

## STEM Activity in Preschool Education: Let's Discover the Light!

Gülşah Günşen<sup>1</sup> & Feride Gök Çolak<sup>2</sup>

### ABSTRACT

Exposing children to STEM education from an early age increases their curiosity and interest in STEM careers. Thanks to STEM education, children learn by working like little scientists and putting forward their own scientific products. Based on this approach, the aim of this research is to raise awareness among preschool children about the concept of light that they encounter in daily life. The study was carried out with 20 children aged 60-72 months in a public school in the spring term of 2022-2023 in Turkey under the name of "STEM Activity in Preschool Education: Let's Discover the Light!". The STEM activity plan was designed by the researchers in accordance with the 5E model under the guidance of the preschool education curriculum and Next Generation Science Standards. During the activity, the steps of the 5E model were followed, allowing children to design their projects to discover light, make observations, and achieve learning objectives related to STEM education in the preschool period. In this context, the present activity is effective for preschool children to receive STEM education and reach the determined international standards.

**Keywords:** 5E model; NGSS; preschool education; light; STEM education.

## Okul Öncesi Eğitimde Stem Etkinliği: Haydi Işığı Keşfedelim!

### ÖZ

Çocukların erken yaşlardan itibaren STEM eğitimine maruz bırakılması STEM kariyerlerine karşı merak ve ilgisini arttırmaktadır. Çocuklar, STEM eğitimi ile çocuklar küçük birer bilim insanı gibi çalışıp kendi bilimsel ürünlerini ortaya koyarak öğrenirler. Bu noktadan hareketle bu araştırmanın amacı okul öncesi dönem çocuklarının günlük yaşamda karşılaştıkları ışık kavramına yönelik farkındalık kazanmalarınıdır. Araştırma Türkiye’de 2022-2023 yılı bahar döneminde bir devlet okulunda bulunan 60-72 aylık 20 çocuk ile “Okul Öncesi Eğitimde STEM Etkinliği: Haydi Işığı Keşfedelim” ismiyle gerçekleştirilmiştir. STEM etkinlik planı araştırmacılar tarafından okul öncesi eğitim programı ve Next Generation Science Standards rehberliğinde 5E modeline uygun şekilde hazırlanmıştır. Etkinlik süresince 5E modelinin basamakları takip edilmiş olup çocukların ışığı keşfedecekleri projelerini tasarlayarak gözlem yapabilmeleri ve okul öncesi dönemde STEM eğitimi ile ilgili öğrenme hedeflerine ulaşmaları sağlanmıştır. Bu bağlamda mevcut etkinliğin, okul öncesi dönem çocuklarının STEM eğitimi almaları ve belirlenen uluslararası standartlara ulaşabilmeleri noktasında etkili olabileceği düşünülmektedir.

**Anahtar Kelimeler:** 5E modeli; NGSS; okul öncesi eğitimi; ışık; STEM eğitimi.

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<sup>1</sup> Assist. Prof. Dr., Trakya University Faculty of Education Department of Basic Education,  
E-mail: gulsahgunsen@gmail.com, ORCID: 0000-0002-6882-5645

<sup>2</sup> Assist. Prof. Dr., Yıldız Technical University Faculty of Education Department of Basic Education,  
E-mail: feridegok79@gmail.com, ORCID: 0000-0001-5196-9178

## INTRODUCTION

From the moment they are born, children start to explore their world and are constantly exposed to knowledge, skills, and ideas related to STEM (Campbell & Speldewinde, 2022). In this period, during which children display the fastest development, children want to explore their environment in a curious, questioning, and imaginative way (National Science Teacher Association (NSTA, 2014). Children resemble scientists with these features (Büyüktaşkapu et al., 2012). Studies in the field of education have shown that the percentage of individuals' skill, habit, and learning competency is very high between the ages of 3-7, which is the childhood period (Torres-Crospe, 2014).

STEM education is an important subject for children and provides them with skills that they can use throughout their lives. STEM is an educational approach that combines science, technology, engineering, and mathematics topics (Gonzalez & Freyer, 2014; McClure et al., 2017). It is also important to support children's interests in STEM fields during this period when their curiosity and exploration emotions are highest (Akgündüz & Akpınar, 2018; Bagiati & Evangelou, 2015; Erol & İvrendi, 2021). STEM education in the preschool period provides an opportunity to develop children's understanding of nature, problem-solving, analytical thinking, creativity skills, communication, and thinking abilities, as well as supporting the development of scientific process skills (Campbell et al., 2018; Clements & Sarama, 2018; Çetin & Demirçan, 2020). Therefore, it is important to include the STEM approach in the education process starting from early childhood.

The STEM approach primarily focuses on project-based learning. This approach begins with scientific life experiences and encourages children to actively learn, explore all possible solutions, and produce projects practically (Stearns et al., 2012). The process starts with a real-world problem or an original project (National Academy of Engineering [NAE], 2014). Children are expected to think critically, design the engineering/technology process, solve problems by mathematical modeling, or complete the project (NRC, 2012). Among these processes, engineering design, problem definition, development of possible solutions, selection of the best solution, and prototyping

and testing are frequently used (Merrill & Comerford, 2004; Wendell et al., 2010). Sumarni et al. (2021) taught Indonesian traditional medicine and drug preparation techniques to children through project-based learning and the STEM approach. The education includes material selection, cleaning, measuring, grinding, filtering, and packaging, as well as mathematical calculations. As a result, the children successfully achieved learning. According to Clements (2013), learning STEM skills starts with a goal and involves developmental progress. During this process, teachers rely on children's understanding of their thoughts and help children achieve their goals. It is important to create an environment where children can ask questions, investigate, experiment, and express their thoughts and opinions freely. Teachers can also use various teaching methods such as storytelling, play-based learning, and technology-based learning to support children's STEM learning.

Literature review revealed that there were a limited number of studies that include STEM activities in the preschool period. For children in the preschool period, the starting point of science education is the environment they live in (Larimore, 2020), and one of the fundamental science concepts that attracts their attention and they encounter in their daily lives in this environment is the concept of light (Gallegos-Cazares et al., 2009; Worth & Grollman, 2003). Children learn about light and darkness in the context of life and realize that light is necessary to see everything in the environment. However, explaining to preschool children that light is a type of energy, its absorption, reflection, and refraction can be quite abstract (Herakleioti & Pantidos, 2016).

Numerous studies have been conducted on the concept of light at various educational levels, from primary education to higher education (Akdeniz et al., 2001; Eshach, 2003; Gallegos-Cazares et al., 2009; Heywood, 2005; Ravanis et al., 2013; Uzun et al., 2013). In their research, Herakleioti and Pantidos (2016) and Worth & Grollman (2003) found that children construct the concept of light in their minds and are able to apply the information they learn to different situations. As seen in these studies, the concept of light is a concept that children are curious about and can learn about in the preschool period. It is thought that conducting studies

related to “light” in the preschool period will be important for children to notice and understand the concept of light from an early age. No studies containing light teaching were found in the existing literature. Based on this approach, the present study has been carried out to set an example for the implementation processes of STEM activities in pre-school classrooms and to support the dissemination of the practices.

### Ethical Statement

This study was approved by Trakya University Social and Humanities Research Ethics Committee (approval date: 30/12/2022). This research was conducted with a preschool teacher who voluntarily wanted to participate in the STEM activity involved in this research, and the children in the teacher’s class. At this point, permission for the research was first obtained from the school administration. Then a ‘parental consent form’ was sent to the children’s parents asking for their permission for their children to participate in the research, and the permission was obtained for all participants.

### ACTIVITY IMPLEMENTATION

The study was conducted in a public school with 20 children (12 girls, 8 boys) aged 60-72 months in the spring term of 2022-2023 in Turkey under the name “STEM Activity in Preschool Education: Let’s Discover the Light!” The ethical permission for the research was obtained through decision number 11/35 taken at the meeting of the Trakya University Social and Humanities Research Ethics Committee on December 28, 2022. During the activity, the participating children worked individually by sitting at tables in groups of four. The activity was carried out by the researchers in four lesson hours (80 minutes). The implemented STEM activity is based on the learning goals and indicators included in the preschool curriculum of Ministry of National Education (2013) and the Next Generation Science Standards (NGSS 2013) (Table 1).

**Table 1.** *Learning Outcomes/Indicators of the Activity in Turkey and Compliance with NGSS*

	Learning Outcomes	Indicators
<b>Learning Outcomes and Indicators (MoNE, 2013)</b>	1. Outcomes regarding cognitive development	Indicators of Cognitive Development
	1.1. Pays attention to object/situation/event.	1.1.1. Focuses on the object/situation/event that needs attention. 1.1.2. Asks questions about the object/situation/event that draws his/her attention. 1.1.3. Asks questions about the object/situation/event that draws his/her attention.
	1.2. Makes a prediction about the object/situation/event.	1.2.1. Tells his/her prediction about the object/situation/event. 1.2.2. Explains the key points of his/her prediction. 1.2.3. Examines the real situation. 1.2.4. Compares the prediction with the actual situation
	1.3. Makes a cause-effect relationship.	1.3.1. States the possible reasons of a situation. 1.3.2. States the possible outcomes of a situation.
	1.4. Generates solutions to problematic situations	1.4.1. States the problem. 1.4.2. Suggests various solutions to the problem. 1.4.3. Chooses one of the solutions. 1.4.4. States the reason for the chosen solution. 1.4.5. Tries out the solution.

		1.4.6. Chooses a new solution when the previous one does not work out.
		1.4.7. Suggests creative solutions to the problem
2. Outcomes regarding linguistic development.	Indicators of Linguistic Development	
2.1. Uses the language for communicative purposes.	2.1.1.	Waits his/her turn to speak.
	2.1.2.	States his/her feelings, thoughts, and dreams.
	2.1.3.	States the reasons for his/her feelings and thoughts.
2.2. Improves his/her vocabulary.	2.2.1.	Notices new words and asks their meaning upon listening.
	2.2.2.	Recalls the words and their meanings.
	2.2.3.	Uses newly learned words in accordance with their meanings.
3. Outcomes Regarding Social Emotional Development	Indicators of Social Emotional Development	
3.1. Expresses himself/herself in creative ways.	3.1.1.	Expresses feelings, thoughts, and dreams in original ways.
	3.1.2.	Uses objects in an unusual way.
	3.1.3.	Creates products with unique features.
4. Outcomes Regarding Motor Development	Indicators of Motor Development	
4.1. Performs movements that require the use of small muscles.	4.1.1.	Gives shapes to materials by hands.
	4.1.2.	Gives shapes to materials by tools.
<b>Next Generation Science Standards (NGSS)</b>	1. K-PS3 Energy	
	1.1. K-PS3-1.	Make observations to determine the effect of sunlight on Earth's surface.
	1.2. Science and Engineering Practices	
	1.2.1. Planning and Carrying Out Investigations	Planning and carrying out investigations to answer questions or test solutions to problems in K-2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. <ul style="list-style-type: none"> <li>Make observations (firsthand or from media) to collect data that can be used to make comparisons. (K-PS3-1)</li> </ul>
	1.3. Connections to Nature of Science	Scientific Investigations Use a Variety of Methods <ul style="list-style-type: none"> <li>Scientists use different ways to study the world. (K-PS3-1)</li> </ul>
	1.4. Crosscutting Concepts	
	1.4.1. Cause and Effect	Events have causes that generate observable patterns. (K-PS3-1)
	2. K-2-ETS1 Engineering Design	
	2.1. K-2-ETS1-1.	Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
	2.2. K-2-ETS1-2.	Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
2.3. K-2-ETS1-3.	Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	
2.4. Science and Engineering Practices		

2.4.1.	Asking Questions and Defining Problems	Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions. <ul style="list-style-type: none"> <li>• Ask questions based on observations to find more information about the natural and/or designed world(s). (K-2-ETS1-1)</li> <li>• Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1)</li> </ul>
2.4.2.	Developing and Using Models	Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. <ul style="list-style-type: none"> <li>• Develop a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2)</li> </ul>
2.4.3.	Analyzing and Interpreting Data	Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. <ul style="list-style-type: none"> <li>• Analyze data from tests of an object or tool to determine if it works as intended. (K-2-ETS1-3)</li> </ul>
2.5. Disciplinary Core Ideas		
2.5.1.	ETS1.A: Defining and Delimiting Engineering Problems	A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1) <ul style="list-style-type: none"> <li>• Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)</li> <li>• Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)</li> </ul>
2.5.2.	ETS1.B: Developing Possible Solutions	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem’s solutions to other people. (K-2-ETS1-2)
2.5.3.	ETS1.C: Optimizing the Design Solution	Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)
2.6. Crosscutting Concepts		
2.6.1.	Structure and Function	The shape and stability of structures of natural and designed objects are related to their function (s). (K-2-ETS1-2)

The STEM activity plan was prepared in accordance with the 5E learning model. The 5E learning model consists of five stages: attention-grabbing, research-exploration, explanation, deepening and evaluation. Accordingly, the teacher first draws the attention of the children, and then, by creating a research-exploration environment, the teacher gives the children the opportunity to do research with small experiments. Next, the teacher enables children to learn through activities in which they can find the answers to the questions that arise in their minds in line with the information they have obtained through their own research. The fourth

stage is the deepening stage where the learned basic information can be deepened, and they can make observation by creating their own designs. Finally, in the evaluation phase, the entire learning process is evaluated (Bybee, 2009). Before starting the activity, five square tables are placed in the classroom. Chairs are arranged so that there are four chairs for each table. Then, the children are seated at the tables by drawing lots. Children are told that they will do individual work. Researchers explain the purpose of the activity they have prepared and place the necessary materials on the tables. The activity lasts approximately 80 minutes. In the following section, the activities carried out

throughout the process are presented step by step.

### Materials

The following materials were used in the activity:

- Empty paper towel roll
- Craft knife and/or scissors
- Blank or old CD
- Pencil
- Small piece of cardboard or cardstock
- Tape
- Aluminum foil
- Tape
- Kaleidoscope
- String
- Newton and Me book
- Paint (optional)

### Step 1. Engage (20 minutes)

The teacher comes to the classroom having worn the butterfly wing, which he/she has prepared before. It has colorful transparent papers on the wings, and the teacher gives the children the opportunity to examine it. Then, as in Figure 1, the children are allowed to try the butterfly wing and create and observe the butterfly wing shadow with the help of sunlight (MoNE 1.1.1 in Table 1).



**Figure 1.** Discovery of the sun's rays with a butterfly wing

Afterwards, the children go out to the garden, and they are allowed to observe the sky. Children are given Butterfly Wings allowing them to explore independently by having them create and record butterfly wing shadows outdoors according to the direction of sunlight (Figure 2).

Explanations are given to the children about how this activity took place and the effects of the Sun on our Earth (whether they see the rainbow, what colors they see in the rainbow, etc.). (MoNE 1.1.2., NGSS 1.1. in Table 1.).



**Figure 2.** Discovering the effects of the sun's rays on the earth

Afterwards, a game called "Player Shadows" is played in the garden with the children. Before the game, a model man from aluminum foil is designed with the children the day before (Figure 3). This model is named "Shadow Hunter Model Man" together with the children (MoNE 3.1.3/ 4.1.1./4.1.2., NGSS 2.2./2.5.1. in Table 1.).



**Figure 3.** The phase of designing and making the "Shadow Hunter Model Man" by children

The Shadow Hunter Model Man is taken out and placed on a table. It is cut by drawing its shadow on a piece of paper placed behind it. Later in the game, one of the children is chosen as an it by counting and the other children are lined up.

The it quickly finds the friend with the longest shadow by looking at the height of her friends and immediately draws his/her image on the ground with chalk. Then, the length of this shadow is compared with the shadow length of the Shadow Hunter Model Man (taking the cut paper into consideration).

Then the child whose shadow is drawn chooses an it. The remaining children continue the game in the same way. Thus, how many Shadow Hunter Model Man shadow heights each child has is determined and written on paper as a graph (Figure 4).

In this process, an attempt is made to integrate science and mathematics (MoNE 3.1.1/3.1.2., NGSS 2.5.2. in Table 1.).



**Figure 4.** Children are measuring the height of their shadow according to the Shadow Hunter Model Man

After the children's own observations and the activity, provocative questions are asked to test their preliminary knowledge of the concept of light (MoNE 1.3.1./2.1.1./2.1.2./2.1.3. NGSS 1.1./1.3. in Table 1).

- What do you see when you look at the sky?
- How do you think you got the shadow on the ground with the butterfly wing?
- How do you think your own shadow is formed?
- What color do you think sunlight is?
- What colors do you think happens when sunlight is refracted?

### Step 2. Explore (20 minutes)

The teacher and the children return to the classroom and the teacher tells students that the shadow phenomenon observed by them in the garden happened by the reflection of the light. Children are introduced to the kaleidoscope, an instrument that allows them to observe with the reflection of light. Each child is asked to do observation with a kaleidoscope.

The children are asked to act like a scientist. They carefully observe an image that they can see only once, keep them in mind, and record their observations on the observation sheets distributed to them (Figure 5).

In this process, children's scientific process skills are supported (MEB 2.2.1, NGSS 1.3. in Table 1).



**Figure 5.** Children's kaleidoscope observations

### Step 3. Explain (15 minutes)

At this stage, the scientist Newton was introduced to the children to support the image of the scientist as a child. At this point, the children's picture book *Newton and Me*, written by Lynne Mayer, was read interactively to the children. In addition to Newton's discoveries mentioned in the book, Newton's discovery of the refraction of white light with the help of a prism was explained to the children in a narrative language accompanied by the visuals shown from the projection (Figure 6) (MoNE 1.1.3./2.2.1./2.2.2./2.2.3, NGSS 1.3./1.4.1. in Table 1.). While making the Newton's disc, the cardboards were cut in a circular shape and six parts were drawn. Each part was colored by the children with pastel paints. The center was pierced with scissors and a string was passed through.



**Figure 6.** Introducing Newton to children

After the book and storytelling, another STEM discipline (mathematics) was integrated into the activity at this stage. Newton disc was introduced to the children by making one together and the number of colors of white light

was counted (Figure 7) (MoNE 4.1.2. NGSS 1.3./2.1./2.4.1. in Table 1.). 1.3./2.1./2.4.1. in Table 1.).

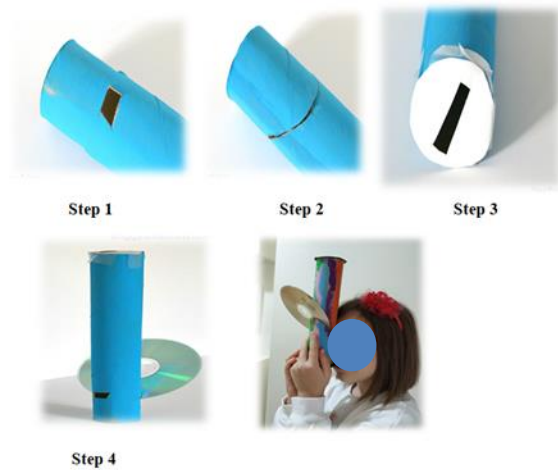


**Figure 7.** Discovering the colors of white light through Newton's disc

**Step 4. Elaborate (25 minutes)**

At this stage, the science of spectroscopy, known as the science of the spectrum of light, was explained to the children who discovered the colors of white light. It was then said that they could design a model spectroscopy device that could observe the light spectrum. In this process, the engineering design process was studied with children using residual materials. For this, first of all, the children were told how Newton was able to observe the refraction of white light, they were told that they could make their own spectroscopes using the limited number of materials put in front of them, and their thoughts on how it could be done were asked (MoNE 1.2.1./1.2.2./2.1.7./2.1.8. NGSS 1.3. in Table 1.).

The construction of the spectroscope is as follows (Figure 8.):



**Figure 8.** Spectroscope construction steps

- The empty paper towel roll can be painted and decorated as desired. Then, a small square observation eye is cut from the bottom end (step 1). A pocket that can fit a CD is cut with a craft knife in the shape of a sad face on the back of the cut part and on the top end of the paper towel roll (step 2).
- A circle is cut from black cardboard large enough to cover the top and bottom ends of the paper towel roll, and a small rectangular slit is made in the exact center of the circle that will come to the top with a craft knife (for light to enter). The top and bottom parts of the roll are closed (step 3).
- The CD is inserted, and children are allowed to discover which colors are inside by breaking the white light and recording it on the observation page below (step 4).

For this, the engineering design page shown in appendix 1 was distributed to each of the children. Each child tried to do their own spectroscope individually using their own materials (Figure 8). Throughout this process, it was discussed in detail about what children can do for their designs (MoNE1.4.1./1.4.2./1.4.3./1.4.4./1.4.5./1.4.6./1.4.7./4.1.1) /4.1.2. NGSS 1.2.1./2.3./2.4.1./2.4.2. in Table 1.).



**Figure 9.** *The phase of spectroscope making*

My Spectroscope Observation Coding Page coding activity was carried out so that children could test their spectroscopes, observe what colors the sunlight really consists of, record their observations, and also support their algorithmic thinking skills (Appendix 2) (MoNE 1.2.3./1.2.4., NGSS 2.4.3./2.5.3.2.6.1. in Table 1.).

### **Step 5. Evaluate (end of the day)**

At this stage, a congress environment was organized where the children could present the products they made during the process and raise awareness of the image of a scientist for the children. Each child, together with their group, was allowed to explain their projects at the table where their projects were located, as if they were a scientist at the congress called the “Light Congress” at the end of the day to the whole school and families, and to introduce their products (MoNE 1.3.2./2.2.3., NGSS 2.4.2. in Table 1).

## **DISCUSSION AND CONCLUSIONS**

In this research, preschool children were made aware of the concept of light through activities prepared based on the STEM approach. While designing the STEM activity, the steps of drawing attention, research-exploration, explanation, deepening and evaluation were followed in line with the 5E model (Bybee

2009; Eisenkraft 2003). These steps enabled children to understand new situations based on their previous experiences and knowledge, to associate the subject with their daily lives, to reveal misconceptions if any, and to learn concepts. In addition, children were given the opportunity to develop scientific understanding by using the engineering design process. The ability to work together with engineering process skills, especially the ability to observe, record observations and draw conclusions, supports the idea that young children can approach problems from an interdisciplinary perspective (Davis, Cunningham & Lachapelle 2017; Gold & Elicker 2020).

During the activity, many projects were carried out with children on the concept of light. Preliminary knowledge of the children on the concepts of light observation, shadow, kaleidoscope, and Newton disc was checked and separate projects were implemented on these concepts. With the further development of the children's sense of curiosity, they were provided with the opportunity to establish their own hypotheses for the discovery of the refraction of light phenomenon and to make a real observation with the spectroscopes they designed and made. This process supported the development of critical thinking and problem-solving skills in children (Cunningham & Higgins 2015), as well as the development of a sense of achievement. In support of this, Trundle and Smith (2017) stated that STEM activities significantly support the development of children. It is indicated that the combined use of the STEM approach and the 5E model helps children experience meaningful learning, supports the development of 21st century skills, and facilitates reaching learning goals (Çorlu, Capraro & Capraro 2014). Drawing attention to the importance of STEM education in early childhood, Chesloff (2013) stated that academic development, critical thinking, and reasoning skills of children who receive STEM education at an early age are increased, and their motivation is boosted. In fact, it was seen that 94% of children participating in STEM activities were extremely happy, especially at the point of creating their own designs throughout the process (Alan, 2020). Considering that STEM aims to increase the number of individuals to be employed in these fields in the future, the importance of STEM activities in early childhood is better

understood. Finally, the present activity is believed to increase social interaction among children. In line with these data, previous studies in the literature reported that these practices for preschool children also support collaborative working and communication skills.

As a result, in the 21st century, it is of great importance to create an educational environment where teachers and children are active in the learning process and can learn by themselves. Such a classroom environment becomes even more important in the pre-school period, where development and therefore learning takes place very quickly, and children are very curious and motivated to learn. The knowledge acquired in the pre-school period forms the basis of the children's education in the future. Considering all these points, preschool teachers can be expected to implement practices that will attract children's attention, enable active participation, and support the development of 21st century skills. In this context, it can be said that STEM activities carried out in early childhood are of great importance.

In this context, the current activity is a very effective tool for preschool children to receive STEM education and reach the determined international standards. As a matter of fact, it was observed that the children followed the activities with great interest and excitement during the practices. Since the activity also includes engineering skills, it created an opportunity for children to demonstrate their creative thinking skills. It is thought that the activity provides children with the opportunity to learn while having fun, and contributes to their development of positive attitudes towards science, technology, engineering and mathematics.

### **Revision Ideas for the Activity**

In the implementation process of the activity, it was decided whether the activity achieved its purpose or not, according to the feedback given by the researcher's diary and the teacher of the class with 15 years of experience. The first of these was that the implementation environment was insufficient for 20 children to work individually. The engineering design process also includes a collaborative process (Cunningham & Higgins, 2014), but while this activity was aimed, it was planned for children

to develop projects individually so that they could make independent observations. In an individual working environment, there is a need for an area where each child can move independently. For this reason, the classroom space was insufficient at this point, the process had to be advanced in different environments at various stages of the project, and it was difficult to provide support especially at the points that required help during the development of children's projects. At this point, instead of designing individual spectrometers with children, a rather large spectrometer could be designed, and an environment could be arranged in the "light observation center" that could be set up in the classroom, or a project could be developed in small groups of 3-4 people.

Another limitation of the activity is time. It is thought that implementing the activity in more than one day would be more effective regarding children's attention skills. Thus, preschool teachers can announce certain days of the week as STEM practice days. Another limitation is that the necessary importance has not been given to the use of materials anymore. Paper towel rolls used in the production of spectrometers were requested from the families before the activity, but not all families sent them. Missing materials were provided by the researchers. This point shows that teachers and families do not have enough sensitivity about the use of materials anymore. It is thought that it would be beneficial to hold family information meetings on material use and recycling and to organize material design days.

In addition, it is thought that creating a material center especially in pre-school classes and enabling children to find solutions to problems by making unlimited designs in the context of STEM approach in these centers will contribute to the goal that STEM education wants to achieve. Moreover, although Lynne Mayer's picture book *Newton and Me*, which was used in the explain phase of the learning process, was in English and attracted the attention of Turkish children to whom the activity was applied, the fact that the book was not large enough and the text was longer than that of level of preschool children prevented the children to give their full attention to it. The book was presented to the students after the text was edited by the researchers. It is suggested that researchers can prepare appropriate story cards based on the book and grab the attention of children. Finally,

the activity was completed as a family involvement study. However, it has been observed that families do not have enough knowledge about the STEM approach, and at this point, it has been concluded that it would be important to conduct informative meetings or family involvement activities under the name of STEM family studies to support children's skills in STEM fields at home.

### Lessons Learned from the Practice and Suggestions for Preschool Teachers

The present activity was started in the open air, but most of its stages were carried out in a closed classroom environment. Spectroscope observations, especially designed at the last stage of the activity, took place in the classroom environment as it was the end of the day. For this reason, at this stage, it can be carried out in outdoors. Outdoor applications would also avoid the above-mentioned environmental limitations for the activity.

STEM activities are promising in supporting children's inquiry-thinking skills from the pre-school period and supporting their meaningful learning by managing the process like a scientist. The present study is an example of how children can learn the concept of light, which they can constantly observe in daily life, by doing and experiencing. At this point, preschool teachers can make other educational arrangements for the interests of the children in their classes and the scientific activities they are curious about.

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### Appendix 1


Let's Make a Spectroscope and Observe the Refraction of Light! worksheet

**"Let's Make a Spectroscope, Let's Discover the Light"**

**MATERIALS**

- Empty towel paper roll
- CD
- Scissors
- Colored cardboard or paint for decoration
- Tape

Name: \_\_\_\_\_



↓

- How can we make a spectroscope to observe light using these materials?

```
graph TD; think((think)) --> Plan((Plan!)); Plan --> apply((apply!)); apply --> Evaluate((Evaluate!));
```

### Appendix 2

#### My Spectroscopie Observation Coding Page!

**My Spectroscopie Observation Coding Page**

Name: .....

Look at your spectroscopie! Match the colors correctly!  
Paint the boxes!