Universal Journal of Educational Research 6(10): 2160-2168, 2018 http://www.hrpub.org
DOI: 10.13189/ujer.2018.061014

Impact of Visuals on Primary School 4th Graders' Problem-solving Success

Neslihan Usta[1], Muamber Yılmaz[2,*], Seçil Kartopu[3], Ömer Faruk Kadan[4]

[1]Department of Mathematics and Science Education, Faculty of Education, Bartın University, Bartın, Turkey
[2]Department of Basic Education, Faculty of Education, Bartın University, Bartın, Turkey
[3]Department of Fine Arts Education, Faculty of Education, Bartın University, Bartın, Turkey
[4]Department of International Relations Office, Mustafa Kemal University, Turkey

Abstract Aim of the research was to investigate possible impact of visuals on primary school 4th graders' problem-solving success.108 fourth graders studying at four primary schools in Bartın city center were assigned as participants of the study. The research was carried out in 2016-2017 academic year. The model of the study was post-test control group experimental design, among true experimental models. Four math problems were created as data collection tool. Four visually-aided problems were asked in the experimental group while the same problems without visuals were asked in the control group. Problem-solving successes of the students in both groups were scored according to Progressive Scoring Scale. Mann Whitney U test was employed for data analysis. As a result of the study, statistically significant difference was revealed between problem-solving success post-test scores of the students in the experimental and control groups. This difference was in favor of the students in the experimental group. Furthermore, when the experimental and control group students' success in understanding problem, planning solution, checking out the plan, checking trueness of the result was compared, significant difference was determined in favor of the experimental group. It was concluded that visuals were effective on problem-solving success of primary school 4th graders.

Keywords Problem-Solving, Visuals, Mathematics Course, Student of Primary School

1. Introduction

In today's world, bringing up individuals whose problem-solving skills are developed, who can comprehend and comment facts and events in every field, who can offer solutions and whose high level skills are developed is regarded as key of the progress. Several developed countries realized this fact years ago, and they have admitted that bringing up individuals having these qualifications is possible through good mathematics education. Various approaches in curriculums have been offered in Turkey in recent years, and improvements have been tried to be implemented from time to time. In this context (Ministry of National Education [MoNE], [16]), communication, reasoning, overarching, being able to use information and communication technologies and problem-solving are among skills required to gain. As it is aimed to improve problem-solving skills in all levels of education, it is also the same for primary education [3].

Understanding mathematical information and making contact among this information come in existence in problem-solving process (Swings & Peterson, 1988, as cited by Karataş, Güven, [11]). That is why problem-solving is located in the core of mathematics (Sweller, Clark, & Kirschner, 2010). On the other hand, learning mathematics is an interpretation process according to Freudenthal. Learning at school cannot be separated from life. Hence, mathematical learning should start with real life problems, and students should be asked to reach formal information through these problems. Freduenthal claimed that students need to enter exploration process by associating mathematics with real life (as cited by Altun, 2014). Knowing the processes of problem-solving has great importance as well as problems' being suitable for mathematics.

According to Polya [22], problem-solving is to know what to do when you do not know what to do. However, problem-solving should not be regarded as finding a correct result since problem-solving is a complex process which includes an extensive mental process and skills. When a problem is encountered, understanding it is the first step for solution, and it is crucial. An individual cannot decide on a way or strategy, and cannot propose a solution unless he/she does not understand the problem. Therefore, not only understanding the problem, but also knowing problem-solving process should be known well [1]. Problem-solving process includes some cognitive process skills which are understanding the problem, developing structure related to the problem, doing representation, choosing suitable strategy towards problem-solving, solving the problem, evaluating the problem, checking solution and adapting the problem to similar situations (OECD, 2003, as cited by Scherer & Beckmann, [24]).

Polya [22], a polish mathematician, proposed four-step problem-solving strategy. These steps are as follows:

- Understanding the problem: understanding what the problem is about and what is asked
- Devising a plan: choosing appropriate strategies for solving the problem
- Carrying out the plan: applying chosen strategies, methods and techniques
- Looking back: checking solution, working out if the result is reasonable and if it is correct solution of the problem.

These steps also show the skills necessary for the students to solve problems successfully [3]. Using these steps in problem-solving process will help students gain problem-solving skills and will increase their academic success [25]. In the step of understanding the problem, students are expected to write the given and asked things in their own words, to express them verbally, to show critical behaviors such as drawing a figure or diagram related to the problem. It is quite important for the students to comprehend their readings in this step.

The next steps in problem-solving process are devising a plan and carrying out it. The final step is looking back which contains checking if the solution of the problem is correct and reasonable. Questioning if there are different ways of solution to the problem, and writing a new problem by changing conditions of the problem are implemented during this step, too. Teachers' asking students to write a similar problem by changing conditions of the problem given after solving it is critical in terms of finishing the process [2].

During problem writing process, the topics to be included in the problem should be accessible by the students and should be created in a way of improving their problem-solving skills. The students should be given an opportunity to write new problems from given situations and to produce new problems by changing conditions of a problem [18]. Problem-writing activity helps students think about solution as well as increasing their mathematical problem-solving skills [28].

As primary school students are not in the formal operational stage, it is obligatory to make teaching concrete. Graphics, diagrams, caricatures and pictures which are used for making abstract concepts understood are some of visual instruments [9]. The most applied tool in making teaching concrete among these is picture. Pictures help complex terms and concepts be understood by making reading attractive [15]. Visualization which is caused by intuition that comes into existence through pictures shaped in mind (Zimmermann & Cunnigham, [29]) is claimed to be effective in learning mathematical concepts (Dreyfus, 1991 as cited by Lavy [13]). According to Van den Heuvel-Panhuizen, Van den Boogaard and Doig [27], using picture books supporting learning in mathematics lessons helps 5-6-year-old children develop mathematical concepts by providing pre-thoughts about those concepts. According to these authors, pictures and stories are inseparable, and they are accordant with principles of realistic mathematics education theory came to existence in the Netherlands. Picture books and stories do not only provide concretization of mathematical concepts but also they contribute children's mathematical attitudes. Furthermore, they reveal their mathematical thinking styles creatively (van den Heuvel-Panhuizen & van den Boogaard, [26] as cited by [7]; [6]).

In constructivist approach, picture books present a setting where children can construct mathematical knowledge in an active way (van den Heuvel-Panhuizen & van den Boogaard, 2008 as cited by Phillips, [20]). Children can solve cognitive conflicts appearing in their minds by making connection between plot of the story and pictures, by creating new ideas, structures and schemes through using their prior knowledge (McLaughlin et al., 2005 as cited by van den Heuvel-Panhuizen, & van den Boogaard [26]).

Pictures are stimulant for children in creating and revealing mathematical thought [14]. These stimulants provide a basis in learning of mathematical concepts. Thus, children encounter new images which help them create new thoughts and understandings about their previous experiences. van den Heuvel-Panhuizen and van den Boogaard [26] concluded in their study that picture books have an inevitable effect on stimulating mathematical thought of little children in mathematical environments.

Additionally, pictures and picture books have strong effect on attracting and concentrating children. Reading and discussing the picture in a setting where there is an intensive group interaction plays an important role in enhancing conceptual and linguistic development in children (van den Heuvel-Panhuizen, van den Boogaard, & Doig, [27]).

Picture books can form a basis for creating mathematical thoughts and understanding mathematics. With the help of this can students show great development in transition from informal to formal knowledge. Piaget [21] claimed that conceptual knowledge in children can be developed through various actions including cognitive objects. This claim was also supported by van den Heuvel-Panhuizen, van den Boogaard and Doig's [27] study in which picture books were used. The experience of learning with visuals in the first step of mathematics may contribute creative and communicative skills of children [12]. Children can make deeper mathematical inferences by making use of each other's thoughts to improve their own thoughts via pictures prepared attractively for them. Primary school students are needed to be given opportunity of learning mathematics with picture books as well as nursery school students. Thus, students can make connection between school and real-life mathematics, and these experiences can provide convenience in their future learning [8].

Impact of visuals on primary school 4th graders' problem-solving skills was investigated in this study.

1.1. Aim of the Research

Aim of this research was to investigate impact of visuals on primary school 4th graders' problem-solving skills. With this aim the following sub-problems were created and answers were sought.

1. Are there any statistically significant differences between post-test scores of the experimental group on whom visually-aided problems were implemented and the control group on whom traditional problems were applied in "understanding the problem" step in primary school 4th grade mathematics lesson?
2. Are there any statistically significant differences between post-test scores of the experimental group on whom visually-aided problems were implemented and the control group on whom traditional problems were applied in "planning solution" step in primary school 4th grade mathematics lesson?
3. Are there any statistically significant differences between post-test scores of the experimental group on whom visually-aided problems were implemented and the control group on whom traditional problems were applied in "carrying out the plan" step in primary school 4th grade mathematics lesson?
4. Are there any statistically significant differences between post-test scores of the experimental group on whom visually-aided problems were implemented and the control group on whom traditional problems were applied in "checking accuracy of the result" step in primary school 4th grade mathematics lesson?
5. Are there any statistically significant differences between post-test scores of the experimental group on whom visually-aided problems were implemented and the control group on whom traditional problems were applied in "writing a similar problem" step in primary school 4th grade mathematics lesson?
6. Are there any statistically significant differences between post-test scores of the experimental group on whom visually-aided problems were implemented and the control group on whom traditional problems were applied in problem-solving success in primary school 4th grade mathematics lesson?

2. Materials and Methods

The model of the study was post-test control group experimental design, among true experimental models. In this model, there are two groups which are randomly constituted experimental and control groups. Only post-test is applied in both groups at the end of intervention. Constituting groups randomly is sufficient for providing similarity of the pre-intervention groups. In this way, negative effects of pre-intervention measurement on internal and external validity can be avoided [10].

2.1. Participants

An equivalence (in order to show equation between groups) achievement test containing 15 questions related to learning outcomes in primary school third grade curriculum was prepared by getting experts' opinions in order to determine equivalence of research groups. The equivalence achievement test was applied in the experimental and control groups before intervention. As the distribution was normal, it was concluded that there were not any statistically significant differences between groups as a result of independent samples t-test. This fact proved that both groups were equivalent.

108 fourth graders (56 girls, 52 boys) studying at four primary schools in Bartın city center were assigned as participants of the study. Two primary schools were selected as the experimental and other two were selected as the control group among four primary schools randomly. While there were 52 students – 25 girls and 27 boys – in the experimental group, there were 56 students – 31 girls and 25 boys – in the control group.

2.2. Data Collection Instruments

The steps of understanding the problem, devising a plan, carrying out the plan, looking back in students' problem-solving process, and their writing a similar problem were discussed as separate sub-problems.

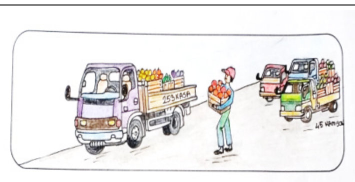
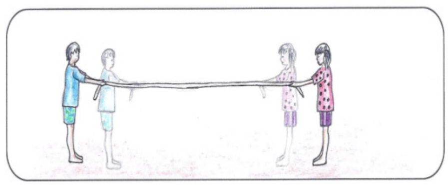
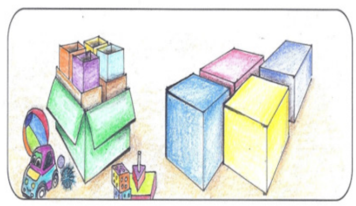
16 mathematics problems appropriate for the students' levels were prepared to be used as data collection tool in the study. Various mathematics books (Posamentier & Krulik, [23]) and Mathematics Curriculum [16] were benefited. The problems were created taking content validity into consideration. Two academic staff was asked to express their opinions about suitability of problems to the students' levels. Then, some of the problems looking alike were removed after assessment of three researchers from the departments of mathematics education, class

teacher education and art education, and existing number of problems became eight. Two academic staff and one class teacher were consulted for suitability of the rest problems in terms of content, level and expression. Pictures illustrating 8 problems were drawn by a researcher from the department of art education. 4 problems which were not appropriate for the level of the students were removed from the content of the study as a result of the pilot study carried out with 12 students in order to determine reliability of the study and usefulness of the data collection tool.

Thereby, four mathematics problems were created as data collection tool. It was considered that one course hour was enough for answering the questions. In the experimental group four visually-aided problems were asked while the same questions without visuals were asked in the control group. Visuals of the problems are shown in Table 1:

Four problems were asked to the 4th graders during one class hour by the researcher. During implementation, the students were informed in detail, and they were asked to solve the problems by taking each step into consideration. Furthermore, the students were asked to write a similar problem regarding subject of the problem in the step of devising a plan. The students' answers were evaluated according to the Progressive Scoring Scale.

Table 1. Problems and Visuals of the Problems

Problem	Visuals of the Problems
There are 253 boxes of fruits in a lorry of a transportation company. The transportation company has 45 lorries. How many boxes of fruits are carried if all lorries transport twice?	
How many millimeters is an elastic band that is 200 cm length if it is pulled for eight millimeters each from two ends?	
Gonca wants to bur a few boxes to keep her toys. She buys five big boxes. There are two medium-sized boxes in each big box. There are also two small-sized boxes in each medium-sized box. How many boxes did Gonca buy in total?	
A shop distributed 40 coupons for giving t-shirts for free. At the end of the day, shop owners gave 2 t-shirts for free in return for 5 coupons. How many t-shirts did they give as a gift in total?	

2.3. Progressive Scoring Scale

Each step is scored in problem-solving process (as cited by Özmen-Hızarcıoğlu, [19]). In this study, the students' answers were evaluated with progressive scoring scale (Annex-1) taken from Baki [2]. This scale was preferred since the students' behaviors related to the process of problem-solving and writing a similar problem were analyzed separately. Progressive scoring scale employed in the research consists of five categories. There are four criteria (3, 2, 1 and 0 points) showing minimum and maximum performances of each criterion under these five categories. In accordance with this criterion, to help scoring understood better maximum and minimum scores that a student can receive from a problem are shown in Table 2.

Table 2. Categories Related to Progressive Scoring Scale about A Problem of A Student and Maximum and Minimum Scores Corresponding to These Categories

Categories	Max.	Min.
Understanding the Problem	3	0
Devising a Plan	3	0
Carrying Out the Plan	3	0
Looking Back	3	0
Suggesting a Problem	3	0

As understood from Table 2 a student can receive 3 points at maximum and 0 point at minimum from a problem. Responses given by the students to four verbal problems were scored according to progressive scoring scale, and scoring as 3-2-1-0 for each category given in this rubric was carried out by the researchers. Scores received by the students from each step were evaluated separately for this scoring.

2.4. Data Analysis

The students' problem-solving skills were tested with Mann Whitney U-test to reveal whether they differed in terms of an approach in which visually-aided problems were asked. Problem-solving skills of the students in the experimental and control groups were evaluated separately in each step according to Progressive Scoring Scale. To understand if there were any statistically significant differences between the experimental and control groups regarding intervention, Mann Whitney U-test was employed. This test is used instead of t-test in cases where normality assumption of scores is not met in empirical studies with few subjects in which there are independent measurements [4]. As parametric statistics make normal distribution essential, if the researcher does not have enough evidence about normality of distribution, in other words if the distribution is skew, nonparametric statistics should be used [5]. Morgan ET. Al [17] stated that criterion of normal distribution is coefficient of skewness and kurtosis should be between -1 and +1. In this study, when normal distribution curves, skewness and kurtosis were studied, it was concluded that distribution was skew. That is why Mann Whitney U-test was preferred since there was not normal distribution. The data were analyzed using SPSS 20.0 statistics program. The sixth sub-problem of the research was "are there any statistically significant differences between post-test scores of the experimental group on whom visually-aided problems were implemented and the control group on whom traditional problems were applied in problem-solving success in primary school 4th grade mathematics lesson?" This problem was analyzed with independent samples t-test because of normal distribution.

3. Results

The results obtained from the research were examined as sub-problems of each step defined in Progressive Scoring Scale, and were interpreted in tables.

3.1. Comparison of the Experimental and Control Groups Based on the Step of Understanding the Problem

"Are there any statistically significant differences between post-test scores of the experimental group on whom visually-aided problems were implemented and the control group on whom traditional problems were applied in "understanding the problem" step in primary school 4th grade mathematics lesson?" was regarded as the first sub-problem. Accordingly, the experimental and control groups' Mann Whitney U-test results by groups based on scores received in understanding the problem step are shown in Table 3.

Table 3. U-Test Result of Scores Received from Understanding the Problem Step by Groups

Groups	N	Mean Rank	Rank Sum	U	p
Experimental Group	52	72.94	3793.00	497.00	.000
Control Group	56	37.38	2093.00		

When Table 3 was studied, it was understood that there was significant difference between scores of the experimental group to whom visually-aided problems were asked and of the control group to whom problems without visuals were asked in the step of understanding the problem ($U = 497.00$, $p < .05$). When mean rank was considered, it was found out that the experimental group students' achievement of understanding the problem was higher than the control group students'. This finding revealed that visuals were effective on understanding the problem.

3.2. Comparison of the Experimental and Control Groups Based on the Step of Devising a Plan

"Are there any statistically significant differences between post-test scores of the experimental group on whom visually-aided problems were implemented and the control group on whom traditional problems were applied in "devising a plan" step in primary school 4th grade mathematics lesson?" was defined as the second sub-problem. Accordingly, the experimental and control groups' Mann Whitney U-test results by groups based on scores received in devising a plan step are shown in Table 4.

Table 4. U-Test Result of Scores Received from Devising a Plan Step by Groups

Groups	N	Mean Rank	Rank Sum	U	p
Experimental Group	52	71.73	3730.00	560.00	.000
Control Group	56	38.50	2156.00		

When Table 4 was analyzed, it was understood that there was significant difference between scores of the experimental group to whom visually-aided problems were asked and of the control group to whom problems without visuals were asked in the step of devising a plan ($U = 560.00$, $p < .05$). When mean ranks were taken into consideration, it was found out that the experimental group students' achievement of devising a plan was higher than the control group students'. This finding also showed that visually-aided mathematics problems were effective on their solutions in devising a plan.

3.3. Comparison of the Experimental and Control Groups Based on the Step of Carrying Out the Plan

"Are there any statistically significant differences between post-test scores of the experimental group on whom visually-aided problems were implemented and the control group on whom traditional problems were applied in "carrying out the plan" step in primary school 4th grade mathematics lesson?" was defined as the third sub-problem. Accordingly, the experimental and control groups' Mann Whitney U-test results by groups based on scores received in carrying out the plan step are shown in Table 5.

Table 5. U-Test Result of Scores Received from Carrying out Plan Step by Groups

Groups	N	Mean Rank	Rank Sum	U	p
Experimental Group	52	71.80	3733.50	556.50	.000
Control Group	56	38.44	2152.50		

It was understood from Table 5 that there was significant difference between scores of the experimental group to whom visually-aided problems were asked and of the control group to whom problems without visuals were asked in the step of carrying out the plan ($U = 556.50$, $p< .05$). Achievement of the experimental group students in this step was higher than of the control group. This finding revealed that visually-aided mathematics problems were effective on their solutions in carrying out the plan.

3.4. Comparison of the Experimental and Control Groups Based on the Step of Looking Back

"Are there any statistically significant differences between post-test scores of the experimental group on whom visually-aided problems were implemented and the control group on whom traditional problems were applied in "carrying out the plan" step in primary school 4th grade mathematics lesson?" was defined as the fourth sub-problem. Accordingly, the experimental and control groups' Mann Whitney U-test results by groups based on scores received in looking back step are shown in Table 6.

Table 6. U-Test Result of Scores Received from Looking Back Step by Groups

Groups	N	Mean Rank	Rank Sum	U	p
Experimental Group	52	71.36	3710.50	579.50	.000
Control Group	56	38.85	2175.50		

When Table 6 was studied, there was significant difference between scores of the experimental group to whom visually-aided problems were asked and of the control group to whom problems without visuals were asked in the step of looking back ($U = 579.50$, $p < .05$). Achievement of the experimental group students in this step was higher than of the control group. This finding revealed that visually-aided mathematics problems were effective on the step of looking back.

3.5. Comparison of the Experimental and Control Groups Based on the Step of Suggesting a Problem

"Are there any statistically significant differences between post-test scores of the experimental group on whom visually-aided problems were implemented and the control group on whom traditional problems were applied in "suggesting a problem" step in primary school 4th grade mathematics lesson?" was defined as the fifth sub-problem. Accordingly, the experimental and control groups' Mann Whitney U-test results by groups based on scores received in suggesting a problem step are shown in Table 7.

Table 7. U-Test Result of Scores Received from Suggesting A Problem Step by Groups

Groups	N	Mean Rank	Rank Sum	U	p
Experimental Group	52	62.32	3240.50	1049.50	.011
Control Group	56	47.24	2645.50		

With reference to Table 7, there was significant difference between scores of the experimental group to whom visually-aided problems were asked and of the control group to whom problems without visuals were asked in the step of suggesting a problem ($U = 1049.50$, $p < .05$). When mean ranks were considered, it was found that the experimental group students' achievement of writing a similar problem was higher than the control group students'. Correspondingly, it can be inferred from this finding that visually-aided mathematics problems were effective on their solutions in suggesting a similar problem.

3.6. Comparison of the Experimental and Control Groups Based on the Scores Received from Progressive Scoring Scale (Comparison of the Groups by Their Problem-Solving Skills)

"Are there any statistically significant differences between post-test scores of the experimental group on whom visually-aided problems were implemented and the control group on whom traditional problems were applied in problem-solving success in primary school 4th grade mathematics lesson?" was identified as the sixth sub-problem. Accordingly, the experimental and control groups' independent samples t-test results by groups based on scores received based on their problem-solving success are shown in Table 8.

Table 8. Problem-Solving Success T-Test Result of the Experimental and Control Group Students' Scores Received from Progressive Scoring Scale

Groups	N	$\bar{X}$	S	sd	t	p
Experimental Group	52	2.18	.334	106	8.456	.000
Control Group	56	1.50	.475			

According to Table 8, there was statistically significant difference between problem-solving success of the experimental group to whom visually-aided problems were asked and of the control group to whom problems without any visuals were asked, and this difference was in favor of the experimental group[$t_{106} = 8.456,\ p < .05$]. With reference to this finding, it is possible to suggest that problem-solving success of the experimental group students was promoted by visually-aided problems.

4. Discussion and Conclusion

As a result of the study, it was revealed that there was statistically significant difference between problem-solving success post-test scores of the experimental group to whom visually-aided problems were asked and of the control group to whom problems without any visuals were asked. Furthermore, this difference was in favor of the former one. Therefore, it was concluded that visuals promoted primary school 4^{th} graders' problem-solving success. On the other hand, when the experimental and control groups were compared based on the steps of "understanding the problem", "devising a plan", "carrying out the plan", "looking back" and "suggesting a similar problem", significant difference was observed in favor of the experimental group students.

When the obtained findings were compared with the previous researches, the results were similar. Visuals were found to improve problem-solving success of the students in this study. Van den Heuvel-Panhuizen and van den Boogaard [26] as cited by Griffiths and Clyne, [7]) suggested that using visuals in mathematics lessons can attract students' attention, and can help them acquire positive attitude towards learning. Additionally, Lovitt and Clarke [14] claimed in their research that visuals concretize teaching, help concepts be understood and function as a stimulator in revealing mathematical thought.

Developing mathematical thought is dependent on developing mathematical skills. O the other hand, problem-solving skill is a crucial mathematical skill. In obtaining or enhancing this skill, problem-solving process should primarily be known very well. Understanding the problem, devising a strategy for solution, carrying out the strategy, looking back and suggesting a similar problem are the steps included within this process. The most important step of this process is understanding the problem. That is because of the fact that if the problem cannot be understood, it is not possible to suggest a solution, and the problem cannot be solved. Herein, visuals contribute to understanding the problem. Işık and Konyalıoğlu [9], Meydan and Akdağ [15], Zimmermann and Cunningham [29] stated that expressing problems with visuals concretize teaching. Besides, according to them illustrating problems attract students' attention and affect their problem-solving success in a positive way.

A research in which picture books were used and which was carried out by van den Heuvel-Panhuizen, van den Boogaard and Doig [27] supported the idea that visuals form a basis for little children in emerging and understanding mathematical ideas, and they provide convenience for transition from informal to formal knowledge. The idea that Lovitt and Clarke [14] suggested as a result of their study was that visuals have a stimulant role in revealing mathematical thought, and this finding is similar with ours. Ginsberg [8] found out in his study that teaching mathematics with visuals help students connect with real-life mathematics and school mathematics. This experience gained in learning mathematics with visuals provides convenience for students in their higher level learning. Using picture books or visuals is also suitable for the principals of realistic mathematics education theory, and it supports a suitable environment for students to construct their knowledge (van den Heuvel-Panhuizen & van den Boogaard, [26] as cited by Phillips, [20]). Van den Heuvel-Panhuizen, van den Boogaard, and Doig [27] and van den Heuvel-Panhuizen and van den Boogaard [26] stated in their studies that illustrating problems enhanced concentration needed for problem-solving.

Van den Heuvel-Panhuizen and van den Boogaard [26] claimed that picture books are effective on stimulating mathematical thoughts of little children. The study carried out by us also revealed that illustrating problems affected the students' problem-solving success in a positive way. On that sense, findings of both studies are similar.

Briefly, it has been confirmed by several domestic and overseas studies that students in every phase of education – from elementary school to university – have difficulty in mathematics classes. This makes new approaches to be adapted necessary. Teaching abstract concepts of mathematics by concretizing and visualizing them particularly in early years of childhood is quite important. Thus, concepts and structures of mathematics can become more comprehensible, and mathematical thought can improve. One way for enabling this is illustrating the problems given. Visuals create new images in a child's mind, and work as stimuli. As presented in the literature, group works made for understanding what visuals tell improve not only children's social and linguistic intelligence, but also their mathematical process skills. The most prominent of these skills is problem-solving skill. As revealed in this study, visualization of the problems raised mathematical success of the children especially in the steps of understanding the problem and of choosing, carrying out, analyzing and evaluating the strategy required for the solution. Therefore, using more visuals about the problems related to the subjects in course books and other materials prepared for primary school children can be useful. On the other hand, it can be suggested for the researchers willing to study on this subject that the results of this study can be supported with a qualitative study. Additionally, the topic "problems" was studied in this research, and the researchers can carry out quantitative or qualitative studies on different topics and with students from different class levels.

Annex 1

Progressive Scoring Scale

Problem		
A		*Understanding the Problem*
	3	Understanding the problem entirely
	2	Understanding some points of the problem
	1	Being not able to understand the problem
	0	Not showing any efforts to understand the problem
B		*Devising a Plan (Choosing a Strategy)*
	3	Choosing a strategy that can lead to an appropriate solution
	2	Choosing only one part of strategy that can help solution
	1	Choosing an inappropriate strategy
	0	Not choosing any strategies
C		*Carrying Out the Plan*
	3	Finding suitable and correct solution
	2	Finding a solution which is partly correct
	1	Finding a solution which is inappropriate and incorrect
	0	Not being able to find any solutions
D		*Looking Back*
	3	Solving the problem and newly created problem based on it
	2	Verifying the results reasonably
	1	Verifying the results partially
	0	Not knowing how to verify the results
E		*Suggesting a Problem*
	3	The problem created is reasonable and solvable
	2	A new problem has been created by changing values of the problem
	1	The problem created is unreasonable and unsolvable
	0	The same or new problem has not been suggested

REFERENCES

[1] Altun, M. (2014*). Ortaokullarda (5, 6, 7 ve 8. sınıflarda) matematik öğretimi*. Bursa: Aktüel Yayıncılık.

[2] Baki, A. (2014). *Kuramdan uygulamaya matematik eğitimi.* Ankara: Harf Yayınları.

[3] Baykul, Y. (2014). *Ortaokulda matematik öğretimi (5-8. Sınıflar)*. Ankara: Pegem A Yayıncılık.

[4] Büyüköztürk, Ş. (2006). *Sosyal bilimler için veri analizi el kitabı*. Ankara: Pegem A Yayıncılık.

[5] Büyüköztürk, Ş. (2007). *Deneysel desenler öntest-sontest kontrol grubu desen ve veri analizi*. Ankara: Pegem A Yayıncılık.

[6] Elia, I., van den Heuvel-Panhuizen, M. & Georgiou, A. (2010). The role of pictures in picture books on children's cognitive engagement with mathematics. *European Early Childhood Education Research Journal*, *18*(3), 125-147.

[7] Griffiths, R., & Clyne, M. (1991). The power of story: Its role in learning mathematics. *Mathematics Teaching, 135*, 42–45.

[8] Ginsberg, H. P. (1996). Toby's math. In R. J. Sternberg & T. Ben-Zeev (Eds.), *The studies in mathematical thinking and learning series. The nature of mathematical thinking* (pp. 175-202). Hillsdale, NJ: Lawrence Erlbaum Associates.

[9] Işık, A., & Konyalıoğlu, A. C. (2005). Matematik eğitiminde görselleştirme yaklaşımı. *Kazım Karabekir Eğitim Fakültesi Dergisi.* 11, 462-471.

[10] Karasar, N. (2005). *Bilimsel Araştırma Yöntemi*. Ankara: Nobel Yayıncılık.

[11] Karataş, İ. & Güven, B. (2003). Problem çözme davranışlarının değerlendirilmesinde kullanılan yöntemler: klinik mülakatın potansiyeli. *İlköğretim-online e-dergi, 2*(2), 2-9.

[12] Lambert, E., & Clyde, M. (2000). *Re-thinking early childhood theory and practice.* Katoomba, Australia: Social Science Press.

[13] Lavy, I. (2006). Dynamic visualization and the case of 'stars in cages'. In Jarmila, N; Hana, M; Magdalena, K and Nad_a, S. (Eds.), Proceedings of the 30th International Conference on the Psychology of Mathematics Education (PME), IV (25-32). Prague, Czech Republic.

[14] Lovitt, C., & Clarke, D. (1992). *The mathematics curriculum and teaching program (MCTP): Professional development package activity bank (Vol.2)*. Carlton, Victoria, Australia: Curriculum Cooperation.

[15] Meydan, A. and Akdağ, H. (2008). Sosyal bilgiler dersinde öğretim teknolojileri ve materyal tasarımı. B. Tay ve A. Öcal (Ed.). *Özel öğretim yöntemleriyle sosyal bilgiler öğretimi.* Ankara: Pegem A Yayıncılık.

[16] MoNE. (2017). *Matematik dersi öğretim programı (1,2,3,4,5,6,7 ve 8. sınıflar)*. Ankara: Talim Terbiye kurulu Başkanlığı.

[17] Morgan, G. A., Leech, N. L., Gloeckner, G., W., & Barret, K. C., (2004). *Spss for Introductory Statistics: Use and*

Interpretation. Second Edition. London, Lawrance Erlbaum Associates.

[18] National Council of Teachers of Mathematics [NCTM]. (2000). *Principles and standards for school mathematics.* Reston.

[19] Özmen-Hızarcıoğlu, B. (2013). *Problem çözme sürecinde dereceli puanlama anahtarı (rubrik) kullanımında puanlayıcı uyumunun incelenmesi.* Yayımlanmamış yüksek lisans tezi, Abant İzzet Baysal Üniversitesi, Eğitim Bilimleri Enstitüsü, Bolu.

[20] Phillips, D. C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher, 24*(7), 5–12.

[21] Piaget, J. (1974). T*o understand is to invent.* New York: Viking Press.

[22] Polya, G. (1957). *How to Solve It*: A New Aspect of Mathematical Method. New Jersey: Princeton University Press.

[23] Posamentier, A. S., Krulik, S. (2016). *Matematikte problem çözme (3 - 6. sınıflar için).* (Çev. L. Akgün, T. Kar, & M. F. Öçal). Ankara: Pegem A Yayıncılık.

[24] Scherer, R. & Beckmann, J. F. (2014). The Acquisition of Problem Solving Competence: Evidence from 41 Countries That Math And Science Education Matters. *Large-Scale Assessments in Education. 2*(10), 2-22.

[25] Van de Walle,. J.,A., Karp, K. S., Bay-Williams, J.M. (2013). *İlkokul ve ortaokul matematiği, gelişimsel yaklaşımla öğretim.* (Çev. Edt. S. Durmuş). Ankara: Nobel Yayıncılık.

[26] van den Heuvel-Panhuizen, M., & van den Boogaard, S. (2008). Picture books as an impetus for kindergartners' mathematical thinking. *Mathematical Thinking and Learning, 10*(4), 341-373.

[27] van den Heuvel-Panhuizen, M., van den Boogaard, S., & Doig, B. (2009). Picture books stimulate the learning of mathematics. *Australian Journal of Early Childhood, 34*(3), 30-39.

[28] Xia, X., Lü, C., & Wang, B. (2008). Research on mathematics instruction experiment based problem posing. *Journal of Mathematics Education. 1*(1), 153-163.

[29] Zimmermann, W. and Cunningham, S. (1991). Editor's introduction: What is mathematical visualization? In W. Zimmermann and S. Cunningham (Eds.). *Visualization in teaching and learning mathematics*, (pp. 1-8). Mathematical Association of America, Washington, DC.