Makale Gönderim Tarihi:10.05.2016 *Makale Kabûl Tarihi:14.10.2016*

Analyzing Applicability of a Mathematical Story Named "My Fractal Tree" Teachers' and Students' Views Regarding Its Application[1]

Yrd. Doç. Dr. Elif BAHADIR*
Yıldız Teknik Üniversitesi, Eğitim Fakültesi, İstanbul / Türkiye
Nur UYGUN
Yıldız Teknik Üniversitesi, Eğitim Fakültesi, İstanbul / Türkiye
Emine USLU
Yıldız Teknik Üniversitesi, Eğitim Fakültesi, İstanbul / Türkiye
Hadiye HENDEM
Yıldız Teknik Üniversitesi, Eğitim Fakültesi, İstanbul / Türkiye

Abstract

This study analyzes the applicability of a mathematical story named "my fractal tree" during the lessons of fractals on 8th graders' math class. In order to determine students' attitudes and practicability of the application, classroom observations and students' views were collected. To this end, the research was conducted in two different schools where there are advantageous and disadvantageous groups of students

[1] This work was supported by TUBITAK 2209 project support "Matematik Hikâyesi ile Matematik Derslerinin İlişkilendirilmesi".

* Sorumlu Yazar. Tel: +90 212 383 48 92 E-posta: elfbahadir@gmail.com

 ISSN: 2146-5606

in Istanbul province in 2015-2016 academic year. It was conducted with 42 students and 8 math teacher. Students were firstly distributed visual materials about fractals, then they were told about fractals and were explained the story of “my fractal tree” with visual supports. Later on, each student’s opinions in relation to the application was taken in written. After the application was completed, considering the analysis of students’ opinions and the situation during students’ practices, the applicability of mathematical story named “my fractal tree” has been analyzed. Students' and math teachers’ opinions about the mathematical story used in the application were found to be positive. During the application, the students were observed to have watched the activity carefully and have participated it. As a result, it was concluded that the application was appropriate and applicable for 8th grade level.
Keywords: Fractal; Math story; 8th grade.

“Fraktal Ağacım” İsimli Matematiksel Hikâyenin Uygulanabilirliğinin İncelenmesi ve Uygulamaya Dair Öğretmen ve Öğrenci Görüşleri

Öz

Bu araştırmada, “Fraktal Ağacım” isimli bir matematiksel hikâyenin ortaokul 8. sınıf matematik dersindeki fraktallar konusunun işlenmesi esnasındaki uygulanabilirliği incelenmiştir. Uygulamanın yapılabilirliği ve öğrenci tutumların belirlenmesi için ders içi gözlem ve öğrenci görüşlerine başvurulmuştur. Bu amaçla, araştırma 2015-2016 eğitim-öğretim yılında İstanbul ilinin avantajlı ve dezavantajlı öğrenci gruplarının bulunduğu iki farklı okulda yapılmıştır. Araştırma, 42 öğrenci ve 8 matematik öğretmeni ile gerçekleştirilmiştir. Öğrencilere öncelikle fraktallarla ilgili görseller dağıtılmış, fraktallardan bahsedilmiş ve “fraktal ağacım” hikâyesi görsellerle desteklenerek anlatılmıştır. Daha sonra uygulamalar ile ilgili olarak her bir öğrenciden görüşleri yazılı olarak alınmıştır. Uygulama sona erdikten sonra öğrenci görüşlerinin incelenmesi ve öğrencilerin uygulama esnasındaki durumları göz önünde bulundurularak “fraktal ağacım” matematiksel hikâyesinin uygulanabilirliği incelenmiştir. Öğrencilerin ve öğretmenlerin uygulamada kullanılan matematiksel hikâye ile ilgili görüşlerinin olumlu yönde olduğu görülmüştür. Öğrencilerin etkinlik bo-

yunca dikkatli bir şekilde etkinliği izledikleri ve katıldıkları gözlenmiştir. Araştırma sonucunda, yapılan uygulamanın ortaokul 8. sınıf düzeyi için uygun ve kullanılabilir olduğu sonucuna ulaşılmıştır.
Anahtar Kelimeler: Fraktal; Matematiksel hikâye; 8. sınıf.

Introduction

Effective learning occurs when the student attends classes actively during his/her learning process, and when she/he is involved in the learning process while learning. Since maths is based on the perceptions and the mental visualizations, it cannot be transferred into the student's inactive mind directly through narration like pouring water into an empty container. The most common way for a student to be active is his/her participation in the problem solving activities which don't have the algorithms that have easy solutions or include previously unsolved problems (Bayraktar, 1998, p.35).

To Altun (2006), while children enjoy playing games and doing sportive activities as part of their physical developments, they like thinking about events, problems and issues as part of their mental developments, and while doing them, they get pleasure because they develop themselves as well (Skemp, 1986). However, students dislike formulas or information they are exposed directly. Therefore, if the activities that attract the students' attentions, increase their eagerness of learning, and make them constantly active during their math education are used, their success significantly increases (Altun, 2006; Başer, 2008; Hiçcan, 2008; Şen, 2005; Tural, 2005).

Given that learning is an active process, in order to prepare an educational environment in which students learn by doing and applying in mathematics education, activities must be brought into the forefront. In general, teaching material or activity have been defined as the means which visualize abstract mathematical expressions and present them clearly (Moyer, 2001), enable the transition of concrete mathematics to abstract mathematics, help the students to see mathematical relationships and practices and ensure more effective education (Moyer, Bolyard and Spikell, 2002). It is suggested that teaching materials or activities can also be used as mediators between the real world and the world of mathematics (Durmuş and Karakırık, 2006). The teaching materials or activities are known to make mathematics teaching enjoyable, to attract the attention of students, to increase their curiosity and to

encourage using them (Moyer, 2001). Therefore, the materials and the activities that will ensure some learning environments where students are as effective as possible in mathematics teaching should be provided (Baki, 2006).

Children are needed to be saved from the boredom of the classroom environment and from the borders of thinking with strict patterns. They are also needed to be taken into a multiple choice world where the processes of imagination, intuition, and feeling are intricate. In order to provide students' establishing the link of Math course with life, it is needed to be benefited from actual situations during educational activities. However, creating actual situations and going to the places where they occur may not always be possible. But, with the help of effective teaching techniques and high quality materials, these challenges can be overcome. Educational stories are one of those methods. Stories are extremely important tools which are formed by related and consistent information and they try to give the information a meaning. Explanatory stories use the power of the story to create a learning content which is meaningful and based on real life (Akyol and Temur, 2006; Karakuş, 2012). So, scientific information can be presented as a combination of several explanatory stories in the curriculum. These stories emphasize that understanding is not a single proposition or a concept, rather it is an interrelated series of ideas that build a structure with each other. Stories also bring to the fore the fundamental ideas of curriculums which have become incomprehensible with excessive details. Students and teachers more clearly see the most important points of the subject and their relations with each other and they can work more effectively together (Millar and Osborne, 1998). Storytelling methods develop children's language use in verbal, provide a fun learning experience for students, increase their vocabulary usage and improve their social and emotional developments through social experiences (Belet, 2011).

Storytelling is a powerful tool that creates a rich, meaningful, exciting, permanent image in students' minds. A student needs some methods to understand abstract mathematical concepts. Listening to the story makes the student a partner for solving the problem in the story. Using the stories is a pedagogical tool for students' building a relationship with the subjects of mathematics they need to learn. In this study, the students were presented a sample story and were expected to go to the result. Students were expected to convert the expression about how many branches were drawn in the story into

a mathematical expression and to write it as an exponential number and to reach a conclusion. Although they were not very experienced, the students solved the problem in the story using their basic math skills. Despite the experience a student has is a fiction story, the story character has a real problem to be solved and using the digit values has helped to solve this problem. Even though storytelling is not considered as a model, it is discussed as a pedagogical technique that facilitate the understanding of mathematics. For students' comprehending math topics, contacting, speaking, listening and writing are essential elements (Goral and Gnadinger, 2006).

Mathematical stories are the stories which are integrated with mathematical terms including characters, places, scenarios and topics; not the stories include only problems shown as a story or calculation problems. Mathematical stories should not be confused with the mathematical problems. The aim is not to ask students the questions, but it is to present the solution of the problem in an attractive way depending on the storyline. Narrative texts are the texts which students read with many purposes such as reading for curiosity, learning by having fun in reading-comprehension studies (Borasi, Sheedy and Siegel, 1990).

Despite the recent calls to use mathematical stories, stories have not been taken place in the mathematics curriculum, yet (Hieber and Hartel, 2003; Lewis, Long and Mackay, 1993; Wells, 1986; Young-Loveridge, 2004). Story writing is one of the basic tools to create meaning. If teaching mathematics focuses critical thinking rather than the technique, students can do their own learning directly in this way. Teachers mustn't embody math. This primarily requires that the stories become integrated with mathematics education. If mathematical stories are not rationalized with a way of thinking which values the thinking process of finding the correct answer and thinking over it, reading mathematical stories will not have an impact on students (Borasi, Sheedy and Siegel, 1990).

In literature, reading and understanding of these texts is easier than the informative texts; and the readers seemed to be more successful at reading and understanding these texts (Akyol and Temur, 2006; Baştuğ, 2012; Hiebert, 2003). Even if storytelling is not considered as a model, it is discussed as a pedagogical technique that facilitate the understanding of mathematics. Activities of mathematical story writing are important for students' being literate

in mathematics. With mathematical stories which will be told in the classes, mathematics can be objectified and be shown as a part of everyday life. Starting from the pre-school period, these stories can be used as a teaching tool at all levels. Although there have been many studies abroad to eliminate the misconceptions of the explanatory stories, a few studies have been found in our country (Ayvacı and Şenel-Çoruhlu, 2009). Most of the works have been done in the area of science education (Barker and Millar, 1999, 2000; Banister and Ryan, 2001; Demircioğlu, Demircioğlu and Ayas, 2006; Fensham, 2001). The studies about the education with mathematical stories are limited. (Lewis, Long and Mackay, 1993; Thatcher, 2001; Young-Loveridge, 2004; Casey, Erkut, Ceder and Mercer-Young, 2008)

Fractals

In the curriculum, fractals that take part in the pattern decoration, are the essential structures in terms of understanding of mathematical structure, and analyzing the patterns and their relationships (Hargreaves, 1999). Fractals can be referred as patterns that repeating is the same every time and the repetitive parts change randomly.

In recent years, fractal geometry has been widely used in many different areas such as art, astronomy, biology, chemistry, physics, computer, economics, engineering, geology and genetics. Since the use of fractals has been intense in many areas, they have become mandatory to be taught and be learned in the math courses in schools. Besides, since fractals are in a close relationship with geometry and many traditional mathematical subjects such as symmetry, proportion, measurement, and fractions in elementary level and logarithms, compound functions, Pascal's triangle, arithmetic, geometrical sequences, and complex numbers in secondary level, their helping students' establishing a relationship between math and other disciplines, fractals' integrating into the existing math curriculum has been indicated in many studies (Fraboni and Moller, 2008; Goldenberg, 1991; Lornell and Westerberg, 1999; Vacc, 1999).

In NCTM 1989 report, students are recommended to study with non-Euclidean geometry in order to be able to recognize the universe and identify with it. In the additional reports published by NCTM between the years of 1991-1993, besides the traditional mathematical subjects, it has also been focused that the new mathematical subjects which will increase each

student's interests and needs to math at all levels, will ensure positive attitudes towards mathematics, will establish a direct relationship between nature and mathematics and will allow to use the technology in this relationship. One of the suggested topics is fractal geometry.

When the studies were analyzed on teaching fractals in the literature, it is seen that these studies have been about the activities which will be used to teach fractals. For example, Thomas (1989), in his study, created fractal shapes using the Logo program and included the activities about two basic features of fractals, self-similarity and fractal dimension. Similarly, Lornell and Westerberg (1999) introduced the activities that they developed about teaching the basic features of fractals, complexity, repetition and self-similarity for the 9^{th}-12^{th} grades. In his study, Naylor (1999) included the activity samples related to creating fractal structures, analyzing self-similarity and repetition characteristics and calculating the area and primeter of fractals. Adams and Aslan-Tutak (2006) created the Sierpinski triangle and determined the patterns in it in their study sheet they prepared for 5^{th} and 7^{th} grades. Fraboni and Moller (2008) briefly introduced fractals and explained their aspects separated by Euclidean geometry in their study. Karakuş and Baki (2011) evaluated the studies conducted about the subject of fractal geometry in the math curriculum and textbooks of 8^{th} grade.

This study has been conducted about teaching fractals with the story based education and if the story named "my fractal tree" used in the course is effective by using observations and taking opinions of students and teachers on the story.

Objective and importance of the study

In the aforementioned stories above, it has been reached to the findings regarding the story method used in various areas has affected the achievements, attitudes, recall levels, and comprehension skills of the students positively. National Council of Teachers of Mathematics [NCTM] (1989, 2000) has recommended the use of children's trade books (story books) as a way of introducing mathematical ideas through literature. Such trend has become quite popular in the last 2 decades (Lewis, Long and Mackay, 1993; Thatcher, 2001). This phenomenon occurs for children as well: a narrative context helps them learn and remember information better (Lucariello and Nelson, 1985).

Cordova and Lepper (1996) found that for fourth and fifth graders, a fantasy story context substantially improved performance on a math test.

In this study, the students were presented a sample story with examples of fractals, and they were expected to reach the conclusion at the end of the story and then their opininons were determined about the application. This study has been thought to set an example for the studies about using mathematical stories in math education. The story of My Fractal Tree used in the study was written by researchers. To achieve this objective, the answers will be sought to the following sub-problems.

Is the mathematical story named "my fractal tree" which is in 8^{th} grade math curriculum and prepared for the fractals an effective application that can be used during the lecturing this topic? What are the opinions of students and teachers regarding this application?

Method

In this part, the research model of the study is explained, the information about data collection instruments of the study, sample group participated to the study, data analysis techniques and the implementation process is provided. Among qualitative research methods, phenomenography was used in the study. In this method, perceptions and events are revealed in their natural environment in a more realistic and a holistic manner (Yıldırım and Şimşek, 2005). Emerged in the 1980's, phenomenographic research studies have been considered as a new approach (Akerlind, 2005). During phenomenographic analysis, firstly, the categories of the qualitative differences are tried to be determined, then how the participants perceive the events and the concepts are revealed, and finally the researcher starts to create categories by comparing the similarities and differences between the participants of the study (Baş and Akturan, 2008).

Participants

The study was conducted in two different schools where there are advantageous and disadvantageous groups of students in the 2015-2016 academic year in Istanbul Province. The study was conducted in 2014-2015 as a part of 2209 projects supported by Tübitak. The topic of Fractals in the story was not in the mathematics curriculum published in 2013. At the date when study was conducted, the topic of Fractals was in the 8^{th} grade curric-

ulum. The sampling method was used to determine the participants for the study. The advantageous student group was chosen from the students who have a parent profile with high income and high social status which is over Turkey's average. A private school in Etiler area was chosen as an advantageous school. The disadvantageous student group was chosen from the students who live in a region with low income families and have a social status on average or below average in Turkey. A public school located in Esenler was preferred as a disadvantageous area.

For academic success and creative thinking skills of students, the structure of society they grew in has been known to have a great importance. The recent studies have been revealed that there is a significant relationship between the student's socio-economic infrastructure and his/her success in school (Schoon and Bartley, 2008; Hanushek and Woessmann, 2010; Lacour and Tissington, 2011).

Considering the fact that mathematical story activity which is the focus of this study is based on creative thinking, mathematical skills, and verbal expression skills, this study was conducted with two study groups as advantageous and disadvantageous, by thinking parent support and socio-economical structure were also important. On one hand, students living in advantageous regions are supported by their parents effectively, students living in disadvantageous regions are known to reach some opportunities very limitedly. Conducting the study in both advantageous and disadvantageous regions has been seen to be important. Because the subject of fractals takes place in the 8th grade curriculum, the application was made in both schools' 8th grades. The study was carried out with a class with 13 eighth graders in the advantageous regional school and a class with 29 eighth graders in the disadvantageous regional school. Also 8 math teachers' views have been taken about the story named "My fractal tree". Mathematics teachers have been encoded as T1, T2, so on ... . Teachers T7 and T1 have been working their 1.-5. years as a professional seniority. T2, T3, T6, T8 have 6-10-year seniority in their professions while T4 and T5 have 21-25-year seniority.

Design and Execution of Research

In the first stage of the application, students were asked what they understood from the concept of fractal and their answers were written on the board. These ideas remained on the board until the end of the application. As

students had already studied fractals during the semestr, majority of them managed to answer the question. Some of the replies from students are as follows: “it is an arts of decoration, they are geometric shapes, they are intertwined shapes, it is a symmetry, it is a mosque decoration, and lances are fractals...”. A presentation prepared with some examples of fractals was shown to the students and some examples of fractals in the nature were presented to the students. Students were given a worksheet that had simple fractals and were helped to remember fractals. Looking at the examples of fractals, students were seen to have an idea that fractals actually have formal structures. The presentation lasts approximately 25 minutes.

Figure 1. Views from the application.

Students were presented the story named “my fractal tree” by enriching the visual presentation (Appendix 1). Our story character Murat draws a fractal tree and wonders about how many branches he drew. Murat divides every shape into 2 for many times and repeats this process for 9 times regularly and reaches to the last stage he drew. In this stage of the story, students are asked how many branches there are in the final stage. Some students find difficult to count them, and some others reach to the result by multiplying 2 for 9 times easily. In the story, our character reaches the result by using exponential numbers. After the story was completed, students’ first opinions about fractals on the board were discussed again. In this study, even though, the students were not very experienced, they solved the problem in the story using their basic math skills. Although the students' own experience is a fiction story, the character in the story has a real problem to be solved and using exponential numbers has helped students to solve the problem.

Data Collection Tool and Analysis of Data

In the analysis of data, the worksheets which had been given to the students were analyzed. This process was carried out according to the research question. In order to determine the distribution of students' opinions on the application, the frequency (f) and their percentages (%) related to each of response given to the 7 questions were put in tables and necessary assessments have been made. In this part, in order to get the answer of research question, the work sheets were examined and the percentage results of the students' responses were included at the end of the application.

Storytelling application was presented in the classroom with the support of a visual presentation. After the presentation the students were asked 8 questions which will reflect their opinions. Teachers were asked if they found the activity applicable and they were asked about their general opinions for it.

Findings

Findings have been presented in separate tables for different groups of students. Teachers' opinions are at the end of this section.

Table 1. Distribution of the Replies to the Question, "Did You Like the Story?" for Advantageous Regional School

		Yes		**Not much**		**No**	
		f	%	f	%	f	%
Did you like the story?	Advantageous Regional School	12	92.30	1	7.69	0	0

As seen in Table 1, 92.30% of the students replied the question of "Did you like the story?" as "Yes" and 7.69% of them answered it as "not much", while none of the students answered it as "No".

The students who liked the application are numerous and that the application is an additional application to the general math applications attracted interest because the students found it distinctive. This method might have enabled students to think the course was more fun and was easier to build a connection with the real life.

Table 2. Distribution of the Replies to the Question, "Did You Like the Story?" for Disadvantageous Regional School

		Yes		Not much		No	
		f	%	f	%	f	%
Did you like the story?	Disadvantageous Regional School	24	82.75	4	13.79	1	3.44

As seen in Table 2, 82.75% of the students replied the question of "Did you like the story?" as "Yes" and 13.79% of them answered it as "not much", while 3.44% of the students answered it as "No".

The students liked the application. The presentation was completed with absolute silence by the classes, it has been observed that students canalized all their attentions towards the subject. Besides the students' reading the story, a presentation was presented as being supported by visual elements and it was read aloud by the researcher. It means that students were evoked by the technology with a visual and an audible way and were enabled to master the subject, so the majority of the students appreciated the topic.

Table 3. Distribution of the Replies to the Question, "Was the Mathematical Story Understandable Enough for You?" for Advantageous Regional School

		Understandable		Not understandable	
		f	%	f	%
Was the mathematical story understandable enough for you?	Advantegous regional school	13	100	0	0

As seen in Table 2, 100% of the students replied the question of "Was the mathematical story understandable enough for you?" as "Yes" and none of them answered it as "No". The story's not being complex and its having a single connection which leads to the result might have made the 8th graders find it simple.

Table 4. Distribution of the Replies to the Question, "Was the Mathematical Story Understandable Enough for You?" for Disadvantageous Regional School

		Understandable		Not understandable	
		f	%	f	%
Was the mathematical story understandable enough for you?	Disadvantegous regional school	28	96.55	1	344

As seen in Table 2, 96.55% of the students replied the question of "Was the mathematical story understandable enough for you?" as "Yes" and 3.34% of them answered it as "No". Students' having learned the subject before, the story's containing multiple samples (baklava desert and tree) and its including many more solutions and the topics' being related to each other may have made understanding easier. Since that the presentation had visuals and real-life examples in it enabled students to discuss the problem perceptibly, students might have understood it.

Table 5. Distribution of the Replies to the Question, "Do You Think the Story Sets an Example for the Applications of Mathematics in Daily Life?" for Advantageous Regional School

		Yes		No	
		f	%	f	%
Do you think the story sets an example for the applications of mathematics in daily life?	Advantageous Regional School	12	92.30	1	7.69

As seen in Table 5, 92.30% of the students replied the question of "Do you think the story sets an example for the applications of mathematics in daily life?" as "Yes" and 7.69% of them answered it as "No". The character was a student like themselves, students were thought to have correlated everday life with this mathematical story.

Table 6. Distribution of the Replies to the Question, "Do You Think the Story Sets an Example for the Applications of Mathematics in Daily Life?" for Disadvantageous Regional School

		Yes		No	
		f	%	f	%
Do you think the story sets an example for the applications of mathematics in daily life?	Disadvantageous Regional School	28	96.55	1	3.44

As seen in Table 6, 96.55% of the students replied the question of "Do you think the story sets an example for the applications of mathematics in daily life?" as "Yes" and 3.44% of them answered it as "No". The examples of baklava and tree were used in the story.

Table 7. Distribution of the Replies to the Question, "Which Mathematical Subjects You Had Learned Were There in This Story?" for Advantageous Regional School

		Fractal and Exponential numbers		Fractal and Pattern		Fractal	
		f	%	f	%	f	%
Which mathematical subjects you had learned were there in this story?	Advantegous Regional School	10	76.92	1	7.69	2	15.38

As seen in Table 7, 76.92% of students replied to the question of "Which mathematical subjects you had learned were there in this story?" as "fractal and exponential numbers"; 7.69% of them answered as "fractal and pattern" and, 15.38% of them said "fractal". Since the story title is "my fractal tree", students' finding that one of the subjects is fractal may be easier. We believe that the students found the topic easily because they had already finished the subject of exponential numbers and then they saw them in the story. Several students' thinking that fractal and pattern were different from each other shows that they have a concept confusion.

Table 8. Distribution of the Replies to the Question, "Which Mathematical Subjects You Had Learned Were There in This Story?" for Disadvantageous Regional School

		Fractal and Exponential numbers		Fractal and Pattern		Expo-nential numbers		Other	
		f	%	f	%	f	%	f	%
Which mathematical subjects you had learned were there in this story?	Disadvantegous Regional School	23	79.31	2	6.89	2	6.89	1	3.44

As seen in Table 8, 79.31% of students replied to the question of "Which mathematical subjects you had learned were there in this story?" as "fractal and exponential numbers"; 6.89% of them answered as "fractal and pattern" and, 6.89% of them said "exponential number; and 3.44% of them replied as "other". One student said he did not know any subjects mentioned in the story. The student who didn't identify any subjects said that s/he only knew the arts class. S/he might have correlated math with arts because the story character drew a fractal tree.

Table 9. Distribution of the Replies to the Question, "Did You Wonder About the End of the Story?" for Advantageous Regional School

		Yes		Not much		No		Undecided		Other	
		f	%	f	%	f	%	f	%	f	%
Did you wonder about the end of the story?	Advantegous Regional School	6	46.15	3	23.07	3	23.07	0	0	1	7.69

As seen in Table 9, 46.15% of the students replied the question of "Did you wonder about the end of the story?" as "Yes" and 23.07% of them answered it as "Not much". 23.07% of the students didn't wonder about it and 7.69% of them remained other. During the presentation at one of the schools (Advantageous Regional School), it was observed that a few student answered the question before the answer was revealed. This situation may have caused them not to wonder about the end, because they had already known the answer. We believe that those who wondered about the solution were the ones who would be interested in what the character was going to do in the course of the story. Their wondering about the story can contribute the objectives' achieving to the intended aims. The percentage of students who said yes than

those who said no was higher in advantageous regional school, but this percentage is opposite in disadvantageous regional school.

Table 10. Distribution of the Replies to the Question, "Did You Wonder About the End of the Story?" for Disadvantageous Regional School

		Yes		Not much		No		Undecided		Other	
		f	%	f	%	f	%	f	%	f	%
Did you wonder about the end of the story?	Disadvantegous Regional School	11	37.93	2	6.89	15	51.72	1	3.44	0	0

As seen in Table 10, 37.93% of the students replied the question of "Did you wonder about the end of the story?" as "Yes" and 6.89% of them answered it as "Not much". 51.72% of the students didn't wonder about it and 3.44% of them remained undecided.

From the students who were studying in the disadvantageous region school, the number of students who liked and did not like the story was very close. During the practice applied in the disadvantageous region school, the students seemed to be more active. Since the students were more active to find the number of branches on the trees in the mathematical story presented by the researcher and some students had difficulty in finding the result, they were thought to have answered this question as "I did not wonder about it.".

Table 11. Distribution of the Replies to the Question, "Do You Prefer the Story to Have a Solution?" for Advantageous Regional School

		Yes, I do.		Not, I don't.		Either.		Not applicable	
		f	%	f	%	f	%	f	%
Did you prefer the story to have a solution?	Advantegous Regional School	4	30.76	9	69.23	0	0	0	0

As seen in Table 11, 30.76% of the students replied the question of "Do you prefer the story to have a solution?" as "Yes" and 69.23% of them answered it as "No".

During the practice, students were given some time to respond to the question asked at the end of the story, but its answer was given in the visual presentation afterwards. There have been some students who thought that the

story character's finding the solution limited them to find the solution and the given time was not enough. This situation might have made the student who wanted to participate the math lesson actively feel himself passive.

Table 12. Distribution of the Replies to the Question, "Do You Prefer the Story to Have a Solution?" for Disadvantageous Regional School

		Yes, I do.		Not, I don't.		Either.		Not applicable	
		f	%	f	%	f	%	f	%
Did you prefer the story to have a solution?	Disadvantageous Regional School	9	31.03	16	55.17	2	6.89	2	6.89

As seen in Table 12, 31.03% of the students replied the question of "Do you prefer the story to have a solution?" as "Yes" and 55.17% of them answered it as "No". 6.89% of the students preferred to answer in two ways. The students complained about the insufficient time given to answer to the problem. This might be the reason why some students who wanted to be more active did not want the answers to be given during the application. It has been concluded that the students in the disadvantageous region school did not give their attentions to the activity, because they did not respond appropriately to this question asked after the activity and answered it as "Both of them are fine.".

Table 13. Distribution of the Replies to the Question, "Would You Like to See These Types of Stories in Math Class?" for Advantageous Regional School

		Yes		No	
		f	%	f	%
Would you like to see these kinds of stories in your Math class?	Advantegous Regional School	9	69.23	4	30.76

As shown in Table 13, 69.23% of the students who were asked if they would like to see these types of stories in math class said "Yes" and 30.76% of them said "No". The students said that mathematics is understandable, fun and daily in this way. The group who did not want to see the stories in math said that they did not like the stories, because they only found the numbers more attractive. Some students may not have wanted to see the stories, because they take time from the class hours.

Table 14. Distribution of the Replies to the Question, "Would You Like to See These Types of Stories in Math Class?'' for Disadvantageous Regional School

		Yes		No	
		f	%	f	%
Would you like to see these kinds of stories in your Math class?	Disadvantegous Regional School	24	82.75	5	17.24

As shown in Table 14, 82.75% of the students who were asked if they would like to see these types of stories in math class said "Yes" and 17.24% of them said "No". Some students may not have wondered about the story and not have wanted to see this in math class. Those who wanted to be active in problem solving might not have wanted to listen to a story containing such a solution.

Teachers were asked if they found the activity applicable and they were asked about their general opinions for it. The answers of the teachers are given below.

> *We have the students tell about the illustrated expressions in the books, but I have never told a story about a particular topic and have never had the students write about a subject. I believe that students can make a story out of the events they face by a mathematical content. This situation increased their interests in the class. These kinds of different applications usually draw their attentions.* (T1)

> *I explain the problems by creating stories, but they are not about these kinds of mathematical problems. My stories are about daily life problems. I think these kinds of stories would be effective in emphasizing the relationship of mathematics with different courses.* (T2)

> *I do not know that the story would be such effective if the story had only been told by verbally instead of presenting by power point presentation accompanied by visual materials, because children are distressed about focusing while listening and they always want to get supported by visualization. In my opinion, the Story idea is great, but the actual results would have been revealed if the story had only been told by verbally without using any visual materials.* (T3)

T4: "*The idea of creating stories sounds good. It can be used in the classes, and is a good practice, but not every subject in math is suitable for creating a story*.".

> *I liked the Story idea, and it was nice to have been established relationships with different courses. I do not think the finding results in overcrowded classrooms would be applied properly. It takes a lot of time and does not reach its goal completely.* (T5)

T6: "*It was a nice narrative style and attracted the attentions of students. They established a relationship between math and other courses and everyday life. They can be used to review the last topics*.".

T7: "*I found this method to be feasible and liked it. I would like to use it in my classes. If the teachers are supported by the prepared materials for each subject, these kinds of stories would be better*.".

T8: "*I think it is a very good activity for students' being literate of mathematics. It combines math with everyday life. I think this practice should be used more in lower grades*.".

It has been concluded that the interviewed teachers have never used mathematical stories as an activity. However, they were seen to have adopted the idea of mathematical story. They also highlighted the difficulty of applying the stories in crowded classrooms, and indicated that these stories could be an effective teaching tool. It can be said that teachers found the mathematical story used in the application generally applicable.

During the application, the students were observed to have watched the activity carefully and have participated it. The story character's finding a solution for a problem about fractals by combining math and art classes drew students' attentions, since the character was a student like them. According to their answers, they seem to have participated in this kind of activity for the first time and liked it. As it is seen in the conducted application, the opinions of teachers and students and the class observations done during the application, it has been reached a conclusion that the activity can be applicable.

Discussion and Conclusion

In this study, a mathematical story designed on the subject of fractals are applied on the level of 8^{th}. The students were presented a sample story, then they were expected to go the the results. Even though, the students were not very experienced, they solved the problem in the story using their basic math skills. Although the students' own experience is a fiction story, the character in the story has a real problem to be solved and using exponential numbers and fractals has helped him to solve the problem. When the data obtained from the views of the students was analyzed, the results such as, the use of mathematical story in mathematics education affected the students positively, attracted their attentions, increased their interests and motivations towards the math course are in harmony with the results of some studies previously conducted (Myerscough, Ploger, McCarthy, Hopper and Feggers, 1996; Güler, 2007).

Based on the opinions of the teachers participated in the study about the application and the classroom observations, we can come to the conclusion that the application became successful. Cordova and Lepper (1996) also mentioned the importance of mathematical fiction stories for the 4th and 5th graders. In addition to the awareness that is created in students by the application, its motivation enhancing feature, its having appreciated by the students and its having followed with interest by them can be interpreted that the application was successful. We believe that the positive results obtained from the study can provide an effective application sample in math courses for different grade levels. Since we provided students' views in our study and our mathematical story sample was related to the other disciplines, we suggest that this research is a sample application for an effective mathematics education. Compared to the schools in disadvantageous and advantageous regions, according to the findings of the study, it can be said that some of the students in disadvantageous region school did not pay attention to the application. It was not the case in other region school students about giving attention.

The students in disadvantageous region school have been observed that they demanded more time to solve the problem. Both groups seemed to have been more active during the application and have liked it. This situation has shown parallelism with the studies (Fındık and Kavak, 2013) that had the

findings indicating students's desires to be more active in different classroom activities.

With these kinds of applications, students will find the opportunity to analyze the concepts and events which are presented as a story but actually are related to the real life using their own thoughts. The created stories can get a response from the students, so that the learners can be active with this way. Students may be given narrative questions and may be expected to give their answers or the answers can be given at the end of the story. Through awakening students' curiosity, their motivations can be increased.

References

Adams, T.L. and Aslan-Tutak, F. (2006). Serving up sierpinski! *Mathematics Teaching in The Middle School*, *11*(5), 248-251.

Akerlind, G. S. (2005). Variation and commonality in phenomenographic research methods. *Higher Education Research &Development, 24*(4), 321-334.

Akyol, H. and Temur, T. (2006). İlköğretim üçüncü sınıf öğrencilerinin okuma düzeyleri ve sesli okuma hataları. *Ekev Akademi Dergisi,* 29, 259-274.

Altun, M. (2006). Matematik öğretiminde gelişmeler. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi*, *19*(2), 223-238.

Ayvacı, H. Ş. ve Şenel-Çoruhlu, T. (2009). Fiziksel ve kimyasal değişim konularındaki kavram yanılgılarının düzeltilmesinde açıklayıcı hikâye yönteminin etkisi**.** *On dokuz Mayıs Üniversitesi Eğitim Fakültesi Dergisi,* 28, 93-104.

Baki, A. (2006). *Kuramdan uygulamaya matematik eğitimi*. Trabzon: Derya Kitabevi.

Banister, F. ve Ryan, C. (2001). Developing science concepts through story-telling. *School Science Review*, *83*(302), 75-83.

Barker, V. and Millar, R. (1999). Students' reasoning about chemical reacti-

ons: What changes occur during a context-based post-16 chemistry course? *International Journal of Science Education, 21*(6), 645-665.

Barker, V. and Millar, R. (2000). Students' reasoning about basic chemical thermodynamics and chemical bonding: What changes occur during a context-based post-16 chemistry course? *International Journal of Science Education, 22*(11), 1171-1200.

Baş, T. and Akturan, U. (2008). *Nitel araştırma yöntemleri. Nvivo 7.0 ile nitel veri analizi.* Ankara: Seçkin Yayıncılık.

Başer, E. T. (2008). *5E modeline uygun öğretim etkinliklerinin 7. sınıf öğrencilerinin matematik dersindeki akademik başarılarına etkisi*. Unpublished master's thesis, Gazi Üniversitesi.

Baştuğ, M. (2012*). İlköğretim I. kademe öğrencilerinin akıcı okuma becerilerinin çeşitli değişkenler açısından incelenmesi*. Unpublished doctoral dissertation, Gazi Üniversitesi, Ankara.

Bayraktar, E. (1998). *Bilgisayar destekli matematik öğretimi*. Unpublished doctoral dissertation, A.Ü. Sosyal Bilimler Enstitüsü.

Belet, Ş. D. (2011). Eleştirel okuma becerisinin geliştirilmesinde hikâye anlatma yönteminin kullanımı: öğretim deneyi uygulaması. *Bilig, Türk Dünyası Sosyal Bilimler Dergisi***,** 59, 67-96.

Borasi, R., Sheedy, J. R. and Siegel, M. (1990). The power of stories in learning mathematics. *Language Arts*, *67*(2), 174-189.

Casey, B., Erkut, S., Ceder, I. and Mercer-Young, J. (2008). Use of a storytelling context to improve girls' and boys' geometry skills in kindergarden. *Journal of Applied Developmental Psychology*, 29, 29-48.

Cordova, D. I. and Lepper, M. R. (1996). Intrinsic motivation and the process of learning: Beneficial effects of contextualization, personalization, and choice. *Journal of Educational Psychology*, 88, 715-730.

Demircioğlu, H., Demircioğlu, G. and Ayas, A. (2006). Hikayeler ve kimya

öğretimi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,* 30, 110-119.

Durmuş, S. and Karakırık, E. (2006). Virtual manipulatives in mathematics education: A theoretical framework. *The Turkish Online Journal of Educational Technology, 5*(1), 117-123.

Fensham, P. (2001). Science as story: Science education by story. *Asia-Pacific Forum on Science Learning and Teaching,2*(I), 1-5.

Fındık, L. Y. and Kavak, Y. (2013). Türkiye'deki sosyo-ekonomik açıdan dezavantajlı öğrencilerin PISA 2009 başarılarının değerlendirilmesi. *Kuram ve Uygulamada Eğitim Yönetimi [Educational Administration: Theory and Practice], 19*(2), 249-273.

Fraboni, M. and Moller, T. (2008). Fractals in the classroom. *Mathematics Teacher, 102*(3), 197-199.

Goldenberb, E. P. (1991). Seeing beauty in mathematics: Using fractal geometry to build a spirit of mathematical inquiry. In W. Zimmermann, and S. Cunningham, (Eds.), *Visualization in teaching and learning mathematics* (pp. 39-66). Washington, D.C: Mathematical Association of America.

Goral, M. B. and Gnadinger, C. M. (2006). Using storytelling to teach mathematics concepts. *APMC, 11*(1), 4-8.

Güler, E. (2007*). Modüler aritmetik konusunun öğretiminde şifreleme aktivitelerinin matematik başarısına etkisi*. Unpablished master's thesis, Marmara Üniversitesi, Eğitim Bilimleri Enstitüsü.

Hanushek, E. A. and Woessmann, L. (2010). *The economics of international differences in educational achievement* (No. w15949). National Bureau of Economic Research.

Hargreaves, D. H. (1999). The knowledge-creating school. *British journal of educational studies, 47*(2), 122-144.

Hiçcan, B. (2008). *5E öğrenme döngüsü modeline dayalı öğretim etkinlikle-*

rinin ilköğretim 7. sınıf öğrencilerinin matematik dersi birinci dereceden bir bilinmeyenli denklemler konusundaki akademik başarılarına etkisi, Unpablished master's thesis, Gazi Üniversitesi.

Hieber, R. and Hartel, I. (2003). Impacts of SCM order strategies evaluated by simulation-based'Beer Game'approach: the model, concept, and initial experiences. *Production Planning & Control*, *14*(2), 122-134.

Hiebert, E. H. (2003). The role of text in developing fluency: A comparison of two interventions. *Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.*

Karakuş, N. (2012). *Türkçe öğretiminde kaynak metin kullanımı*. Ankara: Pegem Akademi.

Karakuş, F. and Baki, A. (2011). Assessing grade 8 elementary school mathematics curriculum and textbooks within the scope of fractal geometry. *Elementary Education Online, 10*(3), 1081-1092.

Lacour, M. and Tissington, L. D. (2011). The effects of poverty on academic achievement. *Educational Research and Reviews, 6*(7), 522-527.

Lewis, B. A., Long, R. and Mackay, M. (1993). Fostering communication in mathematics using children's literature. *Arithmetic Teacher*, *40*(8), 470-474.

Lornell, R. and Westerberg, J. (1999). Fractals in high school: Exploring a new geometry. *Mathematics Teacher, 92*(3), 260-269.

Lucariello, J. and Nelson, K. (1985). Slot-filler categories as memory organizers for young children. *Developmental psychology*, *21*(2), 272-282.

Millar, R. and Osbome, I. (1998). Beyond *2000: Science education for the future*. London: King's College London.

Millar, R. and Osbome, I. (1998). *Beyond 2000: Science education for the future*.

http://www.kcl.ac.uk/depsta/educationlpublications/be2oo0.pdf

Moyer, P. S. (2001). Are we having fun yet? How teachers use manipulatives to teach mathematics. *Educational Studies in Mathematics,* 47, 175-197.

Moyer, P. S., Bolyard, J. J. and Spikell, M. M. (2002). What are virtual manipulatives? *Teaching Children Mathematics,* 8, 372-377.

Myerscough, D., Ploger, D., McCarthy, L., Hopper, H., and Fegers, V. G. (1996). Cryptography: Cracking Codes. *The Mathematics Teacher*, *89*(9), 743.

Naylor, M. (1999). Exploring fractals in the classroom. *Mathematics Teacher, 92*(4), 360-366.

Schoon, I. and Bartley, M. (2008). The role of human capability and resilience. *The Psychologist*, *21*(1), 24-27.

Skemp, R. (1986). The psychology of mathematics learning. Suffolk: Penguin Books

Şen, F. (2005). *İlköğretim 7. sınıflarda matematik dersi 1. dereceden 1 bilinmeyenli denklemler konusunda aktif öğretim temelli etkinliklerin öğrenci başarısına etkisi.* Unpablished master's thesis, Gazi Üniversitesi.

Thatcher, D. H. (2001). Reading in the math class: Selecting and using picture books for math investigations. *Young Children*, 56, 20-26.

Thomas, D. A. (1989). Investigating Fractal Geometry Using LOGO. *Journal of Computers in Mathematics and Science Teaching. 8*(3), 25-31.

Tural, H. (2005). İlköğretim matematik öğretiminde oyun ve etkinliklerle öğretimin erişiye ve tutuma etkisi. Unpablished master's thesis, Dokuz Eylül Üniversitesi.

Vacc, N. N. (1999). Exploring fractal geometry with children. *school science and mathematics, 99*(2), 77-83.

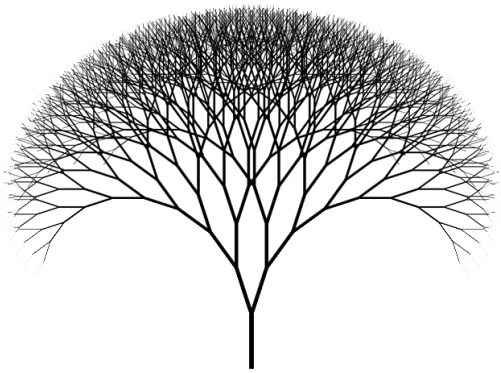
Yıldırım, A. and Şimşek, H. (2008). *Sosyal bilimlerde nitel araştırma yöntemleri*. Ankara: Seçkin Yayıncılık.

Young-Loveridge, J. M. (2004). Effects on early numeracy of a program using number books and games. *Early Childhood Research Quarterly*, 19, 82-98.

Wells, G. (1986). *The meaning makers: Children learning language and using language to learn*. Portsmouth, NH: Heinemann Educational Books, Inc.

Appendix 1

MY FRACTAL TREE



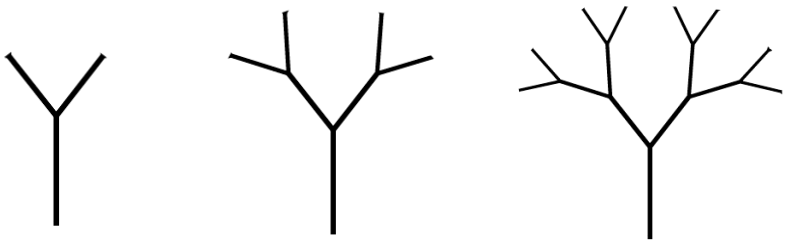
After his math class, Murat Thought that his math class was like an art class because he was more interested in the shapes his teacher showed them the numbers.

For instance, this picture was a tray of baklava dessert for Murat. He thought to himself: “I wish I couldu have it cut like this. Or couldu it actually be cut like this?”.

He was surprised to find something mathematical in the kitchen and he thought it would be fun to discover this side of math.

While he was having these thoughts, break tme was over and the arts teacher came to the classroom. Today, they were going to learn about charcoal drawings.

Murat made a couple of scratches on the paper. However, since his mind was still stuck in fractals, he drew a simple figure on the paper and wondered what was going to come out of it.



He thought its shape was like a small tree and he decided to enlarge it. New branches were coming out of the branches and as they were becoming smaller, they were starting to resemble leaves. After he worked on the drawing for 30 minutes, the charcoal tree was completed and the following figure came out of it.

This tree reminded Murat the tree that he had seen on the roadside.

The arts teacher noticed Murat's drawing and congratulated hm. Excited, Murat told the teacher how he drew it.

However, Murat admitted that there were too many branches at the end of the drawing and they gave him a hard time.

The arts teacher asked Murat: "At the final stage, drawing how many branches gave you a hard time?" and Murat started to think.

Actually, how many branches did he draw at the final stage?

Murat divided each figure into 2 and repeated this operation 9 times.

In that case, the result could only be 2^9

2^9= 2.2.2.2.2.2.2.2.2

=512

In that case, the result could only be 2^9. "at the last stage, drawing 512 branches was a bit hard." he replied. This result became a big deal in Murat's eyes at that moment. The fact that he could draw and that he did not have to count one by one gave Murat a big pleasure.