



Effects of story writing training on development of mathematical problem posing skills

Efectos del entrenamiento de escritura de historias en el desarrollo de habilidades para plantear problemas matemáticos

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Resumen

El propósito del estudio es examinar los efectos de la escritura de historias en las habilidades de planteamiento de problemas en maestros de escuela primaria. Este estudio fue diseñado en base al diseño mixto de triangulación concurrente. En la parte cualitativa, se realizó el análisis de documentos analizando los problemas planteados por los participantes utilizando la Rúbrica de Desempeño de Planteo de Problemas. Los datos cualitativos fueron analizados por análisis de contenido para diseñar esta rúbrica. Los temas identificados por el análisis de contenido fueron la claridad, la limpidez, la unidad, el estilo de escritura de la historia, la ficción, los elementos de la historia y el arco de la historia para la educación y el problema turcos, la suficiencia de la información, la idoneidad matemática, la idoneidad pedagógica, la creatividad, la relación y el equilibrio operativo y conceptual. para problema matemático. La parte cuantitativa del estudio se realizó mediante un diseño de prueba previa y posterior de un grupo como una especie de diseño de investigación experimental débil. En esta parte, los datos cuantitativos recolectados a través de la rúbrica fueron analizados mediante estadística descriptiva y prueba t para muestras pareadas. Se condujo a 50 participantes al instrumento de presentación de problemas antes y después de la capacitación de escritura de historias de cuatro semanas. Con base en los hallazgos del estudio actual, se observó que la capacitación en escritura de historias mejoró las habilidades de planteamiento de problemas de los maestros de escuela primaria en formación.

Palabras clave: Pedagogia, escritura, redaccion, matematica, educacion, Turquia.

Abstract

The purpose of the study is to examine the effects of story writing on preservice primary school teachers' problem posing skills. This study was designed based on the concurrent triangulation mixed design. In the qualitative part, document analysis was performed by analyzing the problems posed by the participants using Problem Posing Performance Rubric. The qualitative

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data were analyzed by content analysis in order to design this rubric. The themes identified by the content analysis were clarity, limpidness, unity, story writing style, fiction, elements of story and story arc for Turkish education and problem, sufficiency of information, mathematical appropriateness, pedagogical appropriateness, creativity, relatedness and operational and conceptual equilibrium for mathematical problem. The quantitative part of the study was performed by one-group pretest-posttest design as a kind of weak experimental research design. In this part, the quantitative data collected through the rubric were analyzed through descriptive statistics and paired-samples *t*-test. 50 participants were conducted to Problem Posing Instrument before and after four-week story writing training. Based on the findings of the current study, it was observed that story writing training improved the preservice primary school teachers' problem posing skills.

Keywords: Pedagogy, writing, writing, mathematics, education, Turkey.

Introduction

Steve Maraboli state “Sometimes problems do not require a solution to solve them; instead they require maturity to outgrow them.” Problem posing is a skill having critical importance in the process of scientific investigations (Einstein & Infeld, 1938), reading (Rosenshine, Meister, & Chapman, 1996), and mathematical learning (Cai et al., 2015; Silver, 1994; Singer, Ellerton & Cai, 2013). Hence, there have been research emphasizing the usage of classroom instruction and student learning of mathematics (Brown & Walter, 1983; Cai et al., 2015; Silver, 1994; Singer et al., 2013). In this respect, teachers are expected to form and pose worthwhile problems regularly enhancing students' mathematics understanding related to particular contexts stated in the curriculum (NCTM, 1991; Cai et al., 2015; Stein et al., 2000).

For the other hand, problem posing enhances student learning because problem posing activities as cognitively demanding tasks improve mathematical reasoning and increase motivation (Doyle, 1983; NCTM, 1991). Moreover, problem posing improves problem solving since it includes solving problems in addition to formulating problems (Polya, 1957). In other words, problem posing includes the activities of understanding problem contexts and solving problems by using advanced strategies. By posing a problem, it is required to examine a particular situation and solve a given situation in order to form a new problem or reformulate a given problem (Silver, 1994; Tichá & Hošpesová, 2009). Previous research have showed that the more qualified the students are in problem posing, the more successful the students are in problem solving (Ayllón, Gomez, & Ballesta-Claver, 2016; Silver & Cai, 1996; Xie & Masingila, 2017). Furthermore, problem posing can be used as a useful assessment tool because it can represent the way of students' construction of their knowledge by making connection

between daily life problems, mathematical content and problem solving strategies (Abu-Elwan, 1999).

Although the importance and effects of problem posing on student learning, problem posing can force teachers to pose problem and incorporate it into instruction (Silber & Cai, 2017). Stein, Grover and Henningsen (1996) found that teachers might reduce the value and cognitive demand of problem posing tasks. Moreover, preservice teachers initially tend to pose incorrect or simple factual problems (Austin, Carbone & Webb, 2011; Isik & Kar, 2012). Isik and Kar (2012) also discussed about the preservice teachers' difficulties about problem posing. They explained that preservice teachers experienced conceptual difficulties in which they convert mathematical operations and equations into verbal problem statements accurately, explaining unknowns by using realistic values or organizing the word problems by focusing on their conventions.

This skill needed for the students from various grade levels from kindergarten to university can be acquired with the help of the teachers who can effectively incorporate problem posing into mathematics teaching (Stoyanova, 2003). In this case, Silber and Cai (2017) emphasizes the importance and difficulty of integration of problem posing into teaching by improving problem posing skills. In this respect, problem posing skill affecting student learning can be effectively acquired with the help of teachers attained this skill in preservice years (Lowrie, 2002). On the other hand, previous research has showed that preservice teachers had difficulty in posing worthwhile and valid problems (Crespo & Sinclair, 2008; Silver & Cai, 1996; Silver et al., 1996; Vacc, 1993). It can also be claimed that when preservice teachers get problem posing skills through teacher education programs, they can improve their knowledge and skills from conceptual and pedagogical aspects (Kılıç, 2013; Tichá & Hošpesová, 2013; Toluk-Uçar, 2009).

Writing education aims to create a text in Turkish education from primary school to university years (Can & Topçuoğlu-Ünal, 2019). Because no matter what job the individual does, he has to express himself in his native language in written or oral form. For this purpose, writing skill is one of the areas that every occupational group needs. The teaching profession is one of them. Written expression of the teachers trained in the faculty of education in various branches should also be sufficient. For this purpose, the writing education studies conducted to classroom teachers were carried out over the narrative genre. In order to use this knowledge in different areas, it was aimed to develop their problem posing skills from pre-service teachers by using the concretization of the story. For this purpose, a four-week study was conducted on story-writing processes. In this respect, this study examining the effects of story writing training

can contribute to teacher preparation programs and professional development of preservice teachers by providing them training how to formulate high quality of problems. The purpose of the current study was to answer the following research questions:

1. Are there any statistically significant differences between the PPSTs' pre-test and post-test problem posing scores according to Turkish education?
2. Are there any statistically significant differences between the PPSTs' pre-test and post-test problem posing scores according to mathematics education?
3. How do the PPSTs' problem posing scores differentiate before and after taking Story Writing Training?

Method

Design

The current study is conducted based on mixed method research design. More specifically, in order to represent the effects of story writing training on preservice teachers' problem posing skill in detail and by acquiring a better understanding, the concurrent triangulation mixed design in which two-stage qualitative and quantitative methods are conducted together in the same period of time by considering both approaches in equal weight was conducted (Creswell, 2003). In this approach, while the data collected simultaneously were analysed separately based on the framework of both approaches, all of the findings were interpreted combining these approaches based on the principles of the mixed method research design.

The quantitative part was performed based on one-group pre-test/post-test design as a kind of weak experimental research design. On the other hand, document analysis was performed in the qualitative dimension. Through document analysis, it was aimed to review and evaluate documents collected in the study (Creswell, 2003). With this motivation, the effects of the story writing training that was evaluated and tested via experimental model, were encouraged and carried out with the problems posed by preservice primary school teachers.

Participants

The participants of the current study were composed of 50 senior students enrolled in primary education in a public university in northern part of Turkey. They were selected based on criterion sampling strategy as a kind of purposive sampling strategy because there was not randomness and matching in the single group pre-test/post-test design (Karasar, 2010). There were two criteria because they were selected.

Firstly, they had taken the undergraduate courses about mathematics, mathematics education and Turkish education such as “General Mathematics”, “Teaching Mathematics” and “Teaching Turkish” in addition to the courses helping preservice teachers acquire pedagogical dimension. Of these preservice primary school teachers (PPSTs) who would be the teachers from the 1st grade to 4th grade students participating in the study, 16 of them were male and 34 were female.

Instruments

Problem Posing Instrument including six open-ended questions was used in the current study. The first item was asked to pose for a given shape in the first question, the second and the third items were asked to complete given unfinished problems, the fourth and the fifth items were asked to pose parallel problems to given problems and the last item was asked to pose problems related to a specified objective in five learning areas of mathematics. Each item refers to an open-ended problem stem to be completed in order to form a problem or a problem that the participants are expected to form a similar/related mathematical problem or forming a problem for a particular objective for a particular grade level, respectively.

In other words, the instrument was designed for three sessions: (1) posing a problem based on an open-ended problem stem, (2) posing a similar/related problem, (3) posing a problem based on a selected objective. The problem-posing instrument was formed based on the primary school mathematics curricula in order to examine the preservice primary school teachers’ problem posing skills. The items in initial two sessions were translated into Turkish from the study of Stickle (2006). The items were designed related to different mathematical contents and structures. In order to provide evidence for validity and reliability of the instrument, expert opinion was taken from the academicians having the Ph.D. degree in mathematics education and Turkish teaching different from the researchers of the current study. Moreover, for the reliability and validity, the instrument was conducted to the preservice mathematics teachers who were not the participants of the present study. Based on their suggestions, necessary revisions were made on the items and the last version of the instrument was formed.

In order to analyse the problem posing process related to the Problem Posing Instrument, a rubric was developed. With respect to the rubric development steps suggested by Goodrich-Andrade (2000), firstly, the worksheets (Problem Posing Instrument) conducted as pre-test were collected and looked over the problem statements produced by the PPSTs by classifying them into good and poor examples. Secondly, how good examples differentiated from poor examples

was focused on. Thirdly, document analysis was used in order to analyze problem statements on pre-tests by the authors independently. In this qualitative data analysis, the categories and themes were identified.

These themes were represented in two groups based on the perspectives of mathematics and Turkish education as illustrated in Figure 2. Fourthly, these themes were used as criteria for rubric and then, each criterion was explained into four levels of quality. Hence, a draft rubric was developed at the end the fourth step. Fifthly, after Story Writing Training had been completed, Problem Posing Instrument as the post-test was conducted to the PPSTs. The document analysis was made for the post-tests. The categories and themes were determined again and existing themes were accepted as the last list in Figure 2. Lastly, the draft rubric was analysed based on the analysis of post-tests.

Data collection

In the current study, Story Writing Training focused on improving the PPSTs' knowledge and skills of problem posing and teaching through problem posing. This training was designed and implemented in the context of professional development in problem posing with the help of story writing. Because the further research about how to provide preservice teachers and teachers opportunities to improve their knowledge and skills of problem posing by teaching was needed (Yoon et al., 2007), professional development was designed through story writing by benefiting from the extensive usage and effects of writing and stories.

In this respect, Story Writing Training was prepared in four stages and each stage was organized that would last one week. In the first stage, the PPSTs were given general information about story and story types. Then, they analyzed story samples; (Refik Halit Karay-Eskici [Ragman], Ömer Seyfettin-Kaşağı [Currycomb], Mustafa Kutlu-Uzun Hikâye [Long Story], Sait Faik Abasıyanık, Son Kuşlar [Last Birds]) through five criteria explained in Table 1. In the second stage, the instructor and the PPSTs were talked about writing education. Then, the PPSTs were explained creative writing process and mental design model as stated in the studies of Temizkan (2014) and Author (2017) as in Table 1.

In the third stage, the PPSTs made applications by writing stories based on the knowledge and skills that they acquired in the first and second weeks. They talked about the stories about main and other characters, their properties, actions and feelings, place, events, and time. Then, they discussed about weaknesses and strengths of the small story examples that they prepared and the features that should be found in short stories. In the last stage, they made

more applications and discussions about story writing in order to improve their story writing skills. Afterwards, they were told storytelling and how to connect their stories to storytelling.

Table 1
Story writing training process

Weeks	Training Process
1st Week (3 hours)	General information about stories Analysis of story samples; Finding the main idea Determining the characteristics of the heroes Describe the incident in one sentence Describe the place Layout-knot-solution partitioning
2nd Week (3 hours)	Creative writing process and mental design model Before writing Planning, Subject selection, determining keywords, working on the main idea-theme, Finding a character ("Will you be my hero?" Activity), Writing a spreading section, Identifying the curiosity element, Writing the result Writing order Elements to be considered in writing, Physical environment, Mental preparation, The importance of spelling and punctuation, Determining the style Post writing Review, Correction, Sharing
3rd Week (3 hours)	Writing application in narrative text type Small story examples and their features
4th Week (3 hours)	Problem posing skill Connection between stories and storytelling

In the current study, the data were collected through Problem Posing Instrument consisting of six items. In the current study, data collection and analysis process was completed through four stages. In the first stage, Problem Posing Instrument was conducted to the PPSTs. Then, the document analysis was performed in order to determine the themes and develop problem posing skill rubric by following the steps suggested by Goodrich-Andrade (2000). In the second stage, the PPSTs participated in Story Writing Training lasting 4 weeks as explained in Table 1.

The Story Writing Training was conducted to them by the researcher holding the PhD degree in Turkish education. In the third stage, after the training had been completed, Problem

Posing Instrument was conducted to the PPSTs as post-test. Then, document analysis was performed and the revisions were made on the draft rubric prepared through the initial document analysis based on pre-test conducted in Stage 1. In the last stage, the pre-tests and post-tests were analysed. Quantitative analysis was performed based on the revised rubric as Problem Posing Performance Rubric in Appendix. Qualitative data analysis was also performed based on document analysis. In order to provide evidence for reliability and validity of data analysis processes, opinions of two experts having the degree of Ph.D. in mathematics education and Turkish education were taken about the data analysis and interpretations of the analysis. Moreover, direct quotations are used for the reliability and validity. These quotations were used in order to represent data analysis process clearly in detail.

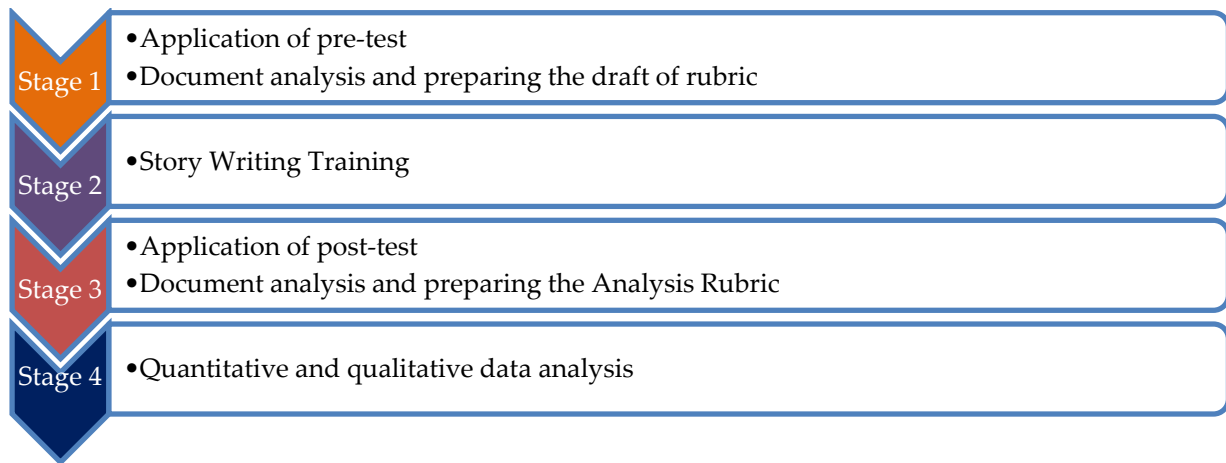


Figure 1. Data collection and data analysis process

Data analysis

The data collection process was performed through Stage 4. In Stage 4, the qualitative data analysis for the pre- and post-tests was made using the themes represented as analysis framework in Figure 2. Moreover, quantitative data analysis was performed for the tests based on Problem Posing Performance Rubric. The pre-tests and post-tests applied by Problem Posing Instrument was scored using Problem Posing Performance Rubric by two researchers independently. Inter-coder reliability was calculated as approximately 92% based on the formula suggested by Miles and Huberman (1994).

The researchers were discussed about the remaining 8% part of analysis until they reached a consensus. In order to provide evidence for reliability and validity, member checking strategy was used. The qualitative analysis and interpretations based on this analysis were discussed with the participants. Moreover, data triangulation was used. The qualitative and

quantitative data were used together in order to provide validity and reliability. With this motivation, a full correspondence was provided. Afterwards, in order to analyse the effects of Story Writing Training, descriptive statistics and paired samples t-test were performed since assumptions of this parametric test was provided. In other words, SPSS Package Program was used in order to identify whether there were statistically significant differences between pre-test and post-test scores of the PPSTs.

Short Story

- Clarity; Limpidness; Unity; Story Writing Style; Fiction; Elements of Story; Story Arc

Mathematical Problem

- Problem; Sufficiency of Information; Mathematical Appropriateness; Pedagogical Appropriateness; Creativity; Relatedness; Operational and Conceptual Equilibrium

Figure 2. Analysis Framework for Problem-Posing Statements

Ethical criteria

This research had been examined by the Senate Ethics Committee of a state university affiliated to the Higher Education Institution and was carried out in line with the approval of the ethics committee approved with the document dated April 30, 2021 and numbered 2021-SBB-0218.

Results

Both quantitative findings acquired through comparing 50 PPSTs' pre-test and post-test scores on Problem Posing Instrument and qualitative results about were explained in this section. Descriptive statistics obtained from the pre-test and post-test scores based on the titles referring to mathematical themes and themes on Turkish education in Figure 3 and Figure 4.

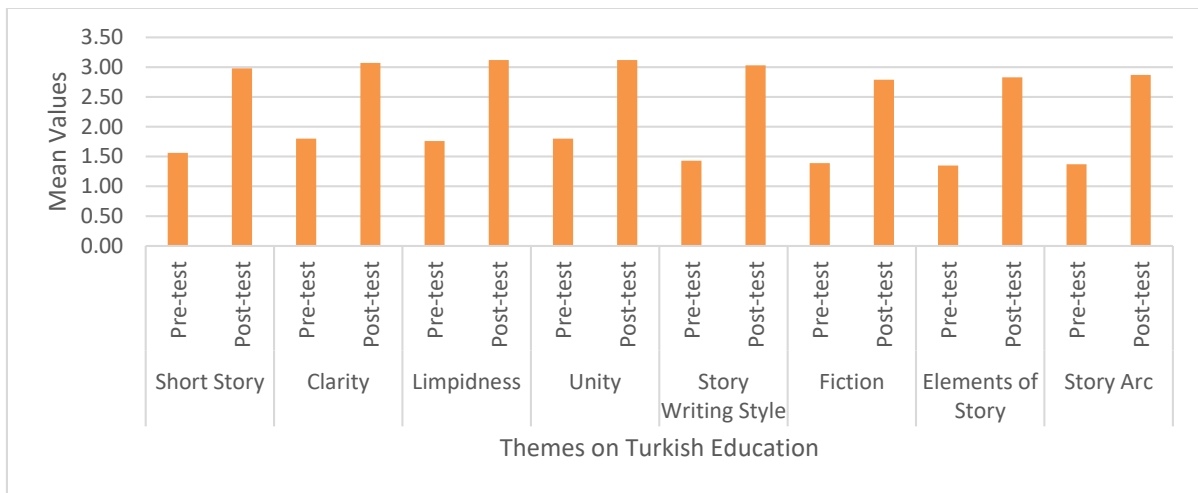


Figure 3. The PPSTs' scores for the themes on Turkish Education

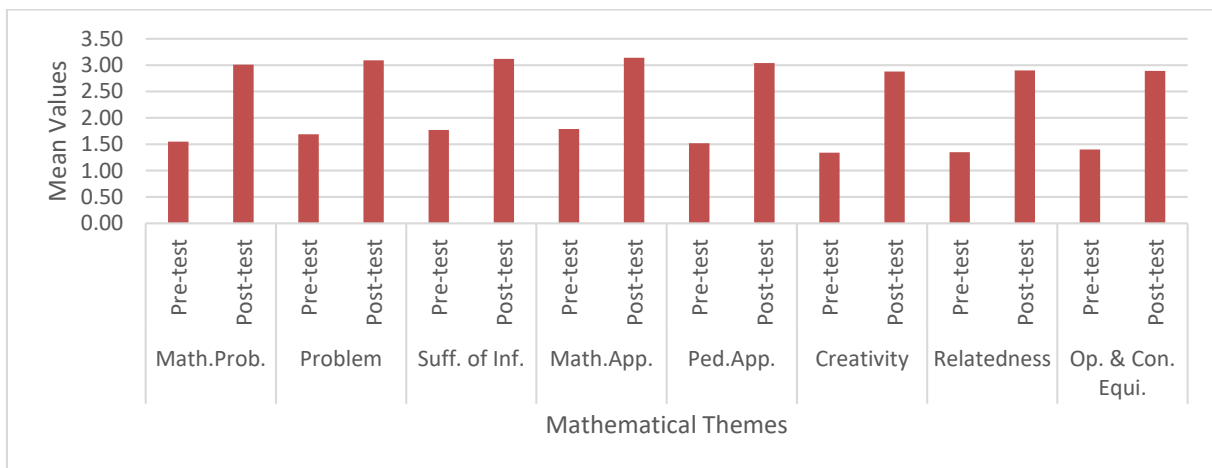


Figure 4. The PPSTs' scores for the mathematical themes

In Figure 3 and Figure 4, pre-test and post-test mean scores and standard deviations of the PPSTs' problem posing performance on themes on Turkish education and mathematical themes were represented. In other words, the PPSTs' pre-test and post-test scores acquired from Problem Posing Instrument were illustrated before and after Story Writing Training was given. When these scores were observed represented in Figure 3, the PPSTs' mean values were increased after taking this training on the themes of short story, clarity, limpidness, unity, story writing style, fiction, elements of story, story arc and totally short story. When these scores were observed represented in Figure 4, the PPSTs' mean values were increased after taking this training on the themes of problem, sufficiency of information, mathematical appropriateness, pedagogical appropriateness, creativity, relatedness, operational and conceptual equilibrium and totally mathematical problem.

In Table 2, the comparison of the pre-test and post-test mean scores of the PPSTs' problem posing performance was given. Paired samples t-test results related to the scores of problem posing performance received by the PPSTs were represented based on the themes and total scores referred by Short Story and Mathematical Problem.

Table 2
T-test results based on problem posing

Themes	Tests	N	\bar{x}	SD	Df	<i>t</i>	<i>p</i>
Short Story	Pre-test	50	1,56	0.31	49	14.80	.000
	Post-test	50	2.98	0.74	49		
Clarity	Pre-test	50	1.80	0.38	49	12.63	.000
	Post-test	50	3.07	0.73	49		
Limpidness	Pre-test	50	1.76	0.39	49	12.92	.000
	Post-test	50	3.12	0.75	49		
Unity	Pre-test	50	1.80	0.48	49	13.31	.000
	Post-test	50	3.12	0.74	49		
Story Writing Style	Pre-test	50	1.43	0.35	49	13.99	.000
	Post-test	50	3.03	0.84	49		
Fiction	Pre-test	50	1.39	0.32	49	13.77	.000
	Post-test	50	2.79	0.76	49		
Elements of Story	Pre-test	50	1.35	0.27	49	14.64	.000
	Post-test	50	2.83	0.78	49		
Story Arc	Pre-test	50	1.37	0.32	49	13.75	.000
	Post-test	50	2.87	0.83	49		
Mathematical Problem	Pre-test	50	1.55	0.30	49	12.73	.000
	Post-test	50	3.01	0.74	49		
Problem	Pre-test	50	1.69	0.40	49	11.84	.000
	Post-test	50	3.09	0.72	49		
Sufficiency of Information	Pre-test	50	1.77	0.35	49	12.04	.000
	Post-test	50	3.12	0.75	49		
Mathematical Appropriateness	Pre-test	50	1.79	0.42	49	11.53	.000
	Post-test	50	3.14	0.74	49		

Pedagogical	Pre-test	50	1.52	0.34	49	12.26	.000
Appropriateness	Post-test	50	3.04	0.82	49		
Creativity	Pre-test	50	1.34	0.35	49	11.65	.000
	Post-test	50	2.88	0.80	49		
Relatedness	Pre-test	50	1.35	0.31	49	12.16	.000
	Post-test	50	2.90	0.81	49		
Operational and Conceptual Equilibrium	Pre-test	50	1.40	0.33	49	12.32	.000
	Post-test	50	2.89	0.80	49		

Paired samples *t*-tests were conducted in order to evaluate the impact of the intervention on the PPSTs' scores on Problem Posing Instrument. According Turkish education, there was statistically significant increase in short story scores representing total scores from pre-test ($\bar{x}=1.56$, $SD=0.31$) to ($\bar{x}=2.98$, $SD=0.74$), $t(49)=14.80$, $p<.000$. Moreover, there were statistically increases in clarity scores from pre-test ($\bar{x}=1.80$, $SD=0.38$) to ($\bar{x}=3.07$, $SD=0.73$), $t(49)=12.63$, $p<.000$, limpidness scores from pre-test ($\bar{x}=1.76$, $SD=0.39$) to ($\bar{x}=3.12$, $SD=0.75$), $t(49)=12.92$, $p<.000$, unity scores from pre-test ($\bar{x}=1.80$, $SD=0.48$) to ($\bar{x}=3.12$, $SD=0.74$), $t(49)=13.31$, $p<.000$, story writing style scores from pre-test ($\bar{x}=1.43$, $SD=0.35$) to ($\bar{x}=3.03$, $SD=0.84$), $t(49)=13.99$, $p<.000$, fiction scores from pre-test ($\bar{x}=1.39$, $SD=0.32$) to ($\bar{x}=2.79$, $SD=0.76$), $t(49)=13.77$, $p<.000$, elements of story scores from pre-test ($\bar{x}=1.35$, $SD=0.27$) to ($\bar{x}=2.83$, $SD=0.78$), $t(49)=14.64$, $p<.000$ and story arc scores from pre-test ($\bar{x}=1.37$, $SD=0.32$) to ($\bar{x}=2.87$, $SD=0.83$), $t(49)=13.75$, $p<.000$. These findings revealed that Story Writing Training was effective in clarity, limpidness, unity, story writing style, fiction, elements of story and story arc, and totally in short story for problem posing performance.

In Table 2, according mathematics education, there was statistically significant increase in mathematical problem scores representing total scores from pre-test ($\bar{x}=1.55$, $SD=0.30$) to ($\bar{x}=3.01$, $SD=0.74$), $t(49)=12.73$, $p<.000$. Moreover, there were statistically increases in problem scores from pre-test ($\bar{x}=1.69$, $SD=0.40$) to ($\bar{x}=3.09$, $SD=0.72$), $t(49)=11.84$, $p<.000$, sufficiency of information scores from pre-test ($\bar{x}=1.77$, $SD=0.35$) to ($\bar{x}=3.12$, $SD=0.75$), $t(49)=12.04$, $p<.000$, mathematical appropriateness scores from pre-test ($\bar{x}=1.79$, $SD=0.42$) to ($\bar{x}=3.14$, $SD=0.74$), $t(49)=11.53$, $p<.000$, pedagogical appropriateness scores from pre-test ($\bar{x}=1.52$, $SD=0.34$) to ($\bar{x}=3.04$, $SD=0.82$), $t(49)=12.26$, $p<.000$, creativity scores from pre-test ($\bar{x}=1.34$, $SD=0.35$) to ($\bar{x}=2.88$, $SD=0.80$), $t(49)=11.65$, $p<.000$, relatedness of story scores from

pre-test ($\bar{x}=1.35$, $SD=0.31$) to ($\bar{x}=2.90$, $SD=0.81$), $t(49)=12.16$, $p<.000$ and operational and conceptual equilibrium scores from pre-test ($\bar{x}=1.40$, $SD=0.33$) to ($\bar{x}=2.89$, $SD=0.80$), $t(49)=12.32$, $p<.000$. In all themes and total scores, the significant difference was found in the favor of post-test which shows that Story Writing Training conducted to the PPSTs was effective on their problem posing performance meaningfully. In the pre-test, in the first question, the PPSTs posed similar problems focusing on the number of figures represented on the first item. An example for this item can be illustrated as follows:

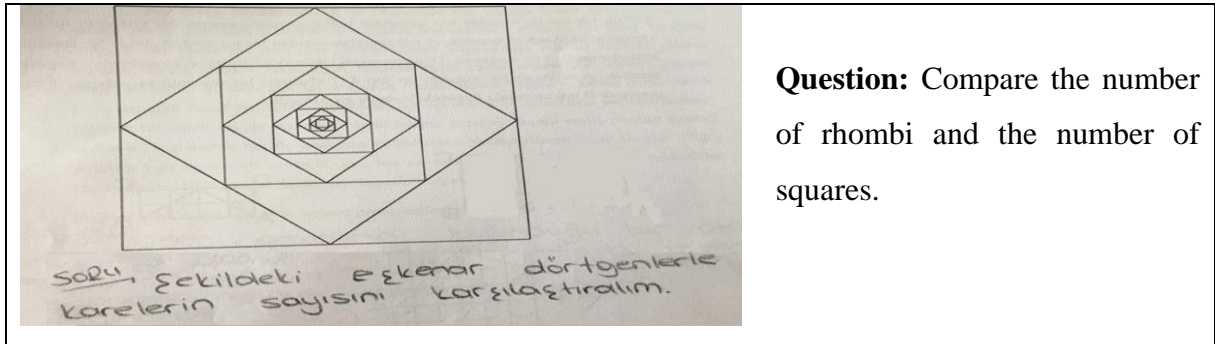


Figure 5. Problem posed for item 1 in pre-test

In this example, when it was examined based on the themes, the PPSTs posed the problem requiring to count the number of identified figures without fictionalizing story arc by connecting to mathematical context. Hence, the criteria of being problem, creativity and relatedness on the rubric was scored as 1. Moreover, based on the criteria of sufficiency of information and mathematical appropriateness, the problem did not include information and guidance how to answer the problem and to make comparison among the numbers of the figures. Hence, these criteria were scored as 2. Furthermore, the problem was posed related to rhombi and square taking place to be learned in primary school mathematics curriculum based on the appearance of these figures without forcing students to make reasoning. In other words, this problem was posed by necessitating visualization level of geometric levels as lowest level of thinking rather than forcing to make mathematical reasoning and relational thinking with insufficient information and guidance. In this respect, the criterion of pedagogical appropriateness was scored as 2.

Lastly, it was observed that this problem was posed by focusing on and necessitating operations such as counting the number of figures rather than conceptualization. Therefore, this criterion was scored as 1. The scoring was made in this way so other items for pre-test were scored similarly. According to the themes in Turkish education, the problem statement was

scored based on the themes of clarity, limpidness and unity as 3. In this scoring, the criteria of grammatical appropriateness of the statement such as its length, connection among words and sentences, its structure (e. g. inversion), selection of words based on students' cognitive levels (i.e. using idioms, proverbs, concretization and figurative expressions that can be understood by students), and using Turkish language effectively were considered.

On the other hand, preparing stories in posing problems were analysed by focusing on the criteria of identifying context and main idea, selecting appropriate characters, fictionalizing story arc, placing the time and place notions into statement and forming the elements for curiosity. Based on these criteria, the themes of story writing style, fiction, elements of story and story arc were scored as 1. In the post-test, in the first question, the PPSTs posed problems focusing on story arcs and various daily life events. An example for this item can be illustrated as in Figure 6. In order to analysed the difference between pre-test and post-test, the problem posed by the PPST forming the problem represented in Figure 5 was analysed. The problem in Figure 6 was examined based on the themes, the PPSTs posed the problem by fictionalizing story arc by connecting to mathematical context to the activity of origami.

<p>Ali, eline aldığı kare şeklindeki renkli kağıtlarla origami yapmaya karar vermiştir. Origami kağıt katlamaya sanattir. Origamide amaç kağıda yapıştırıcı silmeden ve onu kesmeden yeni şekiller oluşturmaktır. Ali, origami yapmayı öğrendiğinden çok çok mutludur. Renkli kağıtlarla çeşitçe şekiller yaparak keyifli zaman geçirmektedir. Origami sayesinde hem eğlenip hem de öğrenmektedir. Bazen tüm gününü kağıtlarla oynayarak geçirebileceği dünyalar kurmaktadır. Şimdi yepyeni dünyalar kurma vaktidir. Ama origami basit gibi görünse de kendi içinde bir sistem vardır. Origami, aşamalı katlamalardan oluşur. Ali, bu aşamaları sırayla, böylece gerçekleştirir.</p> <p>Birinci aşama katlama için, kağıdın, kağıdın köşelerini orta noktada üçgenler oluşturarak birleştirilmiştir. Düzgen dörtgenler üzerinde bu aşamayı tekrarlamıştır. Ali, aşamalı katlamalarını tamamlandıktan sonra oluşan şekli beğenmemiştir, bu nedenle, bütün katlamaları açmıştır. Katlamalar açıldıktan sonra, başlangıçtaki kare kağıt katlama izlerinde dolayı, yukarıdaki şekilde olduğu gibi görülmektedir.</p> <p>- Ali, kağıdın bu şekilde görünmesi için bu aşamalı katlama eylemini kaç kez yapmıştır?</p> <p>- Ali, kare şeklindeki kağıda 12 aşamalı katlama yapıp açarsaydı, kağıt üzerinde toplam kaç üçgen olurdu?</p>	<p>Ali decided to make origami with the square-shaped colored paper. Origami is the art of paper folding. The aim of origami is to create new shapes without applying glue to the paper and cutting it. Ali has been very happy since he learned how to make origami. He spends a pleasant time making various shapes with coloured papers. He has fun and learns with the help of origami. Sometimes he spends his whole day playing with papers and creates imaginary worlds. Now is the time to build worlds again. But even though origami seems simple, it has a system in itself. Origami consists of progressive folds. Ali takes care of these steps in turn. For the first stage of folding, the corners of the paper are joined by creating triangles at the midpoint of the square-shaped paper. He repeated this stage on the formed quadrilaterals. Ali did not like the shape that formed after completing his gradual folding. Therefore, he opened all the folds. The initial square paper when unfolded appears like the above figure due to fold marks.</p> <p>How many times has Ali done this progressive folding action to make the paper look like this figure?</p> <p>If Ali had folded the square-shaped paper through 12-stage folding and opened the paper, how many triangles would there be on the paper?</p>
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Figure 6. Problem posed for item 1 in post-test

In the analysis based on the themes for the field of mathematical problem in Figure 2, the mathematical content was explained about geometrical pattern rather than counting the number of triangles in the context of origami. Hence, the criteria of being problem, creativity and relatedness on the rubric was scored as 4. Moreover, based on the criteria of sufficiency of information and mathematical appropriateness, the problem included information and guidance how to use the information to solve it. Hence, these criteria were scored as 4. Furthermore, the problem that could be used as task in the lesson to help students make reasoning and improve conceptual and relational knowledge was produced. In this respect, the criteria of pedagogical and mathematical appropriateness, and operational and conceptual equilibrium was scored as 4. The scoring was made in this way so other items for post-test were scored similarly.

According to the field of Short Story related to Turkish education in Figure 2, the scores of the problem statement based on the themes of clarity, limpidness and unity were 4. This problem was analysed based on the criteria of grammatical appropriateness of the statement, structure of statements, selection of words and expressions based on students' cognitive levels and using Turkish language effectively. Moreover, in preparing story while posing this problem, it could be stated that identification of the context and main idea, selection of appropriate character, fictionalization of story arc, placing the time and place notions into statement and formation of the elements for curiosity were performed effectively. Hence, the themes of story writing style, fiction, elements of story and story arc were scored as 4.

Especially, for the last item, the PPSTs posed problems referring to typical questions most likely to be placed in many textbooks. Sometimes, they ignored the pedagogical appropriateness because they did not consider about primary school students' readiness and objectives in primary school mathematics curriculum. For example, the typical problems emphasizing operational knowledge without story arcs and relatedness of "How many grams are equal to 1 kg?" related to measurement, " $789 + 986 = ?$ " about numbers and operations, " $\square - 5 = ?$ " in algebra, "What are the mean, range and median of the number set of 1, 2, 4, 5, 5, 7, 9, 11, 12" related to data analysis and "How many obtuse angle triangles are there in the following triangles?" about geometry were posed by the PPSTs. On the other hand, in the post-test, the PPSTs posed problems for the last item by producing story arcs and giving more emphasis on conceptual part rather than operations. Moreover, the problems in the post-test were produced as challenging tasks directing students make reasoning.

Discussion

In the current study, impact of Story Writing Training on problem-posing skills of the preservice primary school teachers was examined. In this mixed-method design research, it was found that the Story Writing Training improved the PPSTs' problem posing skills based on the findings of quantitative and qualitative data analysis. In other words, there were significant differences related to the effects of story writing on the PPSTs' problem posing skills. Before they were conducted to Story Writing Training, they had gotten very low problem posing scores from Problem Posing Instrument applied as pre-test. On the other hand, problem posing skill post-test scores were significantly higher, especially in all themes emerged through qualitative data analysis and the total scores of both fields; short story and mathematical problem.

Based on the themes identified through qualitative data analysis, the PPSTs' problem-posing skills were separately analysed for each item. Accordingly, there were significant

differences in favour of the post-test in both groups of themes which are short story (clarity, limpidness, unity, story writing style, fiction, elements of story and story arc) and mathematical problems (problem, sufficiency of information, mathematical appropriateness, pedagogical appropriateness, creativity, relatedness and operational and conceptual equilibrium). Moreover, the findings acquired from qualitative data analysis were encouraged the quantitative findings. Clearly, it was observed that the PPSTs posed problems including the elements and characteristics of short stories.

It was observed that the PPSTs had a tendency to explain the situation with a short and clear sentence, avoiding descriptions and concretizations while posing problems in the pre-test. While they focused more on mathematical terms in posing the problems, they ignored situations such as the style of expression, the use of terms and expressions in accordance with the students' levels. It was determined that the expressions were made with clear statements. However, no fiction was encountered and there were not story elements in the problems posed by the PPSTs in the pre-test. On the other hand, at the end of the four-week Story Writing Training, which was performed by associating the acquisition of the skill of storytelling with problem posing, it was determined that after the problem determination phase, they narrated in a clear and understandable way to be understood by the target audience in order to pose problems in the post-test. It was seen that fictional characters were written in which the hero of the story took an active role in the problem posing process. Hence, it can be stated that the PPSTs could produce written texts referring to problems that enable the students to perceive any mathematical problem as a part of daily life. The PPSTs were able to concretize mathematical problems by associating them with daily life through storytelling. Thus, it was observed that the problems posed by the PPSTs were more understandable, solvable and intriguing.

The quantitative and qualitative findings of the present study showed that the PPSTs could produce more qualified problems and by improving their problem posing skills with the help of writing stories. This finding is similar to the findings and the expressions provided in the previous study of Burton (2002). This author claimed that mathematical stories impacted the learners' posing problems. Mathematical stories could direct the learners to think about solution strategies and how to solve the problem, make reasoning, and test the accuracy of estimations and ideas produced through posing the problem. In this respect, it could be claimed that while the PPSTs were organizing and preparing the parts of layout-knot-solution in illustrating the flow of events, they could be forced to think about the solution, make reasoning and test their estimations and ideas.

These findings encourage the results of the previous study performed by Franz and Pope (2005). In this previous study as it was found in the current study, it was observed that learners could make mathematical connections and relationship between real life and mathematics. In this respect, it can be stated that story writing directed the PPSTs to produce story arcs by relating a mathematical concept. Moreover, it was observed that the PPSTs could pose problems related to particular mathematical concepts by making connections among other mathematical concepts after story writing training. It can be claimed that the use of elements of story and the necessity of explaining story arc by using Turkish language effectively can enhance the posing problems by considering the mathematical concepts and their properties in detail. With the help of writing stories, they could explain mathematical concepts accurately and clearly. This finding supports the findings of the previous research stating that stories encourage the comprehension and learning of mathematical concepts and their properties (Franz & Pope, 2005; Goral & Gradinger, 2006; Murphy, 1999), and using mathematical expressions and language more effectively (Greenes, Ginsburg & Balfanz, 2004).

The current study focusing on story writing in posing mathematical problems may provide contributions to preservice teachers, teachers and the related literature. For example, it may be easier for the preservice and in-service primary school teachers to pose the mathematical problems that they enjoy and use to organize beneficial classroom atmosphere by story writing. In addition, in the process of creating problems with writing stories, the fact that the mathematical content and plot are explained through a concrete and identified hero may encourage permanent learning and skill development. Sever (2010) suggest to present the real life because this presentation can make abstract concepts concrete in order to help students understand these abstract concepts. Children's world is different from adults' world (Şirin, 2000). Building a world perceived by their eyes can enhance the improvement of their learning (Gürel, Temizyürek & Şahbaz, 2007).

In the lessons such as mathematics in which the students have difficulties in learning, there should be teaching tools that can address the children's world in accordance with their perception levels, interests and expectations. In this respect, stories have critical importance because the type that the children like and read the most is the story. In this respect, it can be claimed that if the mathematical concept desired to be taught is realized on a hero that the child will identify with, students can understand the concept effectively. Furthermore, a primary school teacher should have the responsibility of transferring the knowledge to the students in a concrete and understandable way because the teacher can enhance the students' development by a rich, stimulating environment to be organized (Akyol, 2013).

Conclusion

Storytelling is a tool that can provide this richness significantly. In this respect, classroom teachers are expected to be good story writers. Further research can be conducted to the preservice teachers or in-service teachers in order to help them acquire necessary knowledge and skills about how to be good story writers and how to apply it in teaching concepts by problem posing in mathematics or other disciplines. In other words, the effects of story writing in posing problems can be examined through other preservice teachers or in-service teachers. Moreover, the current study was performed by qualitative and quantitative methods to examine the effects of writing stories on the PPSTs' problem posing skills.

Another mixed study can be carried out in order to detailed information about the effects of writing stories from different grade level of learners such primary school students or middle school students. In addition, a similar study can be conducted to in-service teachers or the training about writing stories for the development of problem posing skills can be conducted by directing the teachers to design and implement these skills in teaching mathematics. Further studies can be performed by focusing on one of these learning areas more specifically. Lastly, the current study is limited to preservice primary school teachers. The further study can be conducted to the students or in-service teachers.

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