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ASSOCIATING MATHEMATICAL STORIES THAT ARE WRITTEN BY THE 8TH GRADE STUDENTS WHO ARE STUDYING AT ADVANTAGEOUS AND DISADVANTAGEOUS REGIONS' SCHOOLS WITH THEIR MATHEMATICAL PERCEPTIONS: ISTANBUL CASE

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Abstract:
In this study, mathematical stories written by 50 middle school students were analyzed. The study group consisted of two different student groups who were living in advantageous and disadvantageous regions in Istanbul. At the first stage, the students were presented a mathematical story called “My Fractal Tree”, then told about what the mathematical story was and asked to write a mathematical story about any subjects. 43 of the stories have story characteristics. The stories were separately analyzed under the headings of "involving a mathematical subject", "having mathematical characteristics or not" and "the math topics students used in their stories". The findings about the contents of the stories were analyzed on 4 main themes; "Mathematics’ relations with other subjects", "Perceptions towards mathematics", "Mathematical level" and "Creativity". Students can be seen to have mentioned about the math’s relations with other subjects. Students’ abilities to use mathematical elements correctly are quite low, their learning about concepts is weak and their misconceptions are too high. Generally, a very plain language is seen in the stories in terms of language expression, but transitions between topics seem weak. Considering the creativity element in the students’ writings, advantageous group was seen to have created highly creative stories.

Keywords: mathematical stories; 8th grade; mathematical advantageous and disadvantageous regions' student groups; mathematical level

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1. Introduction

Many educators and researchers have recently put emphasis on the willingness of students to learn instead of the structure of information. Therefore, learning environments should be organized by factoring in the willingness of students to learn. In order to provide for an effective learning process, it is necessary to provide a context that will help students develop mathematical skills and competence and provide sufficient physical space and suitable material to make it easier for students to learn mathematics as suggested in the learning environment standards mentioned in NCTM. The easiest way to keep students willing is to relate relevant topics to daily life. The purpose of narratives, which become increasingly popular in education, is to relate to daily life, help students develop a better approach to and admiration for sciences through the presentation of scientific concepts in daily situations and raise scientifically literate individuals. Such approach provides students with an opportunity to make their learnings meaningful and to participate actively in helping them improve their information of scientific concepts. Such teaching materials also contribute in students to assume more responsibilities in their own learning process.

According to the Constructivist Learning Theory, learning takes place when an individual constructs information in his own mind as a result of direct interaction with his environment (Baker & Piburn, 1997; Brooks & Brooks, 1999). It is emphasized that existing information of each student is very important to attribute a meaning to new information or simulations since each student constructs his information and concepts on his own through his skills and experience (Duffy & Jonassen, 1991; Wittrock, 1974). Furthermore, many educators and researchers have recently laid a lot emphasis on motivating students to help them become responsible for their own learnings and making them more willing to learn. Therefore, learning environments should be organized by factoring in not only the previous information of students but also their willingness to learn. All children have an innate willingness to learn and need to be supported specifically by high-quality educational environments and experiences. Mathematics learning is based on the curiosity and enthusiasm of children and developed through natural experiences. If children are given the chance to learn mathematics in an ideal way during this period, they will be more ready for school or provided with the opportunity to make a smoother transition to primary education (NCTM, 2000).

According to Kitt & Leitze (1992), students not only perceive mathematics as a difficult but also as a boring course. Other studies also suggest that students consider mathematics as a difficult discipline to understand since it involves very abstract ideas

(Kee & McGovan, 1998; Reid, 2000). However, mathematics is an entertaining area that helps students understand the world they live in aside from being a course necessary to be taught in schools to prepare students for their careers. Nevertheless, when concepts learned do not go beyond theory, they exist as an abstract expression that must be memorized for exams. Therefore, there is a need for different teaching materials that will make learning meaningful for students and address the concepts studied along with what they stand for in daily life. Even though many different methods are used in mathematics teaching, the most common method is still the conventional plain lecturing method. Most students try to learn mathematics by heart even though it is necessary for life, and most teachers' direct students towards memorization through the teaching methods they use. Teachers should teach mathematics by allowing students to maximize their levels of understanding and not forgetting mathematical concepts. The contemporary understanding of education presents teachers with the obligation and responsibility to choose and implement the teaching methods that will ensure a maximum level of learning (Yilmaz, 2001).

According to Bahadir & Ozdemir (2013), it is necessary to save children from the limits of thinking within strict patterns and take them to a multi-optional world where processes like imagination, intuition and emotion exist in a tangled pattern. According to Yenilmez & Bozkurt (2006), it is necessary to ensure that students develop a positive approach towards mathematics first in order to help them be more successful at this course. Educational processes must be organized to change the negative approach of students towards mathematics and facilitate understanding the subject. Principles and Standards for School Mathematics (NCTM, 2000) suggest that mathematics, which is identified with abstract concepts, must be rendered more understandable through the use of physical materials and concentration models, and then, abstract concepts may be taken to the level of abstract ideas.

Zemelman, Daniels & Hyde (1998) recommend that students discuss, read, listen and write about difficult mathematics topics in order to understand them. Some educators claim that Mathematics teaching is a social process. Communication plays an important role in this process. Pirie (1998) categorizes ways of communication in mathematics teaching under six groups. These are ordinary language, mathematical verbal language, symbolic language, visual representations, unspoken but shared assumptions, and quasi-mathematical language. Mathematical language constitutes a dimension of such communication. Syllabuses and in-class activities started to be reviewed after it was realized that communication played an important role in mathematics teaching. In this context, the commission founded in the United States by

the National Council of Teachers of Mathematics (NCTM) to lay down the standards of school mathematics defined communication and 'language in mathematics teaching' as a standard in 1986 and presented its final version in the report published in 1989. This report states that one of the purposes of mathematics teaching is to ensure that the student learns how to speak mathematically. To that end, it is expected from a student to use the mathematical language, namely his mathematical vocabulary.

The activities carried out to enrich the classroom environment have an important place in using language in mathematics teaching. These activities include reading-writing activity and problem creation (Bali & Alvarez, 2003). It is not common for mathematics teachers to conduct writing activities and give writing assignments in mathematics teaching. Thus, students may not quite relate writing to mathematics. In a research conducted in this area by Liedtke & Sales (2001) on 11 females and 20 males' 7th-grade students in American schools, the students were asked about their opinions on writing in mathematics courses, and it was observed that students at first could not relate writing to mathematics at all. Students were later observed to have changed their opinions after certain writing techniques and assignments.

What will ensure improvement in the language of mathematic teaching is reading mathematics books and giving mathematical reading assignments. Orton & Frobisher (1996) put forth in their research on frequency and readability of mathematics books, that the frequency and readability of mathematics books was low. Use of mathematical language plays an important role in mathematics teaching whereas creation of word problems has an important role in improving the mathematical vocabulary and organizing and presenting the mathematical idea. Orton & Frobisher (1996) indicate that the purpose of using word problems in a mathematics course is to define a daily life situation as an area of implementation and turn it into a mathematical problem. Thus, it is purported that mathematics is not only a course lectured at school but also a study that can be related to real life. It is important to encourage students to use mathematical stories in class and write mathematical stories in order to improve mathematical communication in students. It is one of the most effective methods to make topics more entertaining and more relating to life. Stories are extremely important tools that try to give meaning to information and comprise of related and consistent information (Millar & Osborne, 1998). Mathematics stories have a setting that is integrated with mathematical terms, characters, a scenario and a plot (Borasi, Sheedy & Siegel, 1990).

Storytelling method improves verbal language use of children, provides fun learning experiences for students, enhances the use of words and realizes their social

and emotional development through social experiences (Belet, 2011). Storytelling helps children imagine, feel and learn more meaningfully (Goral & Gnadinger, 2006). Children create mental images while listening to a story and make some personal connections because young children are in the age of imagination, and because of this, our teaching must be delivered to them through images (Steiner, 1997). Kurtz & Ketcham (1994) believe that "*stories are the vehicle that moves metaphor and image into experience*". Stories are extremely important tools that try to give meaning to information and comprise of related and consistent information (Millar & Osborne, 1998).

2. Using a Story Context to Teach Mathematics

According to many cognitive scientists, stories contain a great deal of natural pieces of information that have their well-organized versions in the cognitive systems. Thus, information can be learned more meaningfully and permanently through a story context (Bruner, 1987).

Therefore, it can be said that stories as teaching materials have a rather strong effect on remembering information and improving concentration (Bower & Clark, 1969; Graesser al., 1980). In narrative writing, the aim is to allow a student to tell his/her experience based on true events or make him/her create a story based on imaginary events. According to Bereiter-Scardamalia (1982), inexperienced writers only describe information in their writings or tell a simple story. There is no need to plan or set a goal in such writings. Starting from these powerful characteristics of the stories, mathematical stories in which we can review so many components together related to students are important tools in terms of our comprehending the students' mathematical understandings.

A mathematics story should not be confused with a mathematics problem. The goal is not to ask a question to students but to present the solution to the problem in an interesting manner based on the plotline. Narrative texts are the texts that are read during reading-understanding studies and for many purposes such as satisfying the curiosity of students and enabling learning while having fun. The literature indicates such texts are easier to read and understand when compared to informative texts and readers are more successful at reading and understanding such texts (Akyol & Temur, 2006; Bastug 2012; Hiebert, 2003).

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 & Mackay, 1993; Thatcher, 2001). This phenomenon occurs for children as well: a narrative context helps them learn and remember information better (Lucariello & Nelson, 1985). Cordova & Lepper (1996) found that for fourth and fifth graders, a fantasy story context substantially improved performance on a math test. Recent researches on stories have been conducted empirically in order to understand the role of stories in mathematics teaching. For example, (Jennings, Jennings, Richey, & Dixon-Krauss, 1992; Young-Loveridge, 2004) detected a very high mathematical progress in their research on the mathematical literacy of low-income groups through teachings conducted with the aid of mathematical stories.

In his research on students with high socioeconomic statuses, Hong (1996) detected positive effects on their mathematical literacy motivations and did not detect any nonstandard increase in their mathematical scores. There are studies suggesting that ethnic culture, socioeconomic status, and racial structure are effective in mathematical achievements of students. Albert (2000) detected that students from African American and Hispanic cultures were disadvantageous at mathematical learning through verbal lecturing. Furthermore, Haynes & Gebreyesus (1992) concluded that music-based activities and cooperative learning are far more effective in the learning of African American children.

3. Fractals and Fractal Teaching

Fractals in teaching program, which also appear in pattern decorations, are important structures to understand the mathematics structure and examine the patterns and their relations (Hargreaves, 1999). Fractals may be expressed as repeated patterns that are always self-similar or sometimes randomly different in some parts. A fractal has a structure that is different from the patterns consisting of usual Euclidian figures. It can be said that fractals generally have four basic features, which are complexity, iteration, self-similarity and fractal dimension. Complexity is mostly a feature of natural fractals. Natural fractal shapes are irregular, indented and complex in structure (Lornell & Westerberg, 1999).

Fractal objects are formed as a result of iteration rules instead of algebraic formulae, unlike Euclidian objects. Iteration is defined as a continuous repetition process where the result in one step is the beginning in another (Kelley & Allison, 1999; Korvin, 1992). Each result derived from the iteration process presents a beginning for the next iteration process. Even though it is clear how the steps of fractals are iterated,

the structure becomes complex; therefore, the mathematical expression of fractals should be noted (Lee, 1999). In its report in 1989, NCTM recommends students work with non-Euclidian geometries in order to get to know and identify the universe better. Furthermore, the supplemental reports published by NCTM between the years 1991 and 1993 emphasize a series of new mathematics topics, which will increase the interests and needs of students from all levels in mathematics, help them feel positive about mathematics, relate mathematics to the nature and allow use of technology in such relationship, aside from traditional mathematics topics. One of the topics recommended is fractal geometry.

Considering the studies in literature conducted regarding the teaching of fractals, it is seen that these studies are mostly intended to improve the activities to be utilized during fractal teachings. For example, in his study, Thomas (1989) uses Logo program to form fractal shapes and discusses activities regarding two basic properties of fractals, which are self-similarity and fractal dimension. Similarly, Adams & Aslan-Tutak (2006) form the Sierpinski's triangle in the worksheets they have prepared for 5th to 7th-grade students and define the patterns within the triangle.

Naylor (1999) gives activity examples to create fractal structures, examine their self-similarity and iteration properties and calculate the circumference and area of fractals. Fraboni & Moller (2008) shortly define fractals in their study and explain their properties that differ from Euclidian geometry. Lornell & Westerberg (1999) introduce the activities that they use in 9th and 12th-grade courses and have developed regarding the teaching of complexity, repetition, and self-similarity, which are basic properties of fractals. In addition, they include an activity to calculate the circumference and area of the Sierpinski's triangle.

In some studies, conducted on fractals, it was found out that students did not see mathematics as a whole (Simmt & Brent, 1998; Lornell & Westerberg, 1999; Karakus, 2007; Fraboni & Moller, 2008). As understood from the aforementioned studies, fractals can be said to have helped the students to grab a holistic approach.

4. Overview and Goals of the Study

This study is intended to create the classroom environment at the Learning environment standards defined by NCTM (2000) and ensure the 5 standards (information of mathematical problem solving, information of reasoning and proof, information of mathematical communication, information of mathematical connections and information of Mathematical Representation) sought for the principles and

standards for school mathematics as defined by NCTM (2012). In order to reach these standards in the study, an activity that includes a mathematical story is prepared and then secondary school students are asked to create a mathematical story. With this way, mathematical story creating skills of students are analyzed.

This process is intended to build a relation between mathematics and daily life by benefiting from the power of stories by means of making students feel that they can create a mathematical story as well through the creation of an effective learning environment. In addition, the study aims to help students make an interpretation of the mathematics concept of the mathematical stories they write in their minds, learn the skills to clearly and consistently convey their mathematical thoughts to their friends, teachers and others and get an idea about the ability to interpret physical, social and mathematical phenomena together.

In the study, the mathematical story narrated to the students is about fractals. Fractal geometry has been commonly used in many different areas such as art, astronomy, biology, chemistry, physics, computer, economics, engineering, geology and genetics; and the increasing use of fractals in many areas makes it necessary to learn and teach within the frame of mathematics education in school. Besides, it is believed that this study will contribute to the literature in terms of teaching fractals through storytelling technique, which is not so common in mathematics teaching, and analyzing story creation skills of students.

In this study, which will assess the practicality of “My Fractal Tree” story when teaching the fractals topic and examine the mathematical stories created by students, answers will be sought for the following sub-problems:

1. Is the mathematical story called “My Fractal Tree”, prepared for fractals topic, an effective activity that can be used to explain the topic to middle school students?
2. Could middle school students write a mathematical story?
3. What are the characteristics of the mathematical stories created by middle school students?
4. Do the stories exhibit different characteristics when the stories created by the students in advantageous and disadvantageous regions are compared? Were there any differences when these characteristics were categorized?

In the student stories, their levels of "ability of writing a story included a math subject", "whether the written text has a characteristics of a mathematical story" and "the math topics which students choose to use in their stories", "Mathematics’ relationship with other courses", "perceptions towards Mathematics", "Mathematical level" and "Creativity" have been analyzed.

5. Method

The research was conducted during the fall semester of the Academic Year 2015-2016. A qualitative method was used in the research. This study has been modeled as an action research since it is an interventional qualitative study. A case may be a program, an event, an activity or a group of individuals limited to a certain period of time and space (McMillian & Schumacher, 2001). Observational data collection techniques and written sources were used during the research. In the research, data collection tools were used and constant comparison method was adopted to analyze and interpret the data collected.

5.1 Participants

The research was conducted in two different schools comprising students from Advantageous and Disadvantageous groups in Istanbul city in the Academic year 2015-2016. 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 (Hanushek, 2010; Hanushek & Woessmann, 2010; Lacour & Tissington, 2011; Maughan, 1988; OECD, 2011; UNESCO, 2006). Considering the fact that mathematical story writing 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, encouraged to think creatively and promoted socially, on the other hand, students living in disadvantageous regions are known to reach these opportunities very limitedly. Conducting the study in both advantageous and disadvantageous regions has been seen to be important in this study in terms of students' verbal expression and creativity skills.

The purposeful sampling method was used to determine the participants of the research. The students in the advantageous group were selected among the students residing in a region that was populated by high-income parents whose social statuses were above average in Turkey. A private school located in Etiler region was selected as the advantageous region. The students in the disadvantageous group were selected among the students residing in a region that was populated by low-income parents whose social statuses were at or below average in Turkey. A public school located in

Esenler region was preferred as the disadvantageous region. Since fractals are included in the curriculum of 8th grade, the activity was conducted in the 7th grades of both schools. The research was carried out in an 8th-grade class comprising of 30 students in the advantageous region school and an 8th-grade class comprising of 29 students in the disadvantageous region school. The study is conducted with 59 students in total.

5.2 Analysis of the Data

Categorical context analysis was used in the analysis of the research data. The key objective of this analysis is to attain concepts and connections that can explain the data collected. In general, categorical analysis as a sub-category of context analysis involves division of a certain message in units first and then grouping of these units into categories according to predefined measures.

The data gathered was evaluated by two independent specialists in order to ensure the reliability of the research. The effect of the agreements and disagreements between the researchers and specialists on the reliability of the research was analyzed using the formula of Miles & Huberman (1994), [Agreement/(Agreement+Disagreement) x100]. As a result of the analysis, the agreement (reliability) between the decisions of the researcher and the two specialists was found out to be %91 and %87, respectively.

5.2.1 Analysis and Interpretation of the Data

The stories created by the students were collected and used as part of a set of data. Descriptive analysis was used to analyze the research data. The order of the steps carried out in the analysis of the data is as follows;

A. Inventory of data: The data gathered from each story created by the students were inventoried in the data inventory forms, each line in the form was enumerated and the interpretation of the researcher was written down in relevant sections. At the end of this process, all inventories were submitted to a specialist to ensure the validity of the inventoried data. Creating coding keys and coding data: This step of the analysis involved reading and organizing all the data collected and gathering them logically. Thus, it was defined under which themes the research data would be gathered. The data derived from the stories written by the students in the research was separately coded by the researcher and a field specialist and an agreement was reached on the themes created. Comparison of coding and reliability: Following the coding process independently performed by the researcher and the specialist of the field, the researcher and the field specialist met and compared their analyses and defined the points of

agreement and disagreement. The analysis of the data was conducted by the researcher and two field specialists, after which the data was submitted to other researchers for control.

B. Definition and interpretation of the findings

This was the step where all the data were analyzed and determined based on the research questions and the findings were transferred, explained and made meaningful. The findings of the research were directly offered through references and interpreted by relating them to different research findings. The study was conducted with 59 students, and 52 of them were able to create a text. 43 out of 52 texts have been identified to have had story characteristics by the researchers.

The general findings of the data analyzed from the story texts were determined under these headings separately: "to be able to write a story including mathematical subject", "whether the written text has a mathematical story characteristics" and "mathematical subjects that students used in the story texts". In addition, the findings based on the text contents were analyzed under 4 main themes: "Mathematics' relationship with the other subjects", "Perceptions towards Mathematics", "Mathematical level" and "Creativity".

5.2 Activity

The activity was implemented in three stages. At the first stage of the activity, students were handed out various fractal examples and asked to examine them. Students were told about the fractal concept. At the second stage of the activity, the story "my fractal tree" was narrated with the aid of a presentation supported with the visual materials prepared. At the end of the story, students were expected to arrive at a conclusion about exponential numbers on their own. At the last stage of the activity, the students were asked to write a mathematical story. The stories of the volunteering students were shared in the class.

During the first stage of the activity, students were also asked what they understood from the fractal concept and the ideas of the students were written on the blackboard. These ideas were kept on the blackboard until the end of the activity. Since the students were instructed on the fractals topic during the semester, a majority of them answered this question. Some of the answers given by the students included "*they are decoration art, geometric shapes, interwoven shapes, symmetry, mosque ornaments, and laceworks are fractals…*" Some examples prepared from fractals were shown to students and they were given examples of fractals found in nature. Students were given a worksheet containing simple fractals in order to help them remember fractals. By going

over the fractal samples handed out, it was emphasized that fractals actually had a regular structure.

"My fractal tree" story was enriched with a visual presentation and narrated to students (Appendix-1). The story used in the study is as follows: Murat, the character of the story, draws a fractal tree and wonders how many branches he has drawn on the last order he has drawn. Murat divides each figure into 2 repeatedly in order to draw a tree; he comes to the last order having repeated this operation regularly for 9 times. At this stage of the story, the students are asked how many branches there are. Some students mention how difficult it would be to count the branches while others easily solve the problem by multiplying 9 by 2. In the rest of the story, our character solves the problem using exponential numbers. After the story was completed, the ideas of the students about the fractals written on the blackboard at the beginning of the course were reexamined.

In the study conducted, students solved the problem given in the story using basic mathematics skills even though they were not very experienced in it. Even though what the students experienced was a fictional story, the character of the story had a real problem to solve and use of exponential numbers helped the solution of the problem. At the last stage of the activity, the students were asked if they liked the mathematical story. Most of the students indicated that they liked the story. The students were asked to write a story about any mathematics topic

6. Findings

The data obtained from the written stories by the students were analyzed, and the results obtained from the study were analyzed in two separate titles. Firstly, the general findings on the data analyzed from the stories were analyzed separately under these headings: "to be able to write a story including mathematical subject", "whether the written text has a mathematical story characteristics" and "mathematical subjects that students used in the story texts". Secondly, in addition, the findings based on the text contents were analyzed under 4 main themes: "Mathematics' relationship with the other subjects", "Perceptions towards Mathematics", "Mathematical level" and "Creativity".

6.1 General Findings Related to the Data Analyzed from the Story Texts.

First of all, students were asked if they wrote any stories about any subjects. Distribution of the given answers for these questions is seen in Table 1.

Table 1: Distribution of the answers to the question of *"Have you ever written a story about any subjects?"*

		Have written a story		**Have never written a story**	
		(f)	(%)	(f)	(%)
"Have you ever written a story about any subjects?	Advantageous	3	10	27	90
	Disadvantageous	0	0	29	100
Total		3	5,08	56	94,92

It has been reached the conclusion that only 3 out of 59 students have written a story before.

Then, the students were asked the question of "*Can you create a story including a math subject?".* Distribution of the answers for this question is seen in Table 2.

Table 2: Distribution of the answers to the question of *"Can you create a story covering a math subject?''*

		Can write a story		**Cannot write a story**	
		(f)	(%)	(f)	(%)
Can you create a story covering a math subject?	Advantageous	23	76,66	7	23,33
	Disadvantageous	29	100	0	0
Total		52	88,13	7	11,86

As seen in Table 2, 7 students have indicated that they could not create a story, while 57 of them have indicated that they could create a story.

The students who said that they could not create a story have been in the advantageous group. According to the given answers and observations; many of the students who could not create a story could understand the subject, enjoy listening to the stories, but did not want to write a story. However, many of them stated that they wanted to write a story but would not be successful writing it. In the disadvantageous group, there was no student could not create a story. In the texts which were written by the students who indicated that they could write a story, the texts had the story

characteristics and the texts did not have the story characteristics were classified according to the advantageous and disadvantageous regions and presented in Table 2.

Table 3: Percentage and number of students according to the written text had a story characteristics or not

	Advantageous		**Disadvantageous**		**Total**	
	(f)	(%)	(f)	(%)	(f)	(%)
The written text had the characteristics of a story	17	73,91	26	89,65	43	82,69
The written text did not have the characteristics of a story	6	26,08	3	10,34	9	17,30

As seen in Table 3, written texts were evaluated in terms of whether they are mathematical story or not. 43 written texts by the students showed mathematical story characteristics, 9 of them showed no mathematical story characteristics. The texts had no mathematical story characteristics were found to have different states. Some of the students included Word problems in their stories (31-9-34). They have described those word problems as a story. Besides, it has not been seen a specific story line in the texts including simple operations and arithmetic calculations (24-36). The texts that were referred to a particular topic, but were not a mathematical story and only had simple narration and samplings were taken into the mathematical story category (5-42-44-50).

The number of advantageous group students whose stories did not have the characteristics of a story (%26,08) is seen more than the ones (%10,34) in the disadvantageous group. In the written story texts, it was observed that there was a piling up in certain subjects. Data related to the topics covered in the text of the stories written by the students were classified according to the advantageous and disadvantageous regions and presented in Table 3.

Table 4: Mathematical Subjects that the Students used in their stories

	Disadvantageous (f)	Advantageous (f)	f	%
Square root expression	7	3	10	20,83
Square root expression and integer	0	1	1	2,08
Fraction	4	3	6	12,5
Histogram	2	0	2	4,16
Fractal	3	0	3	6,25
Ratio	2	0	1	2,08
Number sets	0	1	1	2,08
Natural Number	3	1	4	8,33
Integer	0	2	2	4,16
Algebraic expression	1	1	2	4,16
Equations	1	1	1	2,08
Exponential expression	3	4	7	14,58
Non-story content texts	3	6	8	16,66
TOTAL	25	23	48	100

As seen in Table 4, mathematical topics that were focused on the written texts have shown a piling up in certain subjects. 10 students have seen to be interested in the square root expressions, 7 of them have been interested in exponential expressions and 6 of them have preferred fractions.

6.2 The Findings Related to the Contents of the Stories

The findings analyzed from the story texts of the students were examined under 4 main themes. A total of 9 texts have not been categorized since they did not have a story characteristics. The themes have been created from 43 texts.

Students' stories have been shown by the initials of their groups and the numbers, such as; D-19 (disadvantageous group-19 numbered story), A-34 (Advantageous group- 34 numbered story). In addition, the first 29 rows represent disadvantageous group numbers and 30 through 52 represent the advantageous group numbers. Themes and codes related to mathematics' relations with other courses were revealed on the basis of the analysis of the students' stories and presented in Table 5.

Table 5: The Findings related to Mathematics' relations with other courses

Theme	**Codes**	**Story Numbers**	**f**
Math's relations with other courses	With Arts course	D-16	1
	With Music course	D-21	1
	With Science course	A-48	1

When Table 5 is analyzed, it is seen that students could establish a relationship between mathematics and other disciplines, and could express their thoughts along with the examples from everyday life. Figure 1 and Figure 2 include these story examples.

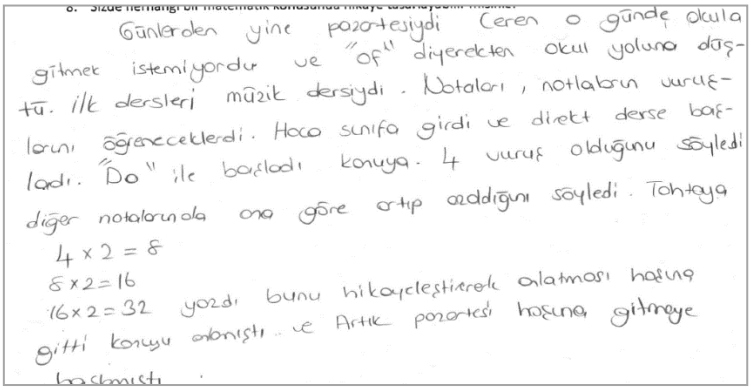

Günlerden yine pazartesiydi Ceren o günde okula gitmek istemiyordu ve "of" diyerekten okul yoluna düştü. ilk dersleri müzik dersiydi. Notaları, notaların vuruşlarını öğreneceklerdi. Hoca sınıfa girdi ve direkt derse başladı. "Do" ile başladı konuya. 4 vuruş olduğunu söyledi diğer notaların da ona göre artıp azaldığını söyledi. Tahtaya
4 x 2 = 8
8 x 2 = 16
16 x 2 = 32 yazdı bunu hikayeleştirerek anlatması hoşuna gitti konuyu anlamıştı. ve Artık pazartesi hoşuna gitmeye başlamıştı.

Figure 1: A story from one of the students

"It was Monday, again. Ceren didn't want to go to school that day, but she set out the school way by puffing. Their first course was Music. They were going to learn about 'Notes' and 'Note Beats'. Their teacher entered the classroom and started directly talking about the topic. She started with the note of "Do" and said that it had 4 beats. She also said that the other notes also increase and decrease depending on it. She wrote 4x2=8 8x2=16 16x2=32 on the white board. Ceren liked her to tell this subject by making a story. She understood the subject. She has begun to like Mondays since then."

In figure 1, the student expressed the connection between the note beats and mathematics in his story.

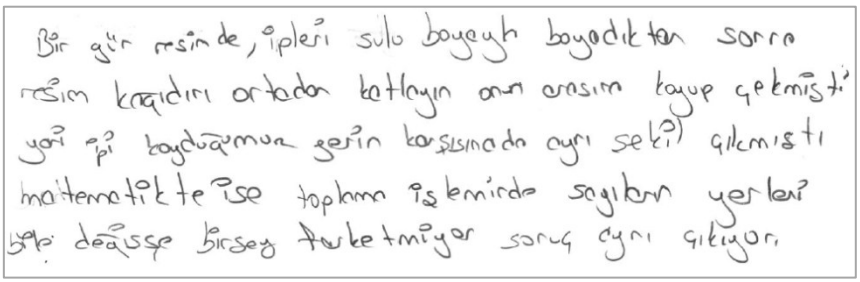

Bir gün resimde, ipleri sulu boyayıp boyadıktan sonra resim kağıdını ortadan katlayın onu arasına koyup çekmiştik yani ipi boyduğumuz yerin karşısında aynı şekil çıkmıştı matematikte ise toplama işleminde sayıların yerleri yer değişse birşey değiştirmiyor sonuç aynı çıkıyor.

Figure 2: A story from one of the students.

"One day, in the art lesson, we painted some strings with watercolor, then folded drawing paper in two and put those strings between papers and pulled them out. There was the same figure on the both sides of the paper. In mathematics, while doing addition operation, changing the places of numbers does not matter and the result is the same."

In figure 2, the student expressed the connection between changing feature of string print and addition in his story. With reference to the texts written by students, the revealed themes and codes related to students' perceptions towards mathematics course are presented in Table 6.

Table 6: The Findings related to Perceptions towards Mathematics

Theme	Codes	Story Numbers	f
Perceptions towards Math	Mathematics is a difficult subject	43-23-39-35-30-4-20-18-41-17-22-11-19-	Advantageous: 5 Disadvantageous: 8 Total: l3
	It is a difficult, unlikable, but necessary subject	10-27-29-46-2-25-48	Advantageous: 2 Disadvantageous: 5 Total: 7
	It is a lovable subject when understood and solved	7-12-14-48-51-38-49-1-8-15-26-40-49-37-13-21-52-32-6	Advantageous: 8 Disadvantageous: 10 Total: 18
	It is a subject in which calculation and arithmetic operations are studied	3-16-28-45-33	Advantageous: 2 Disadvantageous: 3 Total: 5

In table 6, when themes and codes that were revealed about students' perceptions towards mathematics course were analyzed, it has been seen that mathematics was described as a difficult course by them, and the story characters in many of their stories had difficulties in mathematics course. In general, in the stories, story characters were seen to have used such sentences as; "he could not calculate it", "he made this operation wrongly". Also, the ideas of "if studied, it is achievable" and "it is a must course" have been emphasized. In the stories, some characters were seen to have been bored of studying mathematics, but continued studying it. There were not significant statistical differences between disadvantageous and advantageous groups.

With reference to the texts written by students, the findings related to the mathematical level in the stories are presented in Table 7.

Table 7: The Findings related to Mathematical Level in the Stories

Theme	Classification	Story Numbers	f
Mathematical level	Low	10-27-35-30-4-20-18-41-17-22-11-29-46-2-25-19-43-23-39-48	Advantageous: 7 Disadvantageous: 12 Total: 19
	Middle	38-49-1-8-15-26-40-49-37-13-21-52-32-6	Advantageous: 6 Disadvantageous: 7 Total: 13
	High	3-7-12-14-48-51-16-28-45-33	Advantageous: 4 Disadvantageous: 7 Total: 11

Students' stories are assessed by experts, scrutinized in a holistic way, and divided into three mathematical level categories as low, medium and high. While experts categorized the stories, it has been considered if mathematical elements used appropriately, consistent transitions were made between the topics, mathematical operations were calculated correctly -if applicable, and the preferred concepts were used properly. As shown in Table 7, 19 students are in the lower level. It can also be seen that the students' abilities to use mathematical elements correctly is quite low, their learning about concepts is weak and their misconceptions are too high. As well as misconceptions, there are also students who calculated operations inaccurately. The texts in which misconceptions have been detected are 10-27-35-30 and the texts in which incorrect operations have been detected are 4 and 35.

With reference to the texts written by students, the findings related to the creativity levels in the stories are presented in Table 8.

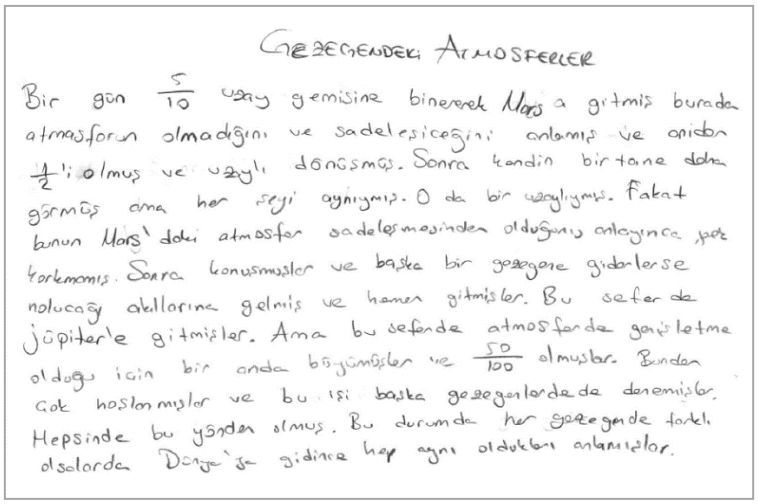
Table 8: The Findings related to Creativity Levels in the Stories

Theme	Classification	Story Numbers	f
Creativity	Low	11-29-46-2-25-10-27-35-30-4	Advantageous: 3 Disadvantageous: 7 Total:10
	Middle	1-8-15-26-13-3-7-21-14-6-28-20-43-23-18-41	Advantageous: 2 Disadvantageous: 12 Total: 15
	High	38-49-12-48-51-16-45-40-37-49-33-17-22-19-39-48-52-32	Advantageous: 13 Disadvantageous: 5 Total: 18

In the stories, originality of the topics and the narrations is taken into account as a creativity. What mathematically notable in the student stories is students' relating mathematics with the examples of daily life nicely in their stories.

In addition to the findings that are identified mathematically, there are some findings available common to both groups in terms of language and expression. In general, a very plain language is seen in terms of language expression, but transitions between topics seem weak. Students often used their own names in their stories. The stories are original and the plots are independent of each other. Story characters have always succeeded. The given problem has been solved despite the obstacles. 13 out of the 18 stories classified as having high creativity were written by students in the advantageous region. The findings showing differences between the two groups are as follows.

In the advantageous region, students wrote stories in fantastic topics. In the stories they wrote, there were events only might have happened in fairy tales and stories often begin with the phrase of 'once upon a time ...'. Numbers were personified and spoken. Some events could be portrayed and a concrete example showing the student's imagination was created by drawings. In the advantageous region, stories had titles and were used to arouse curiosity about the content of the story. (For example; The Secret of Equivalence Mirror, The Numbers that cannot be Grouped, The Wizard of x and y, etc.) In addition, numerical and algebraic expressions were used for entitling the stories in the advantageous regions. The studies using real people were less. There are differences between time and events in the stories written in advantageous and disadvantageous regions. While real events that may relate to real life were chosen in disadvantageous regions, advantageous region students focused on solving problems in imaginary places (War, Interplanetary Journey, etc.). Figure 3 and Figure 4 show the examples of these stories.



GEZEGENDEKİ ATMOSFERLER

Bir gün $\frac{5}{10}$ uzay gemisine binerek Mars'a gitmiş burada atmosferin olmadığını ve sadeleşicceğini anlamış ve onidan $\frac{1}{2}$'i olmuş ve uzaylı dönüşmüş. Sonra kendin bir tane daha görmüş ama her şeyi ayrıymış. O da bir uzaylıymış. Fakat bunun Mars'daki atmosfer sadeleşmesinden olduğunu anlayınca pek korkmamış. Sonra konuşmuşlar ve başka bir gezegene gidarlerse nolucağı akıllarına gelmiş ve hemen gitmişler. Bu sefer de jüpiter'le gitmişler. Ama bu sefende atmosferde gelişletme olduğu için bir anda büyümüşler ve $\frac{50}{100}$ olmuşlar. Bundan çok hoşlanmışlar ve bu işi başka gezegenlerde de denemişler. Hepsinde bu yüzden olmuş. Bu durumda her gezegende farklı olsalarda Dünya'ya gidince hep aynı olduklarını anlamışlar.

Figure 3: A story from one of the students

"Atmosphere in the Planet - One day, '5/10' got on the spaceship and went to Mars. He understood that there was no atmosphere and suddenly simplified and became a '1/2' and converted into an alien. Then he sees his own copy in front of him. He was exactly the same as him. He was an alien, too. When he understood it was from the simplification of the atmosphere in Mars, he was not afraid. They started to talk and wondered about what would happen if they went to another planet. Then they went to Jupiter. However, because there was an enlargement in its atmosphere, they suddenly became bigger and became a '50/100'. They liked this situation and tried it in other planets. Even though they changed in each planet, they realized that they were the same when they went to the Earth."

In figure 3, the student who wrote this story mentioned about the numbers' traveling to space, and the fractions' simplifying and enlarging in his story.

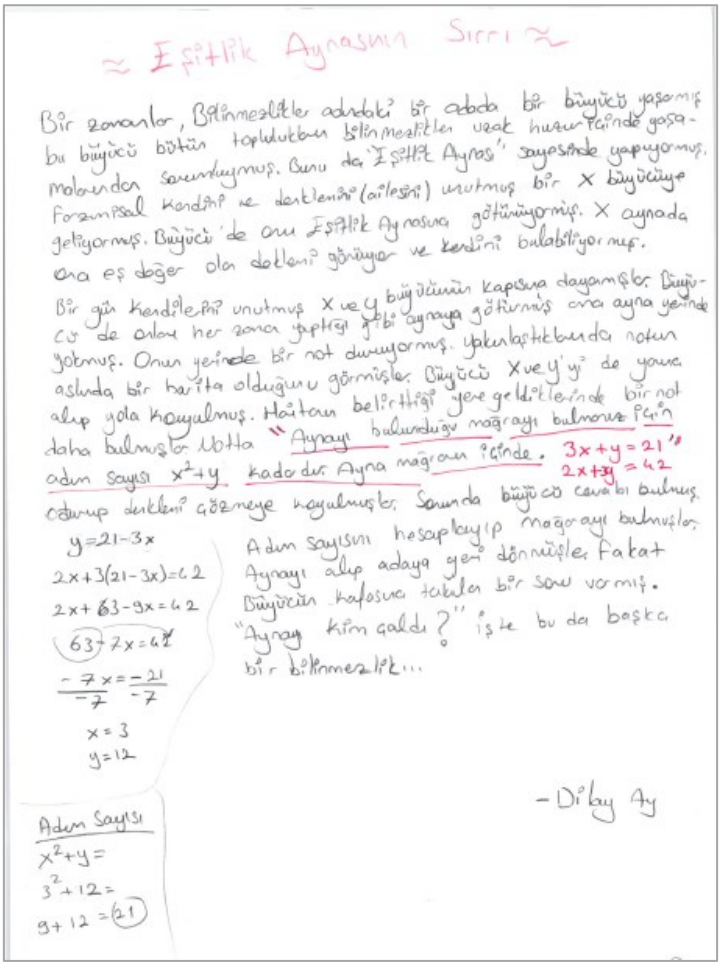


Figure 4: A story from one of the students

"The Secret of Equivalence Mirror - Once upon a time, there was a wizard living on an island called "Obscurities". This wizard was responsible for keeping all communities away from obscurities. He was doing this with an equivalence mirror. For instance; X person who forgot about himself and his equation (his family) to the wizard, and he takes him to the equivalence mirror and X person sees his equinumerous equation in the mirror, then finds himself. One day, forgetting about themselves, X and Y found themselves in front of the wizard's door. As always, Wizard took them to the mirror, but it was not there. There was a small note instead of it. That note was a map, indeed. Wizard, X and Y hit the road. When they arrived at the point which was shown on the map, they found another note saying: "Mirror is inside of the cave. If you want to find it, you should take a x^2+y number of steps.$3x+y=21$ and $2x+3y=42$ They started to solve the equation together and finally the wizard found the answer."

They found it by calculating the number of steps. They took the mirror and went back to their island. But, Wizard was wondering about who stole the mirror. This is another obscurity to solve…

In figure 4, the student who wrote the story mentioned about some fantastical elements such as equivalence mirror and wizard in his story he designed about equations.

7. Discussion

The research has been conducted with the students from two different schools where were located in both advantageous and disadvantageous regions in three stages. At the first stage of the activity, students were handed out various fractal examples and asked to examine them. Students were told about the fractal concept. At the second stage of the activity, the story "my fractal tree" was narrated with the aid of a presentation supported with the visual materials prepared. At the end of the story, students were expected to arrive at a conclusion about exponential numbers on their own. At the last stage of the activity, the students were asked to write a mathematical story. The stories of the volunteering students were shared in the class. The students were asked whether they understood the concept of fractals at the first stage. There were students who defined all ornaments given in textbooks as ornament examples since the answers given by students mentioned fractals on parallel displacement and ornamentation topic (such as lacework, mosque ornaments, etc.).

These findings have shown that the fractals were mixed with ornamentations. The reason of this finding obtained from the study is that the self-similarity characteristics of fractals were implicitly emphasized, and the concept of repeating which is an important factor of fractal was not addressed, and the eternal patterns of fractals were not given in the fractal definition given in the 8.grade mathematics textbooks according to (Karakus & Baki, 2011)'s research. For these reasons, the students had difficulties to make decisions whether an object was fractal or not.

In the second stage, the story of "My fractal tree" was presented to the students. The question for the exponential expression in the story was the final stage of the story and was easily solved by the students. Students' making an operation that is considered a simple operation for an 8th grader eagerly and curiously draw attention. There are studies in which students showed high achievements and attitudes in the situations when mathematical problems were introduced with everyday life. The subjects analyzed in the field studies about this topic are followings: mathematics teaching's being incompatible in schools with the real life, students' inabilities of using knowledge and skills they acquired in the school in real life and solving problems, their acting to go quickly to the results instead of thinking about the problems and creating solution strategies (De Hoyos al., 2002; Fitzpatrick, 1994; Schonfeld, 1985; Selden al, 2000; cited: Nancarrow, 2004; Verschaffel al, 1999;). The section went through the final stage of the study was conducted with the total of 59 students who were in the groups identified as advantageous and disadvantageous groups. However, at the last stage which is also the stage of creating a story, 52 of them were able to create a text. Then, these 52 texts were analyzed by the researchers and only 43 of them were determined to have had a story characteristic. All of 7 students who could not create a story were in the advantageous group.

The reason why those students did not want to participate in the given assignment is that they were set free in non-obligatory tasks throughout the year. It is also noteworthy that 6 out of 9 written texts that did not have a story characteristics were in the advantageous group. The majority of students were able to write at least one story integrated with a mathematical subject, which also included event-situation, place, people and time elements. Thus, the students can be said that they understood the description of a mathematical story. In the texts excluded a mathematical story characteristics, students were seen to have written regular stories that did not contain any mathematical subjects, or to have written the texts describing their attitudes towards mathematics, or to have expressed a word problem as a mathematical story. In the created stories, a plain language can be seen in terms of language and expression in

general, but transitions between topics were weak. The reason of these findings has been thought the fact that the majority of students had never written any stories in mathematics and other subjects. Since this study was conducted with 8th graders, the students knew the most subjects of mathematics. It was observed that some specific topics were mostly chosen in the written story texts. Topic distributions have serious differences in terms of advantageous and disadvantageous groups. In particular, square root numbers and exponential numbers were new subjects for students and introducing them to the students enabled students to create various simulations (For example; a square root expression was thought as a prison and a square number was escaped from there). One of the other mostly chosen issues was the fractions. Fractions are one of the topics that are widely covered in the mathematics curriculum. Because students can often encounter the fractions topic in daily life, its use in stories might have been more than other topics. Although diversity is seen in the topics, geometry subjects seem not to be preferred by the students to write a story. Since geometrical subjects are related to shapes, the students may have had difficulties to make these subjects stories.

Many components could be studied in the student stories. It is seen that students have referred to mathematics' relations with other subjects. Mathematics can be said to have an effective role in the establishment of relations with other disciplines and daily life. There are many studies that mention the importance of this case in a realistic teaching of mathematics and constructive approach (Hein, 2002; Lewis al., 2002; Smith, 2001; Winn, 1997). The students' perceptions of mathematics course were also reached in their writings. The ideas of "Mathematics is often difficult and unlovable, but if studied, it is achievable" and "it is a must course" have seen to have emphasized in the texts. In the stories, some characters were seen to have been bored of studying math but still continued studying it. The perception that mathematics is usually a difficult course is a common perception reached between disadvantageous and advantageous groups. Students' perceptions of mathematics' being a difficult course can also be found in some other sources of research. They suggest that mathematics' being taught in different game activities instead of boring classroom environments can resolve this problem (Kubinova, Novotna & Littler, 1998; Ticha & Kubinov, 1998).

The results obtained on mathematical levels of the students show that the overall level is low. Although the numerical data findings that showed the disadvantageous group was relatively lower than the advantageous group was reached, it has been thought that the data was similar to each other in two groups when the stories were analyzed. This situation suggests that since the number of advantageous group students who did not participate in the activity of writing stories and whose stories

were not accepted as a story was high, the students whose math level was low were thought to have been eliminated at first.

That their levels of being able to use mathematical elements correctly are quite low, their learning of concepts is weak, and their misconceptions are excessive can be also seen. Besides these misconceptions, there are also some students who made operation mistakes. This case shows that students are weak in learning the concepts. This kind of incomplete and inaccurate learning of concepts enables students to misunderstand the topic and to establish a link between other topics. There are also many studies available which emphasized that incomplete learning of mathematical concepts brought along the failure (Baker, 1996; Tall, 1993; Yusof & Rahman, 2001; Zachariades al., 2002; Zaslavsky & Peled, 1996).

In general, students' stories were seen to have a very plain language in terms of language expression, but they were seen to be weak in transitions between the topics. Based on these findings, the importance of mathematical literacy has emerged. Akyuz & Pala (2010), in their study they conducted by using PISA 2003 data belonged to Turkey, Finland, and Greece, found a significant relationship between mathematical literacy and problem-solving, which shows a positive relationship between mathematical literacy and learning mathematics. Furthermore, in order to determine the level of mathematical literacy, Uysal & Yenilmez (2011) conducted a study based on PISA 2003 mathematics questions and evaluations of 8th-grade students and suggested that the majority of students participating in the test were found to have been below the third level. This case reveals that obtaining a sufficient level of information and skills, each individual needs to be literate and strong in mathematics. With the new regulations in 2004, raising students as literates in mathematics in the elementary mathematics curriculum was taken into consideration and necessary arrangements were made in the program (MEB, 2005). However, according to the PISA assessment of EARGED (2007); 76,4% of our students is on the second level or lower in the PISA 2006 mathematical literacy scale. With regard to the results of PISA 2006 report, the average performance of our students was on the second qualification level, while the average performance of OECD countries was on the third level. However, according to the results of PISA 2009 report, in mathematical literacy levels in our country, the percentage of students who are below 2. level, which is considered basic proficiency level by experts, is 42,2%. Moreover, Turkey's average mathematical literacy score is (445) and it is below the OECD average (EARGED, 2010).

Considering the creativity element in the students' writings, the advantageous group was seen to have created highly creative stories. This case can be considered that

those students were more socioeconomically advantageous, because, their creativities were supported and they were offered these kinds of activities from the pre-school period. They were also in a supportive social environment. It has also been thought that students' choosing fantastical topics in their stories came from the effects of computer games they played and movies they watched. In fact, some studies suggest that some of computer and video games affect students in a positive way (Cordova & Lepper, 1996; Ocel, 2002; Schie & Wiegman, 1997).

Such findings of the research are in agreement with the findings of Gaber-Katz in literature that the fact that students read, tell and write stories offer an alternative way to improve the critical and creative reading skill (1991).

It was found out in the research that, storytelling method could be functionally used at some stages of Math teaching process. Also, the prepared activities increased the active participation of students in the course, and students could cooperate as a result of activities which helped them to learn and actively used their prior information. In addition, it also supported students' speaking and writing among language skills. Another conclusion related to the use of storytelling method in Math courses was that students had fun when learning, included many descriptions in their stories and actively used mathematical subjects. The findings of the research supported the views and findings given in literature (Kabadayi, 2005). Storytelling and story writing methods improve verbal language use of children provide entertaining learning experiences for students, increase their use of words and enhance their social and emotional developments through social experiences.

In addition, it could be said that students gained the courage to express themselves, easily adapted to activities and exhibited great willingness to participate in them. Such findings of the research also support the findings that suggest that storytelling method intended for improving reading-writing skills in the early years of primary education ensures willingness of students when participating in such activities (Palmer al., 2001).

8. Recommendations

In order to develop mathematical literacy and to determine students' mathematical perceptions and their preliminary information, mathematical stories can be put in the programs further.

Since fractal geometry is in close correlation with so many traditional mathematical subjects such as; sequence of numbers, symmetry, proportion,

measurement and fractions in primary level; logarithm, composite functions, Pascal's triangle, geometric series and complex numbers in secondary level. It has been known that fractal geometry is in 33 close correlations. Fractal is an important issue in terms of students' being able to see mathematics whose subject exists in nature. There are many studies that were conducted for fractals to have been integrated into existing mathematics curriculum, by the reasons of its helping students to establish a correlation between mathematics and nature, to establish relations between other disciplines, to explore school mathematics with non-analytical ways and to see the latest developments in mathematics (Fraboni & Moller, 2008; Goldenberg, 1991; Lornell & Westerberg, 1999; Vacc, 1999;). A proposal of addressing more to the teaching of fractals can be suggested. Mathematical stories can be involved in the programs for the development of mathematical literacy and the findings of students' mathematical perceptions and preliminary information.

Many studies suggest that fractal geometry is in close relationship with the traditional mathematical subject such as; sequence of numbers, symmetry, proportion, measurement and fractions at primary level, and logarithm, composite functions, Pascal's triangle, arithmetic sequence, geometric sequence and complex numbers in secondary level. This fact helps students to establish relations with math and nature and between mathematics and other disciplines, as well as them to see the latest developments in the field of mathematics and to discover the school mathematics with non-analytical way. Because of these reasons, fractal geometry should be integrated into existing mathematics curriculum (Fraboni and Moller, 2008; Goldenberg, 1991; Lornell & Westerberg, 1999; Vacc, 1999). The proposal of mentioning about teaching of fractals more can be offered.

In the direction of the research results, following suggestions can be made towards the development of mathematical literacy skills of students in mathematics course: some activities and applications can be arranged for students to engage in social activities which are at their final stage of mathematical literacy process.

The researches in which storytelling method is used for students turning critical reading into a habit and observing their usage of strategy in a more detailed way can be conducted in longer terms in order to reveal the effect of teaching experiment application. A study can be fulfilled by using qualitative and quantitative research approaches, as well as using newspaper articles, and television programs along with qualified texts. Integrating mathematics curriculum with mathematical reading and writing skills, some applications can be made towards students' developing these skills.

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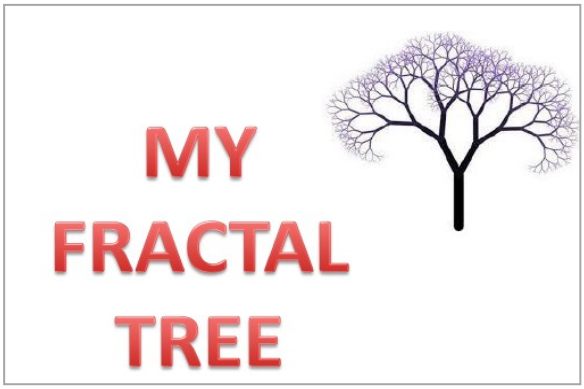
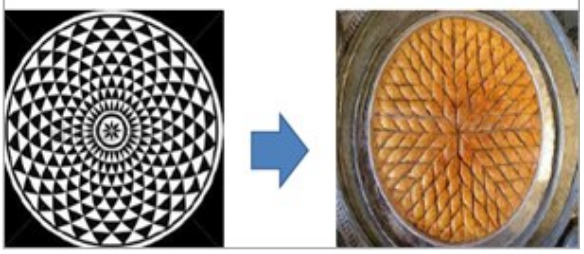
Appendix 1



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 than the numbers.

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



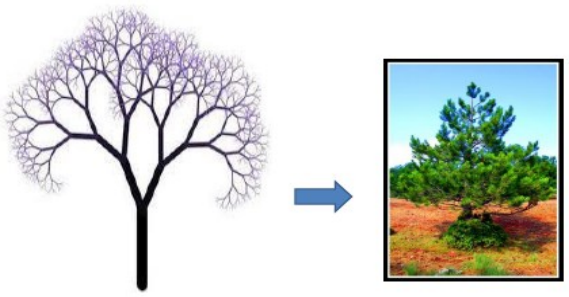
He was surprised to find something mathematical in the kitchen and he thought it would be fun to discover this side of math.

While he was having these thoughts, break time 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 him. 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.