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Analysis of Case Problems by STEM Activities in Children's Stories and Their Effect on Problem-Solving Skills

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Abstract

The development of the problem-solving skills comes into prominence in case the condition of being faced with more difficult and more complicated problems is reflected in education. A mixed method was used in the method of the study with a view to the analysis of the case problems in children's stories by the STEM education and examining its effect on the problem-solving skills. The quantitative data, which benefited both from the qualitative and quantitative methods, was derived as the pre-test and the final test data from the problem-solving skills scale (PSSS), developed by Oğuz and Köksal Akyol (2015). In the collection of the qualitative data, the material and teacher evaluation forms -developed by researchers- were used. According to the findings of the results of this study, the use of the STEM activities in the analysis of the case problems of stories, enhanced the problem-solving skills of children ($p < .001$).

Keywords: Children's stories, problem-solving skills, STEM education

Çocuk Hikayelerindeki Problem Durumlarının Stem Etkinlikleri ile Çözümlenmesi ve Problem Çözme Becerileri Üzerindeki Etkisi

Öz

Çağımızda yaşadığımız sorunlar gittikçe zorlaşmakta ve daha karmaşık hale gelmektedir. Gittikçe zor ve karmaşık sorunlarla karşılaşacak olma durumunun eğitime yansıması halinde problem çözme becerilerinin geliştirilmesi durumu ön plana çıkmaktadır. STEM eğitimiyle çocuk hikâyelerindeki problem durumlarının çözümlenmesi ve problem çözme becerileri üzerindeki etkisini incelemek amacıyla hazırlanan çalışmada karma yöntem kullanılmıştır. Nicel ve nitel yöntemlerden faydalanılan araştırmanın nicel verileri, Oğuz ve Köksal Akyol (2015) tarafından geliştirilen problem çözme becerisi ölçeğinden (PÇBÖ) ön test ve son test verileri olarak elde edilmiştir. Nitel verilerin toplanmasında ise araştırmacılar tarafından geliştirilen materyal ve öğretmen değerlendirme formları kullanılmıştır. Elde edilen bulgulara göre; hikayelerde yer alan problem durumlarının çözümlerinde STEM etkinliklerinin kullanılması çocuklardaki problem çözme becerilerini arttırmış ($p < .001$), aynı zamanda özgün ve yaratıcı ürünler ortaya koyarken, muhakeme etme ve fikir alışverişinde bulunma davranışını göstermişlerdir. Bu çalışma, okul öncesi eğitimde STEM etkinliklerinin uygulanmasına yönelik eğitim etkinlikleri ve uygulanan STEM etkinliklerinin de problem çözme becerileri üzerindeki etkisini belirlemeye yönelik örnekler sunmaktadır.

Anahtar kelimeler: Çocuk hikayeleri, problem çözme becerileri, STEM eğitimi

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1 | Introduction

Problem-solving Skill

The problem-solving skill is a behavior and a process used in various strategies and cases. When the history of problem-solving is taken into account, Polya (1945) characterizes it as defining a problem, planning, and looking behind; Mayer (1977) states that problems involve goals and obstacles, and identifies them as the solving skills to overcome to reach the necessary condition after the present condition, whereas Bourne, Dominowski & Loftus (1979) frame it as a three-stage process comprised of preparation, production, and evaluation. According to Siegler's (1996) overlapping waves theory, it is defined as the strategy which obtains positive feedback in cases of encountering problems.

Children generally learn new problem-solving strategies by observing problem-solving examples of other people. There are differences between the children who learn strategies by observation and the children who learn the strategy by explanation. When explanations are given, it becomes easy for children to apply the learned strategies (Crowley & Siegler, 1999). To actualize that case, children have to acknowledge the process of problem-solving and they have to interpret the existing information. It has been shown that children's problem-solving skill, which is effective in different fields, is very variable (Siegler, 1996). It has been discussed that the investigation of children's variability could lead to significant explorations from the standpoint of clarifying the potential sources of change in different education environments (Siegler, 2002; Siegler & Araya, 2005). Different methods could be made use of for the application of the strategies used for solving present problem cases.

One of the strategies used in children's problem-solving skills is verbal skills to question the process. In this strategy, which is considered as a sort of reporting, children should recognize the alterations with their problem-solving skills, they should evaluate the situation, and they should have verbal reasoning (Ericsson & Simon, 1984, 1993: Farrington-Flint et al., 2009). Instead of solving familiar problems with repetition during retesting, they can use the recall of existing solutions from memory (Farrington-Flint et al., 2008). Another strategy in problem-solving skills might be categorization, it is found that problem solvers who are experts in the field of algebra can categorize with a strong internal control formula (Hinsley et al., 1977). In addition to that, they have the skill to transfer the present strategy in case of a similar problem they encounter; yet, when the constant transfer of those skills is taken into consideration, the necessity of how their problem-solving skills can be developed becomes more of an issue (Mayer, 1998).

The most obvious means to develop the performance of problem-solving is perhaps teaching basic skills. While teaching these basic skills, the problem-solving skills could be developed with the learning programs such as Bloom's (1976) taxonomy of "educational objectives" (Mayer, 1998). The Problem-Solving Model is defined as the identification and relational explanation of a problem by Popper (1972). Şahin (1998) addresses the stages of problem-solving as the comprehension of the problem, the collection of previously acknowledged information and data, the presentation of probable solutions and hypotheses, the evaluation of probable solutions, the trial, and the examination of probable solutions including their outcome. One of the models based on problem-solving skills is the developmental/ecological/problem-solving model (DEP). This model is eclectically formed, and it investigates school, family, and the needs of the school with a systematic diagram in its orbit, and it presents an education model with a basis of field (Simon et al., 2014).

Problem-Solving Skill in Preschool Education

In the period of preschool education, which is the first stage of education, it is a significant step to use problem-solving skills. In order for those skills to develop, environments, in which developmental homework and learning by doing and experiencing, should be allowed. Children also use their cognitive skills when exploring the strategies, they have developed against the problems they encounter (Berk, 2009). Children can try many ways to solve the problems they encounter in daily life, e.g., trial and making mistakes, retrying or reusing the strategies they have developed against the problems they have encountered previously (Siegler, 1995). Starting at an early age, children try to solve problems they encounter in games, life skills, and in many areas in daily life (Aydoğan & Ömeroğlu, 2004). Being a systematic education for developing problem-solving abilities, preschool education helps them develop their abilities such as analysis, synthesis, multi-oriented thinking (Zembat & Unutkan, 2005).

The problem-solving skill makes the child improve himself and provides the opportunity for him to think creatively, develop various points of views, and support expressive language skills. As of early age, problem-solving skills should be allowed for gains up to such an important degree (Oğuz & Köksal Akyol, 2012). Beginning from school starting age, the skills and various evaluation scales of children are investigated in England. One of these skills is the problem-solving skill (Snowling, Hulme, Bailey, Stotdhard & Lindsay, 2011). The problem-solving skill is connected to three components consisting of skill, cognitive ability, and desire. Each component is connected and related to the other. The problem-solving skill should be encouraged by education and children should be ensured to command their cognitive skills (Mayer, 1998). Especially, children's problem-solving skills could be developed through rich stimuli, science and nature activities, and in environments where they are assured that they can test and express their ideas through experiments (Güven, 2004). When the preschool education program of the Ministry of Education – relating to the indicators, explanations, and gains with cognitive development – is taken into account, the statements stating 'problem-solving for problem cases' and the statements stating 'solving problems with each other' are given a place. In addition to that, the statement, stating the necessity of the development of the problem-solving skill in the preschool education environment and learning centers, is also given a place (Ministry of National Education, 2013).

STEM and Problem-Solving Skill

STEM education, as an often and lately debated approach of education, has emerged as a result of the harmonious combination of science, technology, engineering, and mathematics with the education curriculum, among all progressing education levels, starting from the preschool period. STEM education is aimed at children's learning through exploring research, learning, and experiences of problem-solving with interdisciplinary techniques. The STEM education is seen as an important tool for leadership in the economic development and scientific field (Lacey & Wright, 2009) for improving children's thinking skills (Minstrell & Van Zee, 2000), project-based learning (Starkman, 2007), and the problem-solving skills (Morrison, 2006). The STEM activities, which have been used for children to gain those skills up to such an important degree, could pave the way for fast development in many areas, as a result of being used in the preschool education period – the period when the essential building blocks of the mind are formed (Balat & Günşen, 2017).

With the development of technology, innovations are also needed for the education system. Industry 4.0, which will fulfill the needs for the industrial revolution, and the collaboration, communication, creativity, and the development of critical thinking skills – identified as 4C among the required high-level thinking skills of individuals – are closely related to STEM education (Akgündüz et al., 2005). Children are required to interpret, relate, question, and find a solution to use their scientific information for the solution of problem cases (Goossen, 2002).

One of the main problems of STEM education, which is one of the methods of interdisciplinary learning in all of the processes starting from preschool education – the first stage of education – up to higher education, is the integration of the teaching program (Uğraş, 2017). Unfortunately, it has been known that STEM education is not grasped very well by educators, and even those who see it of vital importance, fail to demonstrate a clear vision of it (Brown et al., 2011). Teachers could have concerns for the reason that the STEM education embodies four disciplines with its performance, and regarding the skill of gathering as a result of those disicplines' interrelation (Williams, 2011). The training which will strengthen the integrated teaching skills of teachers and candidates of teachers within in-service education and faculties of education, and the studies for enhancing the STEM education skills, are inadequate (Ministry of National Education, 2016). A Successful STEM education, (Science, Technology, Engineering, and/or Mathematics), teaches the interaction between the performance of effects, cognition, and ideas by the students in the class (House et al., 2014). As a result of the STEM education, children give meaning to what they have learned by doing and experiencing, and concerning their search for a means of a solution when they are faced with a case (Wang, 2012), each lesson, within itself, transforms into a model of learning through doing and experiencing by interdisciplinary teaching (Brown, 2014). In the result of the study, which targets the problem-solving strategies of 6-year-old children and their success level of problem-solving, the children are found to have made use of the modeling strategy and that they have needed prepared materials for it (Altun, et al., 2001). It is also known by teachers that the activities of science and nature, which are performed in the institutions of preschool education, are binding for children's problem-solving skills (Akaya, 2006). In the problem-solving skills, since experiences – that come through slices of life at an early age – encourage individuals to communicate with the environment and form cognitive relations, their support with special education programs appears to be significant (Aydoğan, 2004). For this reason, this study was done so that the STEM activities in the preschool period would contribute to the development of children's problem-solving skills.

2 |Method

In this part, the information relating to the data, the data collection process, the method of data collection, the tools for data collection, the study group is given including the design of the study, which has intended to determine if the problem-solving cases in stories, following their performance by the STEM education, affect the problem-solving skills of the children of the preschool period.

Research Design

In the research, a mixed-method, consisting of qualitative and quantitative research methods, was used to specify the effect of STEM education on problem-solving skills. In the mixed design, instead of choosing only one of the qualitative and quantitative approaches, the conclusion of their cooperation targets a more comprehensive study by obtaining more data relating to the research problem. The mixed-method falls into various designs in itself. The exploratory sequential mixed design is a design that primarily includes the analysis of the results of the quantitative research, and next, its reconfiguration to explain it in detail with the qualitative research (Creswell, 2017). In the exploratory sequential mixed design, during the quantitative stage of the study, the problem-solving skills scale (PSSS) was used as a pre-test and a final test, whereas to support the quantitative results with far-reaching qualitative data, the visual data examination method was used in document examination.

Study Group

To specify the study group, transformative mixed method design was selected. In the transformative method, the sequential data was collected to help make changes (Creswell, 2017). The PSSS was performed to children between 60 and 72 months, and the children who received 18 points and below formed the study group of the research. The study group consists of 5 females, 4 males, and 9 children in total, moreover, the average age is 68 months. The Gender and age information of the children included in the study is given in Table 2. When the demographic qualities of the children included in the study group are taken into consideration, it is seen that 5 females and 4 males from the group and the average age is 68.

Table1. Demographic Qualities of Study Group

Order No	Gender	Age
1	Male	67 Months
2	Female	74 Months
3	Female	72 Months
4	Female	71 Months
5	Male	66 Months
6	Male	71 Months
7	Female	60 Months
8	Female	72 Months
9	Male	59 Months
		$\bar{x}$ = 68 Months

Data Collection Tools

The quantitative data of the study was received by the Problem-Solving Skill Scale (PSSS). The Problem-Solving Skill Scale (PSSS) was developed by Oğuz and Köksal Akyol (2015) to specify the problem-solving skills of the children continuing nursery school. After the calculation of the content validity index values, the validity index was found 0.99 and the reliability coefficient for the whole scale was found .86. The correlation coefficient as a result of the test-retest method was found .60, which means that these results did not differ statistically as a consequence of the first and the last performance [$t(39)=1.63$, $p>0.05$].

The qualitative data of the study was received by the material and the teacher evaluation forms directed towards the evaluation of the items and the process developed by researchers. The forms were organized as the grading score key. The teacher evaluation form consists of the items such as resolution for curiosity, development of a hypothesis, verification, and revision of problems depending on the subject. The material evaluation form consists of the items such as target suitability, the accuracy of the information, drawing attention, robustness, and ease of use.

Data Collection

Twice per week during 4 weeks, 8 Selected stories were read to 9 children in total from the age group of 5-6 years; the problem cases were interrupted and they were asked to find a means of solution with the STEM activities. The environment, in which the STEM activities would be performed, was formed with the selection of the material by researchers. During the performances, there were a video recording and a photoshoot, and the appearing items were examined with the material evaluation and the teacher evaluation forms. After the performances, the PSSS was performed as the final test, and its efficiency was examined. In the process, the children's focus of the process and the behaviors – e.g. interrogation – in the process were taken into consideration by the teacher evaluation form, whereas the ideas – that come out after the activities – and the materials were examined with the material evaluation form. In the course of the performance of the STEM activities, an education environment – supported with various materials – was prepared. The performance of the STEM activities is given a place in the solutions of problem-solving cases, in storybooks of preschool education.

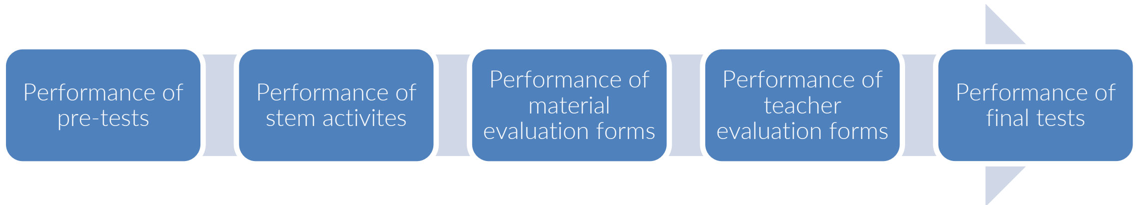

Figure 1. *Work Flow of Data Collection Process*

The PSSS was performed as a pre-test for the study group, in the first week of February of education and teaching the academic year 2017-2018, and the STEM activities were started to be performed for the specified group. After performing the STEM activities, the material evaluation and the teacher evaluation forms were performed by researchers. Selected stories were read to children twice per week for four weeks and they were asked to solve the problem case in stories by the STEM activities. When the STEM activities were finished, the PSSS was performed as the final test to the study group in the first week of May.

Table 2. Study Design

Study Group	Pre-test	Process	Final Test
Experiment	PSSS	STEM Activities	PSSS

Having a single experimental design, the study design – depicted as one of the semi-experimental research for participants cannot be specified as neutral – is a research in which the effect of the performance is evaluated within each test subject by receiving renewed measurements under standard conditions (Gast, 2010).

DATA ANALYSIS

The Statistical Program for Social Sciences (SPSS) version 24 was used for the evaluation of the data received through the study. Whether the scores of the pre-test and final test of the children in the study depicted a normal distribution was determined by the Shapiro Wilk test. As a result of the Shapiro-Wilk test, it was seen that the scores depicted a normal distribution ($p>0.05$). According to the obtained data, the dependent t-test was performed to test the meaningfulness between the two average differences of the relationship between the groups.

3 | FINDINGS

In this section, the findings obtained as a result of the research are presented.

Table 3. Obtained Scores of Pre-Test and Final Test of Children From Problem-Solving Skill Scale

Order no	Pre-test	Final test
1	17	31
2	13	18
3	12	21
4	13	27
5	15	20
6	11	18
7	17	18
8	8	12
9	12	17
	$\bar{x}$ = 13.11	$\bar{x}$ =20.22

When the scores of the children in the study group were examined, their average score of the pre-test was 13.11, and their average score of the final test was 20.22.

Table 4. Performed Paired T-Test Results Between Pre-Test and Final Test

		N	Average	SS	St. Error	t	df	Sig.
Problem-Solving Skill Test Scores	Pre-test	9	13.11	4,45658	1,485	-4,787	8	,001
	Final test	9	20.22					

When the pre-test and the final test scores were examined in reference to the analysis of the problem cases in the preschool stories by the STEM activities, it was found out that there was a meaningful increase in the scores of the children ($t=-4,787$, $p<0.01$). The average pre-test scores of the children before the STEM activities was $\bar{x}$ = 13.11, whereas the average final test scores after the performance of the STEM activities rose up to $\bar{x}$ = 20.22. This finding indicates that the analysis of the problem cases in the preschool stories by the STEM activities affects the increase of the problem-solving skill of children.

Table 5. Material Evaluation Form

Criteria	Good (3)	Average (2)	Bad (1)
Target Suitability	4	26	2
Accuracy of Information	5	7	20
Drawing Attention	15	7	10
Robustness/Endurance	3	15	14
Level of Comprehension	6	19	7
Technical quality	6	6	20
Degree of efficiency	2	24	6
Ease of use/applicability	2	18	12
Total	43	122	91

According to the material evaluation form, the obtained results were 43 times good, 122 times average, and 91 times bad, depending on the conclusion of the evaluation of the total score of the criteria, i.e., target suitability accuracy of the information, drawing attention, robustness/endurance, level of comprehension, technical quality, degree of efficiency, ease of use/applicability. Considering the evaluation of the materials produced, it is seen that the criteria of compliance with target suitability, drawing attention, robustness/endurance, level of comprehension, degree of efficiency, ease of use/applicability are relatively better than the accuracy of the information and technical quality criteria.

Table 6. Teacher Evaluation Form

Criteria	Good (3)	Average (2)	Bad (1)
Asking questions about the subject and resolution of curiosity	30	2	-
Development of hypotheses for finding answers to problems	32	-	-
Seeking extensive acknowledgment by contribution to present information	20	12	-
Revision of problems	2	25	2
Sharing and discussing thoughts, listening to thoughts of other points of views, and inquiry of new information	20	12	-
Total	104	51	2

According to the teacher evaluation form, the obtained results were 104 times good, 51 times average, and 2 times bad, depending on the conclusion of the evaluation of the total score of the criteria, i.e., asking questions about the subject and resolution of curiosity, development of hypotheses for finding answers to problems, seeking extensive acknowledgment by contribution to present information, revision of problems, sharing and discussing thoughts, listening to thoughts of other point of views and inquiry of new information. When considering the teacher evaluation form, it is seen that asking questions about the subject and resolution of curiosity, development of hypotheses for finding answers to problems are relatively better than seeking extensive acknowledgment by contribution to present information, revision of problems, and sharing and discussing thoughts, listening to thoughts of other points of views and inquiry of new information criteria.

4 | Discussion & Conclusion

Having a deep curiosity, a desire for investigation, and exploration in preschool education, children could be helped as well in developing their problem-solving skills, by combining those interests with the activities of science and nature (Akaya, 2006). In the study, in which the nursery school infants of 6 years of age were examined based on the problem-solving skills, it was specified that all the students were eager to solve problems (Tavlı, 2007). The explanation of the problem-solving skills by way of living in the first years of education, i.e., the preschool period, will help children pave the way for long-lasting learning with other skills, for what they have learned through experience by associating and making connections (Aydoğan, 2004). Situated in STEM education, the information – based on science, mathematics, and engineering – should be presented by integrating it with education psychology; otherwise, we cannot imagine children becoming scientists right away without developing thinking processes. For this reason, the content, the cognitive and sensual results of STEM education should be examined by integrating them into the education curriculum (Lamb et al., 2015). Chesloff (2013) states that the frequently used high-level thinking skills in STEM education are required to be present in the educational system, beginning from the preschool period – the first stage of education –. It was concluded that meaningful differences were obtained between the pre-test and the final test scores of the children in the solutions of the STEM activities of the problem cases in storybooks ($p<.001$). In the study, in which the effect of structured and unstructured education programs was examined in the course of helping children gain problem-solving skills, it was seen that both structured and unstructured education programs had a dramatic effect on the problem-solving skills of children (Aydoğan, 2004). Since STEM education is involved in the advanced level of thinking skills, it enables students to have advanced levels of learning opportunities (Lubinski, 2010). In preschool education, problem-solving skills may be promoted with various activities in the program. Activities such as mathematics, music, games, and science support the problem-solving skills of children in the preschool period. Mathematics education is very important in preschool education. Problem-solving is the key to comprehending all the fields of mathematics. Children learn how to solve problems by using a good number of different ways. Through mathematics education, their problem-solving abilities develop (Akman, 2002). According to the results of the study, in which the opinions of the preschool teachers about the STEM education performances have been taken into account, it has been specified that they want to receive a STEM-themed training and perform it with lessons (Uğraş, 2017).

In Özdil's research (2008), he examined the effect of the interpersonal problem-solving education program on the children continuing the preschool institutions. In conclusion, it came into view that there was a meaningful difference in the interpersonal problem-solving skills of the children attending the interpersonal problem-solving education, compared to those not attending the education. When the early period of the preschool education program in Turkey was examined according to STEM education, it was revealed that it involved most of the qualities of STEM education including the basic concepts and the notions relating to it (Aka Aktürk et al., 2017). Similar studies are specifying the requirement of the performance of the STEM education beginning from the preschool period – the first stage of education – for it is one of the educational reforms used in the development of problem-solving skills, i.e., a thinking skill (Katz, 2010; Soylu, 2016). In the solutions of the problem cases in the preschool storybooks, it is suggested that people get support from the teachers of different departments to meet the probable needs for help and answer questions during the group studies of the STEM activities. As Baran et al., (2015) states that it was concluded that the students who received a similar suggestion, benefited from the official instructors' and advisers' help in the project, in the development processes of the STEM spot.

When children are included in the solutions of the problems they encounter in the preschool classes of teachers, they are required to encourage children to attend the solution process and to produce different solutions. For that, the STEM performances could be given a place in the present science activities in preschool education. In that respect, teachers could be helped in benefiting from the necessary in-service training on STEM education.

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STATEMENTS OF PUBLICATION ETHICS

Science and publication ethics were taken into consideration in the research. Written consent was obtained from the families who were planned to be included in the study. Research and publication ethics were followed in the research. There are no unethical problems.

RESEARCHERS' CONTRIBUTION RATE

The first author contributed to finding the problem statement and data collection. The third author contributed to data analysis and interpretation of the results, reporting, All authors checking the final form of the manuscript. All the authors contributed to the literature review.

CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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