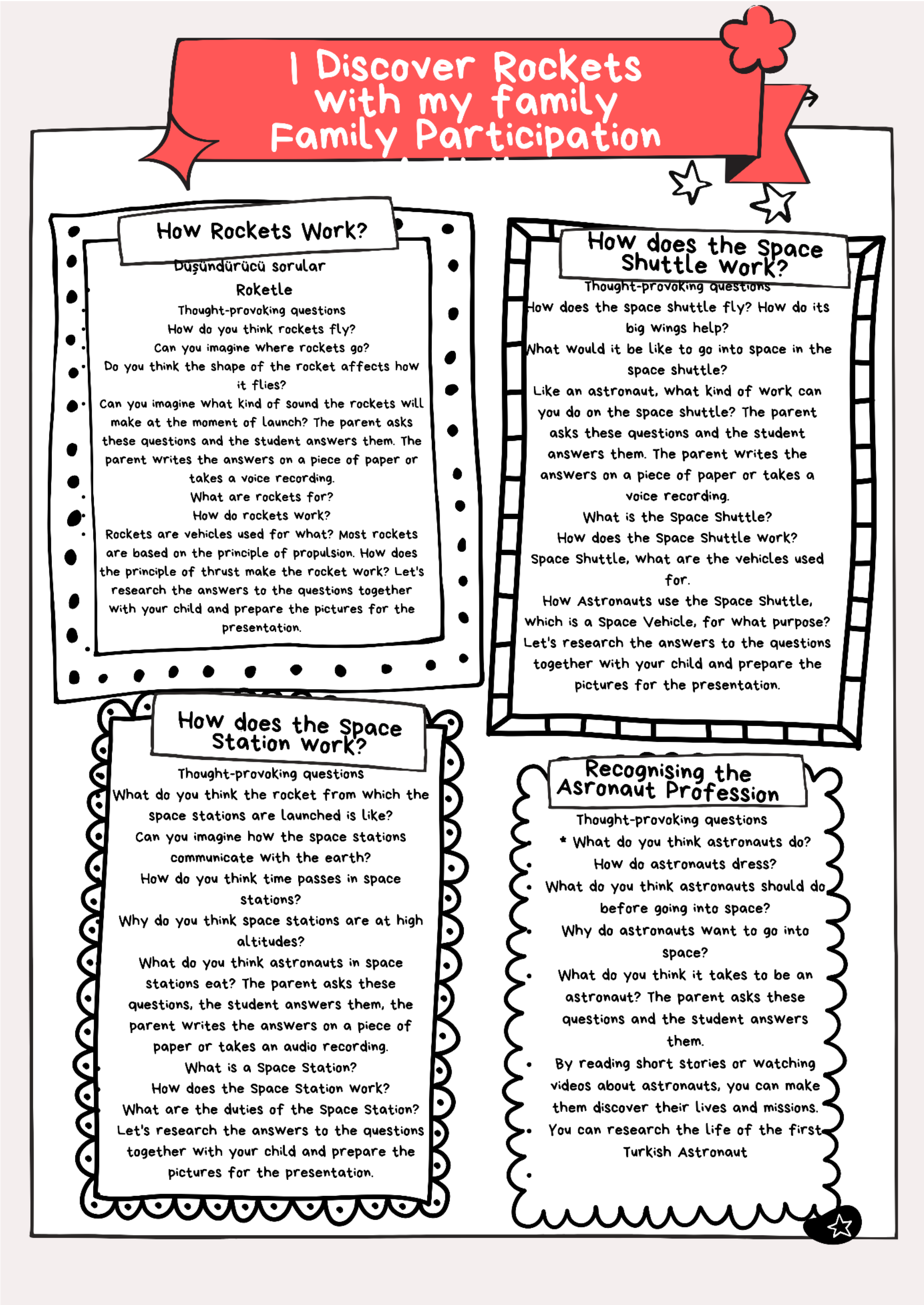
Appendix 1. Family Participation Activity News Letter

Discovering Rockets with my family
Family Participation Activity News Letter

Dear Parents,
Hello,
We are organising an exciting event to explore the frontiers of space and awaken scientific curiosity! We are organising a "Rocket Discovery Meeting" with the participation of our students and their families. In this event, our students will learn the basics about rockets, design and build their own rockets, and finally, our students will have the experience of launching these rockets.
In our event, we want to stimulate our students' scientific curiosity, develop their hand skills and have a pleasant time with their families. We will have fun while exploring topics such as how rockets work, launch principles and the importance of space exploration.
Here are the event details
Date: [APRIL] Time: [13.00/ 17.00]
Location: Namik Kemal Kindergarten] Participants: Our students and their families

During the event, our students and their families,
Our parents and students will do the activities on the Family Participation Activity Worksheet together at home.
The Family Activity Worksheet has 4 sections divided into sections where you can do research with your child.
You can ask your child thought-provoking questions in each section about rockets, space shuttles, space stations and the astronaut profession. By talking together, you can write down your child's answers on a notepad or make an audio recording and learn your child's prior knowledge before discovering rockets.
You can create a bookshelf at home. You can attract the child's attention by putting books and visual materials about space in the bookshelf. You can introduce concepts such as the Sun, Moon, stars and planets in a simple and fun way. For example, you can use picture books, interactive games and songs to help children explore these concepts.
You can give simple explanations about how rockets, space shuttles and space stations work and you can prepare presentations with them to describe these vehicles. For example, you can prepare visuals about how rockets work, visuals about how space shuttles work, visuals about the tasks of the space station from science magazines, scientific websites, and send them to school on cardboard or in a computerised presentation file. You can also read short stories or watch videos about astronauts to help them discover their lives and missions. You can send all the work done at home to school for your child to share and present the information they have learnt.
You can read the instructions on the worksheet called Rocket from Shapes to your child and have your child do the work. You can also send this worksheet to school.
Useful Links
https://www.youtube.com/watch?v=8zApwPBeNAY
https://www.youtube.com/watch?v=-0p74lbvwgY
https://www.youtube.com/watch?v=5sflvpGP8AQ
https://www.youtube.com/watch?v=5sflvpGP8AQ
https://www.youtube.com/watch?v=ni4Ei9aluEw
https://www.youtube.com/watch?v=Ix5uXfgu4Lk
https://www.youtube.com/watch?v=8zApwPBeNAY
https://www.youtube.com/watch?v=2Ragaw2zFW0

Appendix 2. Family Participation Activity Worksheet



I Discover Rockets with my family
Family Participation

How Rockets Work?

Düşündürücü sorular

Roketle

Thought-provoking questions

How do you think rockets fly?

Can you imagine where rockets go?

Do you think the shape of the rocket affects how it flies?

Can you imagine what kind of sound the rockets will make at the moment of launch? The parent asks these questions and the student answers them. The parent writes the answers on a piece of paper or takes a voice recording.

What are rockets for?

How do rockets work?

Rockets are vehicles used for what? Most rockets are based on the principle of propulsion. How does the principle of thrust make the rocket work? Let's research the answers to the questions together with your child and prepare the pictures for the presentation.

How does the Space Shuttle Work?

Thought-provoking questions

How does the space shuttle fly? How do its big wings help?

What would it be like to go into space in the space shuttle?

Like an astronaut, what kind of work can you do on the space shuttle? The parent asks these questions and the student answers them. The parent writes the answers on a piece of paper or takes a voice recording.

What is the Space Shuttle?

How does the Space Shuttle Work?

Space Shuttle, what are the vehicles used for.

How Astronauts use the Space Shuttle, which is a Space Vehicle, for what purpose? Let's research the answers to the questions together with your child and prepare the pictures for the presentation.

How does the Space Station Work?

Thought-provoking questions

What do you think the rocket from which the space stations are launched is like?

Can you imagine how the space stations communicate with the earth?

How do you think time passes in space stations?

Why do you think space stations are at high altitudes?

What do you think astronauts in space stations eat? The parent asks these questions, the student answers them, the parent writes the answers on a piece of paper or takes an audio recording.

What is a Space Station?

How does the Space Station Work?

What are the duties of the Space Station?

Let's research the answers to the questions together with your child and prepare the pictures for the presentation.

Recognising the Asronaut Profession

Thought-provoking questions

- What do you think astronauts do?
- How do astronauts dress?
- What do you think astronauts should do before going into space?
- Why do astronauts want to go into space?
- What do you think it takes to be an astronaut? The parent asks these questions and the student answers them.
- By reading short stories or watching videos about astronauts, you can make them discover their lives and missions.
- You can research the life of the first Turkish Astronaut

Appendix 3. Family Participation Evaluation Form

FAMİLY PARTİCİPATİON ACTİVİTY EVALUATİON

Parent Information

Name and Surname

Address

Telephone

Question: What are your favourite things about family participation?

Question: What are the most difficult parts of family participation?

Question: What are your general opinions about the family participation activity?

Question: Would you like to participate in family involvement activities again?

Question Anything you would like to add.

Annex 4. Student Evaluation Form

STUDENT EVALUATİON FORM

student evaluation form

Name and Surname

Date of Birth

Question: Did you like this activity? Why?

Because I like it:

Because I didn't like it:

Question: Where did you have difficulties during the activity?

Question: What did you learn after the activity?

Question: Would you like to participate in the event again? Why?

Appendix 5. Teacher Activity Process Evaluation Form

TEACHER ACTIVITY PROCESS EVALUATION FORM

Teacher Name and Surname: History: .../.../2024

1. The difficulties I experienced during the activity.

2. What I did in the face of difficulties experienced during the activities.

3. My suggestions for the event.

4.