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Developing STEM skills with water games in early childhood

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Abstract
Children curiously and instinctively ask questions about how, what and why about their environment. The aim of the study is to examine the effect of early childhood water games on the development of STEM skills. The study group consisted of 21 students of fifth grade of a primary school in İstanbul, Maltepe. In the research, water games related to swimming and stinging were played from salvation from desert island, and answers from the children such as let us do submarine, rainbow sherbet and let us carry the water. After the evaluation of the research data, the effect of the water games on the development of STEM skills was determined. In a study related to swimming and stinging in early childhood, children expressed that they found the swimming and stinging experience enjoyable. This paper recommends other researchers to work on different topics and in different age groups within the scope of the contribution of the games to the development of STEM skills.

Keywords: STEM, games, early childhood, Skills, water.

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Introduction

Game with its general definition, canonical or non-canonical, for a specific purpose or not, but not providing material benefit, is one of the most effective and enjoyable ways of learning for the child wherein every child likes to be and forms a social group through voluntary participation, addressing four different developments (physical, cognitive, affective and social). Dönmez (1992) and Tamer (1990) determined that play for individuals is recognised as a tool that enables exploration, research, observation, develops new skills and takes roles (Mangir & Aktas, 1993). At the same time, it embodies abstract concepts in games, science and mathematics and makes the concept more meaningful to students (Guven, 1995).

Children are curious and instinctive about the natural world and ask how, what and why questions about their environment. Increasing this interest supports children to develop their ideas about the world and natural sciences. Increasing children's curiosity leads to an increase in learning and the development of oral and linguistic skills. Effective science education in early childhood offers children opportunities to negotiate and explore. Science-related activities in early childhood are important for the cognitive, social and emotional development of concepts. Play in early childhood enables preschool children to explore science and encourages implicit learning (Bennett, Wood & Rogers, 2009). Implicit learning occurs when children engage on the basis of their own curiosity and inquiry processes. This random learning time is crucial for young children as they begin to develop their own meaning from materials, tools and experiences with peers (Hewett, 2001). Play also inspires intellectual development in language, literacy, logic and mathematics (Balter & Tamis-LeMonda, 2006; Roskos & Christie, 2010). In early childhood, play has been accepted as an important context that supports children's learning and development and reflects their social lives (Broadhead, 2004; Kamogawa, 2010).

Game-based science learning approaches enable children to use their daily experiences and activities in a meaningful way while exploring science concepts. Although previous research on game-based science learning has mainly focused on preschool settings, it also explores the applicability of game-based approaches to science learning in primary school. A cultural–historical perspective is gradually becoming widespread, with the awareness that research on children's science learning at an early age, emphasising cultural and contextual factors improves children's understanding of science (Fleer & Pramling, 2015; Remountaki, Fragkiadaki & Ravanisi, 2017). Robbins (2005) stated that children's science learning can be achieved within a social and cultural context. As Fleer (2009) shows, children experience science phenomena in their daily entertaining experiences, and these experiences give meaning to abstract science concepts. For many children, play is an everyday activity where they can explore the world. The cultural–historical perspective of play occurs in the social and cultural context of the child (Fleer, 2011). While play allows children to engage in activities that benefit from familiar, daily experiences, it can also provide an opportunity for children to learn scientific concepts (Siraj-Blatchford, 2009).

Games connect every day and scientific concepts (Hedegaard & Chaiklin 2005). Everyday concepts develop in the daily lives of children with the contributions of family, friends and society. The knowledge and skills that children need are developed through daily activities (Hedegaard, 2008). Often, children are not aware of this information as it is embedded in daily life. Conversely, scientific knowledge includes an abstract understanding that can be consciously applied to different situations. Every day and scientific concepts are examples of different types of knowledge (Hedegaard & Chaiklin, 2005). Vygostky (1987) linked scientific knowledge with academic concepts learned at school. As children explore the relationships between concepts, both at a certain level and at a general level, their scientific knowledge is actively developed. While every day and scientific concepts are very different, they are basically linked. Because children use their daily knowledge and experience to understand scientific concepts, it improves as children use their new scientific knowledge in daily life (Fleer, 2010). A child playing in the garden of a house (daily knowledge) will recognise the different types of insects and habitats in their garden more meaningfully when they learn about garden plants and animals at school. For example, he/she may want to plant flowers in the garden to create a habitat that provides a food source for his/her beloved insect. Therefore, meaningful learning experiences need to link these two types of concepts. Hedegaard and Chaiklin (2005) define this as the double movement of teaching. In this dual approach, the teacher must design learning experiences that will enhance the relationship between science in everyday life and science in the classroom.

We see those activities such as playing and daydreaming are important in the inventions, and inventions of scientists. For example, Einstein played with toy trains and, as an adult, argued that play is the highest form of research. Michael Faraday was fascinated with games while researching electricity and magnetism. Barbara McClintock studied the genetic makeup of the cornfield ecosystem by imagining it traveling under the microscope (Fox Keller, 1983). Play has been reported to have an exceptional cognitive capacity to visualise, imagine, model and explore theoretical knowledge about some features of the physical world (Kass, 2003). The relationship between imagination in play and creative cognition in science is promising (Blake & Howitt, 2012).

Studies indicate that many teachers are aware of the importance of games in learning, but they are insufficient in how to combine game activities with scientific content knowledge. Although each play experience is different from each other, the common feature of each is that it allows children to think, reason, try to use logic and research the relationships between events and provide cognitive development (Hamlin & Wisneski, 2012). It should develop not only the teacher's awareness of science learning, but also the child's interest and attitude towards science lesson. Siry (2013) reported that this can be achieved through games. Play increases student motivation to science learning, can support the development of academic and personal skills and provide opportunities to relate academic learning with real-world experiences (Briggs & Hansen 2012). Recently, the application of game-based learning approaches designed for primary school level has increased (Walker, 2011). Game-based learning allows children to embody scientific concepts and processes (Briggs & Hansen, 2012).

Various studies have proposed different game implementation strategies in order to design and implement games at school. Bergen (2009) stated that guided creative games exploring the physical world offer an ideal opportunity to teach science concepts. In teacher-guided games, the teachers ask questions during the game and direct the games. It is based on deliberate instruction to stimulate the ability of children to plan, anticipate, observe and record data, with guided questions. With teacher questions, children learn science implicitly during play and expand their ideas about science (Trundle & Smith, 2017).

Play provides opportunities for children to learn science concepts, such as the diversity and interdependence of life, the relationships between force and motion and the structure of matter. It is also a rich context for introducing young children to the scientific research process. Teachers should support the game by including games in their teaching plans. For example, to provide children with opportunities to learn about force and movement, they can encourage children to discover what happens when they touch and move objects made of different materials, such as wooden cars or plastic pipes. The teacher also observes and comments on their actions, such as 'What if?' This can improve children's thinking by asking questions. These planning and interaction result in an ever-increasing knowledge accumulation (Hamlin & Wisneski, 2012). Spontaneous games are lacking in providing information and conveying a content to students. Therefore, educational games should be planned well. It is seen that the game activities used in new studies have been developed within certain frameworks (Cechin, 2013).

In recent years, researchers have defined educational games as pedagogical games. Pedagogical games are defined as games used to encourage children's learning (Abu Bakar, Daud, Nordin & Abdullah, 2015; Wood, 2010). In the studies examined, pedagogical games in early childhood were organised in three different (open-ended, modelled and purposeful) ways (Edwards, Cutter-Mackenzie, Moore & Boyd, 2017; Karayilan & Sahin, 2018; McLean, Jones & Schaper, 2015). Marlina and Kanedi (2017) stated that scientific process skills can be developed in early childhood with hands-on activities such as experiments and games. There are three different ways to teach science through play. The first is 'Don't experiment'. While doing the experiment, the children said, 'I wonder what will happen…' The second is hypothesisation, i.e., 'If I do this… the following will happen because…' Third is a reflection, 'Where have I seen this before?' or 'Where do I know?' As children research, they notice and differentiate various aspects of objects and materials.

Although inquiry-based education and student interest are considered important in scientific education, active participation through manual skills, mind and hearts are kept separate and rarely cooperative (Inan & Inan, 2015). Four areas are needed for students in order to ensure that learning can be integrated. One of them is that students have experience. Other needs are the areas of mind (heads / minds-on), heart (hearts-on) and hand skills (hands-on). Heads-on, hearts-on and hands-on occur when learning with practice. Combining manual skills, mind and heart with an appropriate learning can enable students to have long-term memory of their studies (Rahman, Rustaman & Mudzakir, 2019).

1.1. Game and STEM training

Research on STEM applications has recently focused on preschool and early childhood. Studies have shown that besides the applicability of science and mathematics sciences included in STEM before school, these applications are effective in providing preschool children with 21st-century skills, and the creativity level of a student in preschool age is at the maximum level (Sackes, Akman & Trundle, 2012; Uyanik Balat & Gunsen, 2017).

One of the most effective ways to improve STEM skills in preschool children is playing (Uyanik, Balat & Gunsen, 2017). The game can be used in STEM activities in a planned manner on the important concepts and skills to be acquired. Especially, preschool children are curious and investigative about the people around them, objects and events. By allowing students to ask questions and form hypotheses within the game plans prepared, their knowledge and skills in the STEM field can be improved (Uyanik Balat & Gunsen, 2017). According to Lee and Hammer (2011), games are motivating due to their effects on the actors' cognitive, emotional and social areas. With the educational games prepared by paying attention to this feature, it can be ensured that the students learn better and the learned information becomes permanent. The reason for this is that the game is constantly repeating itself, i.e., the information desired to be taught is repeated many times while playing the game. It is a known fact that repeated knowledge contributes to permanence (Sahin, 2019). Children unknowingly learn and adopt many rules and concepts such as learning, decision-making, cooperation, ranking, organising, sharing, respecting the rights of others and helping each other (Coban & Nacar, 2006).

Based on these studies, which stated that learning science with games is important in early childhood, this research was designed. The problem of the study was determined as follows: Do water games have a significant effect on the development of STEM skills?

2. Methods and materials

2.1. Research Pattern

The type of this research is qualitative, the model is experimental and the design is also experimental. In experimental research, cause and effect connections between variables are sought. The independent variables are changed to a controlled manner and their effect on the dependent variable is measured (Hazar, 2009). Hypotheses put forward in experimental research have a theoretical background. Subjects are randomly selected and randomly assigned to the experimental and control groups. In a poor experimental design, the researcher makes an examination after the application with a group (Sozbilir, 2012).

2.2. Working group

A study group of 21 people, consisting of fifth-grade students of a primary school in Maltepe, Istanbul, was selected. The students consisted of 11 girls and 10 boys.

3. Data collection tools

A total of three data collection tools were used in this research.

3.1. Group evaluation rubr

The group evaluation rubri was prepared by the researchers. During the game, the group evaluation rubri was scored by the researchers who managed the course through observation. There are 10 flat expressions in the group evaluation rubri. The expressions are as follows: active role taking, importance of group work, cooperation, awareness of responsibilities, dexterity, creativity, designs for new ideas, science concept learning and good evaluation of time. The rubrik is prepared on a 3-point Likert scale (Very good: 3; good: 2; and can be improved: 1). The validity and reliability of this scale were calculated and approved by the expert (one of the researchers).

3.2. Student opinion and information evaluation form

The student opinion and information evaluation form was prepared by the researchers. The evaluation form includes nine open-ended questions and one multiple-choice question. In the questions in the form, games, scientific games, games played with pleasure in school, games played for mathematics and science learning, games preferred by students in the classroom, games played with pleasure related to science, engineering, mathematics and science concepts in games and water games that you play with pleasure are used. The student opinion and information evaluation form prepared for this research was prepared qualitatively. The validity and reliability of this form were approved and evaluated by the expert researcher and deemed appropriate.

3.3. Problem-solving scale in science education

This scale has been re-adapted by the researchers according to the purpose of the researchers. The problem-solving scale in Science Education was developed by Unal and Aral (2014) and the validity and reliability studies were carried out. The questions are also related to science and natural phenomena and the games played by students, which include three open-ended questions. The problem-solving scale in Science Education consists of 16 open-ended questions, but according to the purpose of the research, it was prepared in the form of three open-ended questions. The three open-ended questions on the scale contain three different problems. The validity and reliability of the prepared questions were evaluated by the expert researcher.

4. Arastirmanin uygulamasi

4.1. Formation of student groups

While determining the groups, seven groups were formed with each group consisting of three students. The number of male and female students in the groups varied. In order for each student to take responsibility in the division of labour, the groups were tried to be formed with few students. However, due to limited materials, it was deemed appropriate to have three people each.

4.2. Reading the problem scenario

At the beginning of the course, the introduction to the video about the Bermuda triangle or certain sections was shown. We were told that ships and planes in this area were missing, so we had to go deep into that area and make observations. They were asked to design an undersea vehicle for this purpose.

Sample Problem Scenario: You have been assigned to the research team to determine why the ships in the Bermuda triangle sank and why the planes crashed. You need to design the best undersea vehicle and study the depths in that area.

Material Selection: Before the STEM event is started, the material table is prepared. On the material table there are 20 water bottles, 7 jars, 1 pack of straws, 4 rolls of aluminium foil, plastic plates, pieces of cardboard, tires, play dough, stones to make various weights, reels and ropes of different sizes. At least one pair of scissors and transparent tape were distributed to each group.

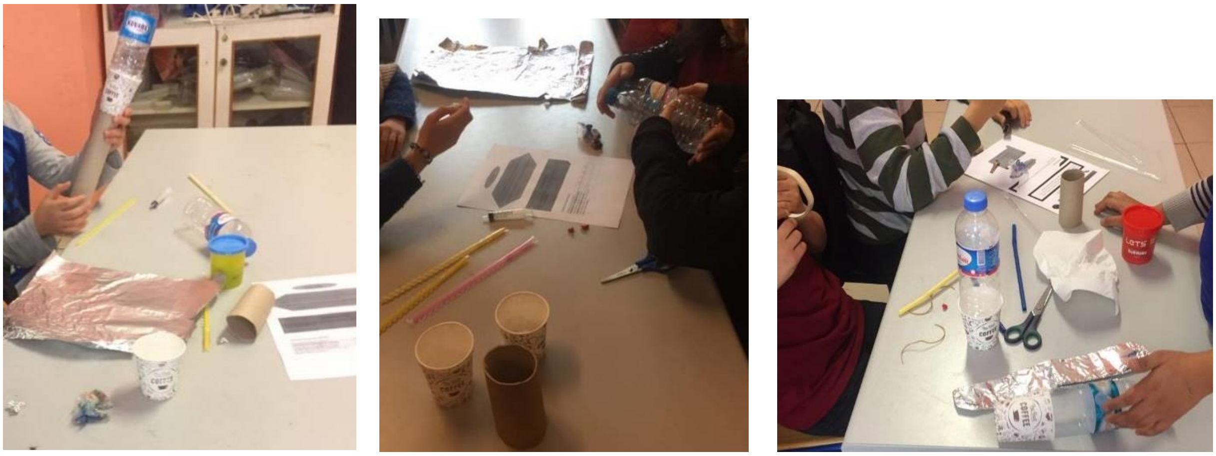


Figure 1. Sample of the students' desks

Teachers expected students to use little material efficiently. The selection of materials was decided by all group members. When choosing materials by the students, information was shared among themselves about how to design.

4.3. Making drawings suitable for the problem

Drawings were prepared by the researchers before the designs were put into practice. Researchers were careful not to start applying students' designs before drawing them.

Figure 2. Sample of the students' drawings

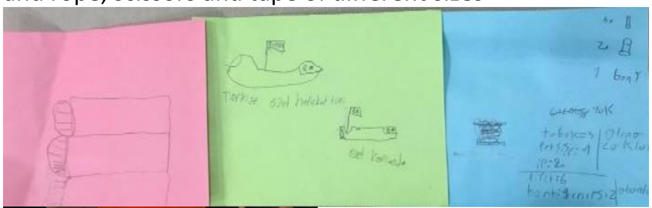
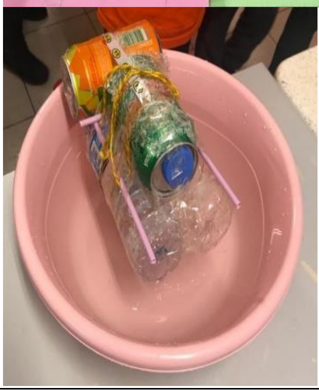
Before product making began, the researchers waited for the drawings of the design from the students. When drawing the design, information sharing was carried out by the students. The element of giving voice within the group was expected by the teachers, respecting and listening to each other of the group members were also carried out very successfully when drawing.

4.4. Creation of the designs

Figure 3. Sample of the students' T-asimlbee

STEM applications were used by students within the time given by the researchers. While the applications were prepared by the students, the group evaluation rubrith was filled out by the researchers. Student designs were more successful than what the teachers expected and were prepared in accordance with the lesson plan. Students demonstrated their products in accordance with the purpose of the STEM lesson plan.

Table 1. Problem stages, student samples and teacher reviews according to the STEM lesson plan

Stages of the project	Student examples	Teacher reviews
Problem scenario	You've been assigned to the research team to determine why the ships in the Bermuda triangle sank and why the planes crashed. You need to design the best undersea and study the depths in that area.	It was found interesting for the students and the task given made them feel important.
Ingredients	Various weights, fastening parts, various sized injectors, 20 water bottles, 7 jars, 1 pack pipette, 4 rolls of aluminium foil, plastic plate, piece of cardboard, rubber, play dough, stones that will make various weights, roller and rope, scissors and tape of different sizes	Their creativity was not limited as the materials were taken on demand.
Drawings		When they drew, they imagined products to design.
Designs	 	Purposeful designs are revealed, although they are different from drawings.

The fact is that each group in the STEM lesson plan has a task aimed at increasing students' sense of responsibility and has given students pleasure. Students have made their designs a product by advancing in both the progress of the course and the awareness that they have a task within the group.

The creativity of the students was not limited in the selection of materials by the teacher. Most words and behaviours were avoided by the teacher in order to not affect the creativity of the students. The teacher of the course gave a general instruction before starting the lesson only when choosing the amount of material. The durability of the material when making products by the students was selected discreetly, thanks to the imagination and planning of the students.

The design drawings were made by asking the opinion of each group member. Although the drawing was often moved away when designing the product, the students tried to stick to the drawing. As a result, products suitable for the purpose of the STEM lesson plan were put forward.

A sample lesson plan applied to students during study is shown in Annex 1.

5. Data analysis

5.1. Group evaluation rubr

The evaluation rubr presented in Table 2 is prepared by teachers who observed the behaviour and attitudes of students during the game.

Table 2. Criteria and opponents of group evaluation Rubr

Expressions	VERY GOOD (3)	GOOD (2)	IMPROVED (1)
Each student took an active role during the game.	Each student took an active role during the game.	Each student took a partially active role during the game.	Each student was incapable of taking an active role during the game.
Students have recognised the importance of group work.	Students have recognised the importance of group work.	Students partially recognised the importance of group work.	Students were incapable of realising the importance of group work.
The students worked collaboratively in the group.	The students worked collaboratively in the group.	The students worked in cooperation in the group in part.	Students were inadequate in collaborative work in the group.
Students are aware of their responsibilities in the game.	Students are aware of their responsibilities in the game.	Students are partially aware of their responsibilities in the game.	Students have failed to remain aware of their responsibilities in the game.
Students have demonstrated their hand skills in games and put products in the middle.	Students have demonstrated their hand skills in games and put products in the middle.	Students have demonstrated their hand skills in the games and partially put products in the middle.	Students have demonstrated their hand skills in games and have been incapable of putting products in the middle.
Students have developed their creativity through games.	Students have developed their creativity through games.	Students have partially improved their creativity through games.	Students have been incapable of improving their injury with games.
Students have come up with new ideas in their designs.	Students have come up with new ideas in their designs.	Students have produced new ideas in part in their designs.	Students have been inadequate to come up with new ideas in the

			design.
Students have completed their designs with precision.	Students have completed their designs with precision.	The students have partially completed their designs.	The students did not complete their designs.
Students learned the concepts of science with the event.	Students learned the concepts of science with the event.	Students have partially learned the concepts of science with the event.	Students did not learn the concepts of science with the event.
Students have made good use of the time given for designs	Students have made good use of the time given for designs	Students did not make the most of the time given for the designs.	Students were not able to complete their designs in the time it takes for designs.

5.2. Student opinion and information evaluation form

The nine open-ended questions in this form were evaluated by the researchers as to whether the games that the students enjoyed had anything to do with the concepts of engineering, science and mathematics. At the same time, the concepts of the students' science course were examined by the researchers in this form.

5.3. Problem-solving scale in science education

The problem-solving skills of students were examined by researchers on the problem-solving scale in science education. Students' approach, attitude and solution-making processes were evaluated by the researchers with this scale.

5.4. Validity and reliability of research

In this study, a faculty member who is knowledgeable about the subject of research and specialises in qualitative research methods in order to increase the credibility of the research examined all the processes of the research: data collection tools and data collection processes, criticisms and interpretations to the researchers. Instead of the concept of reliability in research, he proposed the concept of consistency in qualitative research (Lincoln & Guba, 1985). Consistency rather than reliability is at the forefront of qualitative research. In this context, the planning and realisation of the research process was tried to be explained in detail and with reasons. In qualitative research, the researcher’s diversification was used in the study to ensure affirmability that replaces external reliability. A secondary researcher took part in the analysis of the data obtained from the research. Consistency between the two researchers was evaluated as consistency, in short, external reliability.

6. Results

In this study, the effect of water games on STEM skills in early childhood is examined. The findings obtained by data analysis are presented in Tables 3 and 4.

6.1. Findings of the STEM lesson plan implementation skills according to group evaluation rubr

Students were divided into seven groups by teachers when applying their designs for the STEM lesson plan. The group evaluation form was filled out by the teacher while the students were presenting their products.

Table 3. Percentages of students' responses in group evaluation rubri

Expressions	Total answers (*N* = 70)	Percentile (Very good)	Percentile (Good)	Percentile (Developable)
Each student took an active role during the game.	7	71.43%	28.57%	0.00%
Students have recognised the importance of group work.	7	42.86%	57.14%	0.00%
The students worked collaboratively in the group.	7	57.14%	42.86%	0.00%
Students are aware of their responsibilities in the game.	7	42.86%	28.57%	28.57%
Students have demonstrated their hand skills in games and put products in the middle.	7	42.86%	57.14%	0.00%
Students have developed their creativity through games.	7	85.71%	14.29%	0.00%
Students have come up with new ideas in their designs.	7	%42.86	42.86%	14.29%
Students have completed their designs with precision.	7	71.43%	28.57%	0.00%
Students learned the concepts of science with the event.	7	14.29%	57.14%	28.57%
Students have made good use of the time given for the designs.	7	42.86%	57.14%	0.00%

Looking at Table 3, it can be determined that the students took an adequate active role in the groups and had high levels of creativity. However, it has been observed that the students' awareness levels of understanding and responsibilities of science concepts with effectiveness are inadequate.

6.2. Findings of questions the students answered on the form after STEM the lesson plan implementation

Immediately after the end of the course, the students' opinion and information evaluation form was distributed to the children by the researchers. The answers written by the 21 students on the form are shown in Table 4.

Table 4. Students' answers according to opinion and information evaluation form

Questions	Answers given
What's the game?	The answers given by the students are usually it's all about the kids playing, the things we do for fun, the things I play with my friends and making submarines.
What is the scientific game?	Most of the answers from students: It can be a game related to science, the scientific game is to experiment and to play games related to science. In addition, the answer to the question is a lot of 'I don't know'.
What games do you enjoy playing at school? Tell me their names.	Answers from students: schoolyard games such as ball bounce, hide-and-seek, handkerchief snatching

	and sex.
Have you played games in your class to learn math and science? What are their names?	When the answers were examined, they wrote that the students played games related to multiplication table game, name memorisation game, cook game and natural numbers in mathematics class, but they did not include a game name for science.
What games would you prefer if your teacher in class told you that you were going to play?	The vast majority of students wrote in class that they wanted to play the cook game they played in math class. Other answers include finger-grabbing, day and night and camel-dwarf games.
Would you rather play a science-related game in class? Do you think you'll enjoy it?	Almost all of the students' answers are to the question, 'Yes, I prefer to play games about science and I enjoy it, time goes very well when I experiment with science'.
Which one of the following gives you pleasure? a. Playing football game on your phone b. Designing a model with materials such as sand, play dough, lego c. Designing a kite, toy ship, water gun to spray water away, garden irrigation system and balloon rocket for your brother or yourself d. Playing games such as taboo or sudoku	When the answers of the students are examined; It has been observed that designing a model with materials such as sand, play dough and lego has attracted a lot of attention from students.
Do you think your science, maths, engineering skills will improve in this game you chose above?	Most of the answers from students; he thinks that the science, mathematics and engineering skills of the games will improve.
Does your teacher play tricks on you in teaching science and math in class? Can you give me an example?	Some of the answers from the students were answered as 'Yes, we play jenga and jigsaw puzzles in science class and multiplication competition and cook game in math class', while others said, 'No, we don't play in science and math classes'.
You played games with water today. Did it give you pleasure to play with water?	It has been observed that all of the students enjoy playing with water from their answers.

When Table 4 is evaluated, it can be seen that the concept of 'scientific game' is not known and learned by students. Scientific play is perceived as an experiment by students, and the word 'science' only evokes the word 'science' in students. At the same time, the large number of 'I don't know' answers may indicate that students are not experiencing scientific games in their schools and classes.

For '*Have you played games in your class to learn math and science?*', there is usually no science game in the answers to the question. The fact that the study group students gave more examples of maths lessons may indicate that there is no instructional game on subject or achievement in science class.

At the same time, for '*would you rather play a science-related game in class?*', the vast majority of students answered, *'Yes, I like experimenting*', which explains that students have low perceptions and sample levels of science games. It can be determined that students enjoy experiments and because they enjoy experimentation, they see the experiment and laboratory as a pastime and a game.

For '*Which one of the following gives you pleasure?*', the fact that the majority of the answers to the question are 'designing a model with materials such as sand, play dough, lego' may indicate that students enjoy *hands-on* activities. According to the answer to this question, it is seen that students are not able to continue the modelling phase to the production stage.

In the responses given by the students, students have been shown to decide the game 'jenga' in teaching science and mathematics. At the same time, it is seen that they see the application, which is a 'multiplication competition' in mathematics class, as a game and assimilate it as a game. Students can be identified as having both experience and concept deficiencies in science and math games.

According to the majority of the answers given in the last question, it is seen that the students enjoy water games.

6.3. Students' findings on the problem-solving scale in science education

On this scale, the solutions that students can carry out in the face of a problem have been examined by the teacher. The answers given by the students are presented in Table 5.

Table 5. Students' answers to problems on the scale of problem-solving in science education

Questions	Answers given
In class, you and your teacher experimented with the sinking of oranges. You observed the peeled orange sinking. What would you do to float the sinking orange again?	From the answers given by the students, it was noted that they decided that they had to have peels in order to float the orange. Some students stated this as 'I would tie the shell with rubber', 'I would glue the peel with glue', while others stated 'I would make the orange swim again by draining the water in it with a syringe'.
You're playing with a bottle full of sand. You saw him throw the bottle in the ornamental pool and the bottle sank. What would you do to get the bottle to surface and swim?	The vast majority of the students' responses appear to be that when they empty the sand in the bottle, the bottle can swim without sinking.
You accidentally dropped your shampoo bottle in the bathtub while you were bathing in the bathtub. What can I do to float the shampoo?	Among the responses of the students, the most common expressions were 'I would empty the shampoo', while some students said, 'I would open an air gap in the shampoo'.

Considering the answers given on the scale, it can be seen that students can produce accurate and understandable solutions in the face of the problems in the products they put forward. It has been determined that the students demonstrate various creative skills for problem-solving in the problems they face. At the same time, the materials they use to solve the problem encountered are versatile and remarkable. A certain number of the answers given by the students for question 1 were found successful by the researchers in finding a suitable solution to the problem. It has been determined that students have a high level of imagination and creativity.

The answers given by the students for the second question were evaluated as incomplete in producing a design based on the solution of the problem. The students concluded that emptying the sand from the bottle filled with sand solved the problem. However, there is no production and design phase in problem-solving.

The answers used by the students for question 3 were concluded by the researchers to be highly meaningful and have high levels of creativity. The problem-solving skills they used to play water games were used by the students to solve the problem.

7. Conclusion and discussion

In this study, it is aimed to examine the effect of water games on the development of STEM skills in early childhood. According to the answers contained in the scale and form, water games were found to have a positive effect on the development of students' STEM skills. It has been observed that students experience activities aimed at learning during class hours. It was observed, according to the answers given in this study, that the students had low levels of concept of the scientific game. It can be determined by the products that students are creative and successful in STEM-supported production and design games. The majority of students appear to have high levels of creativity based on their responses on the scale.

During this study process, it was observed that the students who formed the study group enjoyed the water games they experienced. Some of the responses from the students included 'I don't know'. This can be explained by the students' attitude towards the course, motivation and readiness levels. Within the scope of the science course, it is seen that they play games aimed at testing the knowledge they have learned more in the classroom. Multidisciplinary games that will improve STEM skills are thought to contribute more to the development process of students.

Both their creativity and failure to pursue any exam concerns were effective in determining them as a class. Students are very open to new activities. When the results are examined, it is seen that the students enjoy playing water games and designing products. During STEM activity, it aimed to improve both dexterity and creative thinking skills. Among the sample of the study is one integration student. When the results were examined, it was observed that the integration student was not excluded from the group during the activity and was able to move with the group. He was also involved in collaborating with his friends. It has been observed by researchers that the integration student took an active role during the activity.

Experimental studies support the importance of play in early childhood. Cook, Goodman and Schulz (2011) examined the skill development of children playing with toys. As a result of the study, it was determined that playing with the toy contributed to children's understanding of the theory's fragmentation functions. For example, if a child is given a toy with two buttons, if one button does nothing and the other produces light and sound, children have learned what actions help in the work of the toy and which do not. Therefore, during the game, children learn to use objects in a way that helps them study the mechanisms, properties and nature of materials. Scientific games are one of the important tools in teaching by reinforcing the learned knowledge, embodying abstract concepts, making group work more active and increasing the problem-solving ability in students (Bell, 2008; Demirle, 1999). A scientific game for the Force and Movement unit has been applied to students. Among students who learned the concept by traditional method, it was observed that the average scores were different between the game and the students who understood the knowledge. Although it was recess, it was seen that the students wanted to continue the game (Saracaloglu & Aldan Karademir, 2009).

In the teaching of periodic rulers and elements, education was provided with bingo game technique. As a result of the study, it was observed that primary school students showed more interest in the subject than university students, but there was no meaningful difference between them (Aycan, Turkoguz, Bee & Kaynar, 2002). As for the solar system and planets, one group was taught the concept in the traditional way with the game and the other group was taught the concept in the traditional way. At the end of 3 weeks of training, it was observed that learning by game was more effective in increasing academic achievement than traditional learning (Infallible Oren & Erduran Avci, 2004). Looking at the examples, especially in the context of the science course, scientific games effectively increase concept learning and science awareness in students (Saracaloglu & Aldan Karademir, 2009).

Rahman, Rustaman and Mudzakir (2019) wanted to examine the consequences of project-based learning, whether it would increase 3H activities. For this purpose, they formed an experimental group and a control group. They applied 3H activity to the experimental group in order to increase their activity in project-based learning. They focused on students' dexterity (hands-on) and their process skills to implement effectiveness. In the experimental class, applied activity was observed from designing project activity to delivering products and results. In the control class, activity was observed from practical working activity until they presented a practical report. They focused on the thoughts for mental skills (heads-on). They worked with written testing with critical thinking indicators to determine differences from the control group. They also examined a self-assessment form for heart learning (hearts-on) skills. Based on the findings and discussions of the study, we can say that project-based learning can increase 3H activities.

In a study of facial me and stinging in early childhood, they found the children's swimming and stinging experience fun. The children were thrilled to discover whether the objects would float. In this fun experiment, the teacher's role was to clarify children's predictions and help them to test them (Pramling & Pramling Samuelsson, 2001). Again, the teacher, with such a fun learning, helps children think, and make them verbal (Bulunuz, 2013).

The last two lesson hours of the activity applied in this study, preparing the children to go home as the end of the lesson time approaches, may be an obstacle to study. Taking this detail into account in the construction of the studies in which children will be included, the implementation will ensure that the study is carried out more healthily. At the same time, the subject of this study can be made at other class levels and the development of students' STEM skills can be measured.

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Annex 1 An Exemplary Lesson Plan

A total of two STEM lesson plans were applied to the students. Only one of the STEM lesson plans applied is included in the study to serve as an example.

1. Lesson Plan

Course: Science

Class: 5th grade

Unit: Applied Science / Science and Engineering Applications

Duration: 40+40

2. Bermuda triangle

Link to video shown to students: https://www.youtube.com/watch?v=Oecg49QjIX

3. Measurement and evaluation

Group evaluation rubr, student opinion and information evaluation form and problem-solving scale in science education.

4. Knowledge-Based Life Problem

4.1. Problem Scenario

You've been assigned to the research team to determine why the ships in the Bermuda triangle sank and why the planes crashed. You need to make the best undersea design and study the depths in that area.

4.2. Sınırlamalar

Your submarine must swim and sink whenever we want, and stay balanced when we swim.

4.3. Occupations

Mathematician, designer, scientist, environmental engineer and ship engineer

5. Course content

5.1. Introduction to the course

The teacher watches the introduction to the video about the Bermuda triangle or certain sections at the beginning of the lesson. He says that ships and planes in this area are missing, so you have to go deep into that area and make observations. For this, he expects them to design an undersea vehicle.

5.2. Exploring

The teacher distributes the activity papers to the classroom and expects students to draw designs in groups. It helps groups perform calculations and experiments with the materials they choose. Here, students need to know that swimming and stinging are related to intensity. In this section, the student's density reaches the knowledge of swimming objects smaller than liquid density and sinking large ones. She also makes suggestions for making designs look beautiful. Groups distribute the tasks.

5.3. Support

In this section, the teacher helps students get to the truth by giving their questions tips. Students form the submarine they designed in groups. They then try their designs in a deep container, for example, in a container filled with 19 litres of water. In the meantime, costs are also subtracted according to the materials used. Appropriate designs are selected and comparisons are made.

5.4. Deepening

In the principle of operation of undersea, there is a deepening of the effect of the issues such as liquid pressure, fluid-lifting force and density. Thoughts on more technological designs are required, and students whose design is not suitable for CA are given the opportunity to discover and correct the problems.

5.5. Review

The teacher observes and evaluates the ability of the groups to access information during the duration. In the following process, the groups are asked to fill out group evaluations, student opinion and information evaluations and problem-solving devices in science education. In the meantime, the teacher evaluates the designs made by the groups according to the scoring criteria.