



Suggestions for Sustainable Mathematics Teaching: Storytelling of Elementary School Mathematics Topics

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Abstract

In the age of change, rapid changes occur in the education and teaching process as in every field. The changes have brought new insights and practices to the mathematics teaching process, just like any other lesson. One of these changes is teaching with storytelling method. Learning with this method can be envisaged to warrant a more permanent, fun and sustainable structure. The stories always have a significant place for the educational process of children from past to present due to their vital texture. Recently, using stories in mathematics teaching has been considered as a fairly new understanding since the effective mathematics teaching process and academic success in mathematics are a quest that has been going on for many years. This quest has been the main driving force in the emergence of different applications. In this regard, this study aims to examine how the pre-service classroom teachers can transfer elementary school mathematics topics to students through stories for sustainable academic and life skills. Having a qualitative research design, the study employed a phenomenological design. The pre-service teachers were asked to turn a topic they chose from the elementary school mathematics curriculum into a story in accordance with the grade level. The participants consisted of 94 pre-service teachers studying at classroom teaching department. Based upon the results obtained from the stories, the stories written by the pre-service classroom were noted to cover all learning domains and sub-learning domains. 94 stories were identified to include each of the 229 objectives available in the Elementary School Mathematics Curriculum.

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1. Introduction

1.1. Introduce the problem

The changes occurring especially in the century we live in have led to rapid alterations in the structure of education and teaching activities and made it compulsory to develop a different perspective regarding the education-training process. The curricula are implemented in schools with a view to evaluating the problems faced by individuals in real life in a versatile and creative way, working in harmony and cooperation and using higher order thinking skills. Curricula are considered as a significant tool in teaching the objectives of the mathematics lesson. However, mathematics still stands out as the lesson with the most learning difficulties out of all other lessons (Altun, 2013; Akar, 2014; Brown & Quinn, 2006; Çetin & Doğan, 2018; Mutlu, 2019; Olkun & Toluk, 2014; Schwartz, et al., 2018; Van de Walle, Karp & Bay-Williams, 2014).

The purpose of the mathematics lesson at the elementary school level can be summarized as understanding the mathematical concepts in general terms, using them in daily life and other areas, explaining thoughts in a logical way through using a mathematical language, predicting, using mind-based skills effectively, making inferences related to induction and deduction, expressing mathematical thoughts and reasoning in the problem solving process (MONE, 2018). Besides, mathematics lesson holds various purposes such as developing a positive attitude towards mathematics, instilling self-confidence, developing intellectual curiosity, comprehending the historical development of mathematics and its role in the development of human thought in this regard, conducting research, developing the power of producing and using knowledge, and establishing the relationship of mathematics with art as well as aesthetic feelings. Namely, quite different and high number of purposes have been identified related to mathematics lesson at elementary school level. Different methods and strategies need to be employed to fulfill such a variety of purposes.

Various dimensions of education and training should be addressed in order for students to undergone an effective educational process. One of them is the use of methods and techniques to help students learn permanently by attracting their attention. Özden (2020) reported that one of the leading factors that prevent learning in school is that the textbooks that does not allow different thinking styles and that they contain definitive judgments and put an end. It is recommended that the textbooks contain content that appeals to students' imagination worlds rather than expressive lines limiting the thought and that are appropriate for their age and grade levels. The 21st century education and training programs are expected to guide students on versatile, abstract, critical, creative, independent thinking, problem solving, gaining effective communication skills, producing knowledge, learning to learn, feeling valuable, trusting their capacities and valuing differences.

Different methods, techniques and teaching processes have been attempted for many years to overcome these difficulties in learning mathematics. Therefore, students are required to possess some skills to understand the concepts of mathematics, to transfer these meanings to the concepts associated with them, and to use them for solving the problems they face. In order for students to achieve these objectives, it is a need to create an innovative education ecosystem in accordance with the changing conditions. Thus, the underestimation of a thousand-year-long education-teaching culture is illogical while performing different technology-aided educational practices. Considering the variety of objectives and each student's learning styles, the necessity to engage in new techniques has emerged for the permanence and sustainability of learning.

As a basic understanding, sustainability is an approach including the dimensions of environment, economy and quality of life (Soussan, 1992). In this regard, education is also expected to be sustainable in life and to be open to development. To put a finer point on it, sustainability, in the simplest sense, is defined as the fact that a phenomenon can maintain its existence, while development is the increase in human welfare (Bozlağan, 2002). These concepts are also the most basic elements that should subsist in education. Ada (2020) revealed seven characteristics of the concept of sustainable education. These are: i) being holistic and interdisciplinary, ii) focusing on values, iii) directing critical thinking and problem solving, iv) requiring the use of multiple teaching methods, v) encouraging participatory decision making, vi) emphasizing applicability and vii) localness. Having an innovative understanding and attitude has a significant role for both teachers and students. In addition, the sustainability of their education and high level of thinking skills have become a globally competitive exigence (Howell, Williams & Lindsay, 2003; Ilin, 2019). Teachers, who will raise future generations, are supposed to carry the education and training into the future by creating the necessary conditions for a sustainable education.

1.2. Describe relevant scholarship

As teachers prepare students for the future, one of the sustainable education methods is to teach the objectives through stories. Teaching with stories and fairy tales actually dates back to ancient times (Schiro & Lawson, 2004). One of the most basic and deep-rooted structures of the written literary tradition, story is referred to as a short article type that conveys the events that are true or that are possible to occur.

Nowadays, the method of storytelling has become one of those that can be used in almost all levels of education as it can be regarded as the fun side of the stories (Lemonidis & Kaiafa, 2019; Turgut & Kışla, 2015). Moreover, stories improve individuals' problem-solving skills, imagination and support their creativity. In this sense, various studies indicated that stories positively affect the children's language and social development (Chan, Churchill & Chiu, 2017; Istenic Starčić, and at al., 2016; Jackson,

2018; Robin, 2016; Sawyer & Willis, 2011; Turgut & Kışla, 2015; Türkmen & Ünver, 2012; Wu & Chen, 2020; Xu, Park & Baek, 2011). However, mathematics lesson is generally seen as a lesson that students stay away and experience fear and anxiety (Coşkun, 2013; Çetin & Doğan, 2018; Savaş, Taş & Duru, 2010; Van de Walle, Karp & Bay-Williams, 2014). In the study carried out by Taşdemir (2015), teachers were found to be inadequate to adapt to evolving and changing knowledge; Dağdelen and Menderes (2017) emphasized that teachers had great duties to develop a positive attitude towards mathematics. Accordingly, it is likely to use mathematics teaching through stories, which is a sustainable method, although it is a traditional method to ensure that elementary school students who are fond of stories do not develop negative attitudes towards mathematics and pay great attention to learn the subjects better.

The stories can enter children's rich imagination worlds and offer educational opportunities that they can understand (Sertsöz & Doğan-Temur, 2017). The stories contain narratives that people want to tell each other in a funnier way, but most importantly, they will take lessons from them. Each story has a conclusion and a main idea as a lesson. Therefore, it is a significant method to be used especially in education and training. The basis of the storytelling method is constructed on the principle of inductive learning, by facilitating the children's learning, ensuring that the knowledge is permanent, learning lessons without experiencing something experienced, and the relationship between cause and effect.

This method involves starting the learning process with a story in general and strengthening it with time, space and character connections, and then processing it in a logical order as a whole in a gradual set of topics. Thanks to storytelling, students use their experiences to obtain new knowledge based on their previous knowledge and that they actively participate in the process by offering solutions to problems (Sertsöz & Doğan-Temur, 2017). Storytelling method provides skills such as developing a logical and algorithmic thinking structure in children, establishing a cause-effect relationship, a tendency to solve problems, having different perspectives, showing empathy as well as contributing to their understanding and comprehension skills (MacBlain, 2007). The permanence of the knowledge and students' ability to access new knowledge by using the previous one are expected during the mathematics teaching process. Knowledge can be learned and retained more effectively when it is learned within a story context, and therefore, a mathematical topic within a story context does result in greater retention and recall of that information, and this effect is quite robust (Casey, et al., 2008). The use of this method both in teaching mathematics and at elementary school is paramount in terms of providing sustainable and permanent learning. Despite the old history of using stories in teaching, its integration into mathematics teaching is quite a new approach. Teaching methods and techniques are also changing rapidly in the age of change. Various learning methods and techniques such as active learning, student-centered education, activity-based education, and project-based education have started to be reflected in

educational environments (Olkun & Toluk, 2014). With these changes in approaches and methods, there has also emerged significant changes in the transfer of some mathematical knowledge and skills to students, one of which is teaching with storytelling method. More permanent and sustainable learning is expected to be provided with this method.

1.3. Hypothesis and research questions

Mathematics teaching through stories is of great importance in terms of eliminating the problem of arousing children's attention, as well as teaching the heroes and mathematical concepts and rules in a more permanent and sustainable way. In a global sense, stories that are known by all children can be written on topics such as natural numbers, fractions, four operations and measurement units like world-embracing stories "Red Riding Hood", "Don Quixote", "Alice in Wonderland", "Cinderella", "Robinson Crusoe" and "Heidi". This study attempts to search how pre-service classroom teachers can transfer elementary school mathematics topics to students through storytelling method for a sustainable elementary school mathematics teaching. In service of this aim, answers to the following questions were sought.

1. How have the pre-service classroom teachers narrate the topics of learning domains and sub-learning domains among the elementary mathematics topics?
2. How is the logical fiction and content of the stories created by pre-service classroom teachers?

2. Method

2.1. Method of the Research

This research used a phenomenological design, one of the qualitative designs, in order to analyze how pre-service classroom teachers can teach students elementary school mathematics through stories for sustainable elementary school mathematics teaching. The studies carried out with a phenomenological design, attempt to reveal individuals' experiences, living, perceptions and to which they give meanings related to a phenomenon (Johnson & Christensen, 2004; Miller, 2003). Phenomena may appear in various forms such as events, experiences, perceptions, trends, concepts and situations in the world we live in (Yıldırım & Şimşek, 2011). Patton (2014) stated that different individuals' views should be examined in detail to get to the essence of the examined phenomenon. This study tries to make an in-depth analysis about how pre-service classroom teachers narrate the topics in the learning domains and sub-learning domains among the elementary mathematics in order to examine the essence of the phenomenon. As in this study, documents such as textbooks, curricula, student and teacher notes, student course assignments, teacher files, etc. (Bogdan & Biklen 1992; Borman,

LeCompte & Goetz, 1986) can be used as data sources in the research related to education. Mathematics stories written by the pre-service classroom teachers were chosen as a data source. Ethics committee permission was obtained with the decision dated 22.07.2020 and numbered 76218066-020-27728 from the Social and Humanities Ethics Committee of Kahramanmaraş Sütçü Imam University before the data collection process.

2.2. Population-Sampling

The phenomenological studies necessitate careful selection of the individuals who will explain the phenomenon and those must be the primary individuals associated with the phenomenon (Creswell, 2016; Patton, 2014). In this regard, this study was conducted with pre-service classroom teachers to reveal how learning and sub-learning domains of the elementary school mathematics were narrated. The working group consisted of 94 pre-service teachers who learned at the classroom teaching department at a university in Turkey in the Mediterranean region and who were about to finish the 3rd grade during the 2019-2020 academic year. Under the mentorship of the researcher, a total of 123 pre-service teachers began writing a story. However, similar stories and stories that were not considered to have the quality of a story were excluded from the study. The sample was selected by a purposive sampling method, which is one of the non-random sampling methods. Because this sample type enables the selection of information-rich situations in terms of the purpose of the study for conducting an in-depth research (Büyüköztürk, et al., 2008).

2.3. Data Collection Tool

The study deployed the question prepared as a data collection tool by the researcher and posed to the 3rd grade students who received undergraduate education in the classroom teaching department. Requested from the participants was: “Write a story that is appropriate for the level of the students of that age with a logical fiction explaining the subject based on one of the subjects of elementary school mathematics lesson. Your story should be based on a streamlined and logical fiction.”. The pre-service teachers were asked to create a story containing the objectives chosen from the 229 objectives available in the Elementary School Mathematics Curriculum (MONE, 2018). Since the study were planned as online and distance education due to the Covid-19 pandemic process, students were provided a 5-day period to respond to do the work.

2.4. Reliability and Validity of Data

In order to ensure validity and reliability in qualitative research, the study must first be conducted in an ethical manner (Merriam, 2013, p.199). The pre-service classroom

teachers were informed about the study in line with the ethical issues stated by Christensen, Johnson and Turner (2015). Besides, the identities of the preservice teachers were kept confidential during and after the study (Berg & Lune, 2015). Lincoln and Guba (1985) noted four strategies to ensure the validity and reliability of a qualitative study. These are credibility, transferability, dependability and confirmability for internal validity. Accordingly, studies were carried out to confirm the validity and reliability of the study.

2.5. Analysis Technique

Pre-service classroom teachers were asked to write mathematical stories and form an argument. Therefore, the arguments put forward before the data analysis were examined. The argumentation method is a dynamic process by which ideas about a topic or thought are systematically constructed on relevant arguments, criticized and evaluated by groups led by a guide, and as a result, every basic knowledge is expected to be available (Chin & Osborne, 2010; İnam & Güven, 2019). The stories obtained from pre-service teachers were analyzed by three field experts to identify what objectives and topics they were related to. Since human behavior is not static in the social sciences, it is unlikely to repeat the research results. Therefore, the concept of dependability is used in qualitative research instead of reliability, in other words, the research results are to be consistent with the elicited data (Merriam, 2013; Yıldırım & Şimşek, 2011). To this end, researchers should explain in detail the methods of preparing and applying the research method, data collection tools, and how data is collected and analyzed.

Creswell (2016) defines reliability in qualitative research as ensuring consistency between codes with the coding of data sets by more than one researcher. In order to ensure coding consistency during data analysis, the researchers made coding separately without being aware of each other. In addition, support was received from an expert, who continued to doctorate on children's literature and who had a large number of children's story books at a national level, for the analysis of the logical fiction and content of the stories created by pre-service classroom teachers. The agreement between these coders was calculated through using Miles and Huberman's (1994, p.64) formula ($\text{Reliability} = \frac{\text{Agreement}}{\text{Agreement} + \text{Disagreement}} \times 100$) and the agreement ratio was calculated as .87. The coding can be said to be reliable when the value calculated using Miles-Huberman reliability formula is higher than .70 (Akay & Ültanır, 2010: 80). In cases where there was a different objective or coding idea, the reason was examined, the code was identified together.

3. Findings

In the current study, the pre-service classroom teachers were asked to create scientific arguments through stories by choosing one of the learning and sub-learning domains

available in the elementary school mathematics curriculum, and use them in the teaching process for enabling students to gain knowledge and understand the nature of mathematics. They were expected to create these arguments in which mathematical knowledge was produced by using mathematical thinking, questioning and reasoning skills. Thus, one of the basic teaching methods, argumentation method was used in the present study. The obtained findings on the arguments (stories) will be presented with the order of the research questions in this section.

Almost all over the world, Elementary School Mathematics Curriculum consists of four learning domains: "Numbers and Operations", "Geometry", "Measurement" and "Data Processing". However, this study analyzed numbers and operations separately and hence, five learning domains were identified to ensure data diversity. All these learning domains can be observed in each grade level (Elementary School 1st-4th Class), and some sub-learning domains can be activated after a certain grade. 36 of the 229 objectives in the Elementary School Mathematics Curriculum (MONE, 2018) (1st- 4th grades) belonged to the 1st grade, 50 of them were the 2nd grade, 72 of them were the 3rd grade and 71 of them were the 4th grade. The numbers of the 229 objectives in the Elementary School Mathematics Curriculum based upon the learning domains are presented as following.

Table 1. The number of objectives within elementary school mathematics curriculum (MONE, 2018)

Learning Domains	Grade Levels				Total
	1st Grade	2nd Grade	3rd grade	4th grade	
	f (%)	f (%)	f (%)	f (%)	
Numbers	9 (20)	9 (20)	16 (37)	10 (23)	44 (19.2)
Operations	10 (14)	16 (23)	20 (29)	24 (34)	70 (30.6)
Geometry	6 (17)	8 (22)	10 (28)	12 (33)	36 (15.7)
Measurement	10 (14)	16 (23)	23 (33)	21 (30)	70 (30.6)
Data processing	1 (11)	1 (11)	3 (33)	4 (44)	9 (3.9)
Total	36 (15.7)	50 (21.8)	72 (31.4)	71 (31.0)	229 (100)

As is observed in Table 1, the "Numbers and Operations" learning domain was identified to correspond to approximately 50% of the whole elementary school mathematics curriculum. Therefore, numbers and operations were evaluated as separate learning domains in the findings. As the data processing learning domain was represented in the elementary school mathematics curriculum with a total of 9 (3%) objectives, the stories created by the pre-service classroom teachers for problem solving were evaluated in this context. The first research question attempted to identify which topics within learning and sub-learning domains of the elementary school mathematics topics were narrated by the pre-service classroom teachers. The story titles, sub-learning

domains and the objectives regarding each learning domain were given below. Table 2 depicted findings related to the "Numbers" learning domain.

Table 2. Stories regarding numbers learning domain

Learning Domain	Sub-learning Domain	The Title of the Story	The Content of the Objectives in Stories
Numbers	Natural numbers	Number or Digit?	Number and digit concepts
	Natural numbers	Wish Chest	Rhythmic counting up to 100
	Natural numbers	Natural Number Tribe	Properties of natural numbers
	Natural numbers	War of the Decimals	Features of decimal system
	Natural numbers	Number Rounding Factory	Rounding to the nearest decimal
	Natural numbers	Savior of the Numbers	Rhythmic counting and canonical counting
	Natural numbers	Little Pearl	Ordinal numbers
	Natural numbers	Similar Digits	Digits
	Natural numbers	Worker with No Mathematics	Sorting in numbers, greatness and smallness
	Natural numbers	Single and Double Hive	Odd and even numbers
	Natural numbers	Digits Village	Reading the numbers
	Natural numbers	The Story of Increase and Decrease	Decrease-subtraction, increase-addition relationship
	Natural numbers	The Unhappiness of +12	Rounding to decimal
	Natural numbers	The Story of Zero	0 (zero)in natural numbers
	Natural numbers	Numbers Family	Comparison with the number 10
	Natural numbers	Yes 0 (Zero) No One	Determining odd-even by 0
	Natural numbers	Magic Garden	Comparing groups' object numbers
	Natural numbers	Social Distance Between Numbers	Rounding to decimal
	Natural numbers	Natural Mathematics	Estimating the value of multiples
	Natural numbers	Numbers Animal	The status of numbers each other (1-20)
	Natural numbers	Natural Neighborhood	Odd and even natural numbers
	Fractions	17 Camels Story	Fractions, proportions, 1/3, 1/6, 1/9
	Fractions	Did you hear the parity incident?	Fractional multiplicities and values
	Fractions	Fraction Patisserie	1/2, 1/4 concepts
	Fractions	Missing Villages	Whole, half and quarter concepts
	Fractions	From Pizza to Fractions	Whole, half, quarter relationship
	Fractions	Equal Share Is Right	Whole, half, quarter relationship
	Fractions	Fraction Children	Full, half-quarter concepts
	Fractions	From Snow White to Math Realm	Full, half, quarter concepts
	Fractions	A Piece of Me	Unit fraction, ordering in fractions

The pre-service classroom teachers were found to write sufficient number of stories about both the natural numbers and fractions sub-learning domains under the learning domain of the elementary school mathematics curriculum. A total of 30 stories were produced, 21 of which were in the natural numbers sub-learning domain and 9 in the fractions sub-learning domain. While the majority of the stories was found to be related

to numbers and digits in the first grade of the elementary school, the subjects such as odd even numbers, rhythmic counting and rounding were narrated towards the upper classes. In the fraction sub-learning domain, whole, half, and quarter fractions were more dominant at elementary school level. Considering the story titles, they can be said to appeal to the elementary school children and arouse their curiosity.

Table 3. Stories regarding operations learning domain

Learning Domain	Sub-learning Domain	The Title of the Story	The Objectives in the Story
Operations	Addition of Natural Numbers	Emir and Cock	Features of the addition operation
	Addition of Natural Numbers	No need to cry	Double and triadic addition
	Addition of Natural Numbers	Market Shopping	Performing triadic addition
	Addition of Natural Numbers	3 to 5	Addition without carry (1-10)
	Addition of Natural Numbers	You are in the "carry"	Addition with/without carry
	Subtraction of Natural Numbers	Ahmet and Mehmet	Descending, subtrahend, difference concepts
	Subtraction of Natural Numbers	Sign Leaving Home	Features of the extraction operation
	Multiplication of Natural Numbers	With the Effect of Multiplication	Easy multiplication with 10,100,1000
	Multiplication of Natural Numbers	Everything Has a Rule	The importance of the operation order
	Multiplication of Natural Numbers	Zero! You are king	Multiply by 1 and 0
	Multiplication of Natural Numbers	Machine Eating the Bad	The effect of zero on multiplication
	Multiplication of Natural Numbers	Colliding Numbers	Rules of the multiplication operation
	Multiplication of Natural Numbers	War of the Decimals	Multiplication of 10 by shortcut
	Multiplication of Natural Numbers	Secret of the Chords	Multiplication by chords (1-9)
	Multiplication of Natural Numbers	The Zero Element Family	The effect of zero on multiplication
	Division of Natural Numbers	Dividor-dividend	Divide, dividor, dividend, division, remainder
	Division of Natural Numbers	Keloğlan and Numbers	Dividing by numbers 1-20
	Division of Natural Numbers	Fairy and Her Children	Shortcut division (divide by 10)
	Division of Natural Numbers	Divide and Eat	Aliquot in 1-100 numbers
	Operations with Fractions	What are we?	Addition in fractions
	Operations with Natural Numbers	I am: Zero	absorbing element in multiplication, additive identity
	Operations with Natural Numbers	Only Four Operations	Addition, multiplication, division and subtraction
	Operations with Natural Numbers	Gluttonous Zero	The effect of zero on multiplication and addition
	Operations with Natural Numbers	Rolling Slide	Operations in numbers from 0 to 100
	Operations with Natural Numbers	Monster Zero	Effect of 0 on multiplication and addition

The findings suggested that the pre-service classroom teachers included the addition, subtraction, multiplication and division operations of natural numbers since there are four operations in general under the operations learning domain within the elementary mathematics curriculum. A total of 25 stories were produced, including 5 in the addition

of natural numbers sub-learning domain, 2 in subtraction sub-learning domain, 8 in the multiplication of natural numbers, 4 in the division sub-learning domain, 5 in the whole four operations and only one related to the fractions. It may be wise to mention that the pre-service classroom teachers mostly write stories about multiplication. Besides, they seemed to produce very few stories about subtraction of natural numbers and operations with fractions. Most of the stories were found to base upon multiplication rules and the features of the multiplication operation.

Table 4. Stories regarding geometry learning domain

Learning Domain	Sub-learning Domain	The Title of the Story	The Objectives in the Story
Geometry	Geometric Objects and Shapes	It is of My Shape, Keep out of My way	Square, rectangle, triangle etc.
	Geometric Objects and Shapes	Math Forest	The importance of geometric shapes
	Geometric Objects and Shapes	QSW Sphere	Quarter, semi, whole sphere
	Geometric Objects and Shapes	The Loneliness of the Circle	Formation and difference of the circle
	Geometric Objects and Shapes	Three friends	Triangular square circle and the relationship between them
	Geometric Objects and Shapes	Kite	From parts to different shapes
	Geometric Objects and Shapes	From Shape to Shape	Similarities and differences of shapes
	Geometric Objects and Shapes	Queen-Shapes Socializing	Similar properties of shapes
	Basic Concepts in Geometry	Sim-Symmetry	Features of symmetry
	Basic Concepts in Geometry	Geometric Friends	Shapes from triangle to circle
	Basic Concepts in Geometry	Open	Acute, right and wide angles
	Geometric Patterns	Math Necklace	Pattern, design creation, order, series
	Geometric Patterns	Patterns with Gülay	Pattern and ornaments,
	Geometric Patterns	Brother Shape	Polygons forming a whole area
	Geometric Patterns	The Land of Patterns	Geometric layout
	Geometric Patterns	Fox and Stork Story	Pattern of shapes
	Geometric Patterns	Pattern Village	Shape and numerical pattern
	Geometric Patterns	Pat-tern	Geometric pattern with colors

The findings also revealed that the pre-service classroom teachers produced stories about all sub-learning domains such as geometric objects and shapes, basic concepts in geometry and geometric patterns in the geometry learning domain available in elementary school mathematics curriculum. A total of 18 stories were produced, 8 of which were related to geometric objects and shapes, 7 were about geometric patterns and 3 about basic concepts in geometry. The objectives addressed in the stories can be said to be about the basic geometric shapes and features such as triangles, squares, rectangles, similar and different states of geometric shapes and geometric patterns.

Table 5. Stories regarding measurement learning domain

Learning Domain	Sub-learning Domain	The Title of the Story	The Objectives in the Story
Measurement	Weighing	Do Not Underrate Cake	Non-standard measurement units
	Weighing	Surprise Birthday	Comparing masses, weighing objects
	Our money	Penny	Coins and the relationship between them
	Our money	Legend Transformation of Coins	Our coins
	Our money	Money money money	Our paper money
	Our money	From Piastre to Lira	Our currencies and their relationship
	Our money	Difference of Coins	Coins we use
	Environmental Measurement	Square Escaping from Its Country	Environmental measurement units
	Environmental Measurement	Happy Country and Her Ruler	Standard units of measurement
	Length Measurement	Meter Neighborhood	Meter lower and upper floors relationship
	Liquid Measurement	Flowing River and Pool	Liquid measurement units
	Time Measurement	Hungry Caterpillar	1 Week = 7 days, Days of the Week
	Time Measurement	Clock Site	Whole, half and quarter hours
	Time Measurement	Numbers in a Watch	Hour and minute hand relationship and numbers

Due to the diversity of measurement in elementary school mathematics curriculum, there are a great number of sub-learning domains regarding measurement. The pre-service classroom teachers were identified to write stories about all these sub-learning domains. Based upon the measurement learning domain, a total of 14 stories were produced by the pre-service classroom teachers, including our money 5, time measurement 3, weighing 2, environmental measurement 2, length and liquid measurement 1 each.

A basic topic such as standard and non-standard measurement units in weighing was compared with mass measurement and mass units. Both our coins and paper money and their relative values were explained. Standard measurement units and environmental measurement topics were taught within the context of environmental measurement. The lower and upper levels of the meter, which is the basic unit in length measurement, were presented. As for liquid measurement, standard liquid measurement units were narrated. In terms of time measurement, all basic time measurement units the hour and minute hand relationship and minute; whole, half, quarter hours were mentioned up to the concepts of day, week and year.

Table 6. Stories regarding data processing learning domain

Learning Domain	Sub-learning Domain	The Title of the Story	The Objectives in the Story
Data Processing	Data Collection and Evaluation	SQUARE Brothers	Finding logical and strategic solutions
	Data Collection and Evaluation	No Problem	Problem posing and solving
	Data Collection and Evaluation	Market Adventure	Data collection and interpretation
	Data Collection and Evaluation	Accounts in Shopping	Data collection in shopping
	Data Collection and Evaluation	Happiness	Finding unknown value
	Data Collection and Evaluation	Festival Morning	Addition, subtraction, multiplication, division problems
	Data Collection and Evaluation	One Photo 3-4 Frames	Triangle and square with the same edge lengths

The data processing learning domain in elementary school mathematics curriculum holds a total of 9 objectives, 1 in the first grade, 1 in the second grade, 3 in the third grade and 4 in the fourth grade. There is only the data collection and evaluation sub-learning domain under the data processing learning domain. Pre-service classroom teachers wrote 7 stories within the data collection and evaluation sub-learning domain. These stories may be written both for preparing questionnaires and questions to obtain data, and for finding the unknown value in the problems with the available data by thinking logically and strategically. Moreover, the preservice classroom teachers created various stories from questions that require four operations and logical reasoning. These stories were written in a way that made students to use strategies and data appropriately.

The second research question was, "What is the logical fiction and content of the stories created by the pre-service classroom teachers?". Thus, the stories were examined, and answers were sought for both logical fiction and content. Table 7 displayed findings related to the content of the stories.

Table 7. The characteristics of stories written by pre-service classroom teachers

Themes	Categories	Number of views (f)	Samples
The Title of the Story	Classical	57	Market Adventure
	Different	16	SQUARE Brothers
	Striking	13	No need to cry
	Word game	8	Queen-Shapes Socializing
Story Fiction	Logical fiction is consistent	88	Sequential and rule-based narrative features are available
	Content Appropriateness to the Domain	89	Suitable for elementary school mathematics curriculum
	Original	77	Story fiction is original
	There is the Place the Event Occurs	72	Land of Numbers, Happy Country and Her Ruler
	There is Time of Event	65	A place that doesn't exist
	There is an introduction (exposition)	75	Once upon a time, since time immemorial...
	There is development (node)	80	So, what would happen if the money didn't turn into each other?
	There is a result (Resolution)	85	They lived without any problems by doing operations in this way.
	There is personification	35	There was someone called zero, nobody would take it into the game.
The Hero of the Story	Fiction	63	Fairy and Her Children
	A Known Object	18	Cake, pearl, machine
	Animals	5	Fox, caterpillar, turtle, bird
	People	47	Keloğlan, worker, pastry cook
Text Characteristics	Suitable for Level	88	Written with words that elementary school students will understand
	Not Suitable for Level	6	High level language is used, prime number, like Pythagoras
	There is a dialogue	75	Expression with mutual speech is provided
	Fluent	82	The text is fictionally presented fluently
	Descriptions are Understandable	72	The perception of place, time and place is included.

The pre-service classroom teachers were noted to mostly use classical titles (f:57) in the stories. In addition, they produced titles by making different, remarkable or word games. The fictions of the stories were generally in a logical order (f:88), related to the elementary school curriculum (f:89), original (f:77), describe the place the (f:72) and time (f:65). events take place. Besides, the pre-service teachers were identified to use the introduction (f:75), development (f:80) and result (f:85) sections, which are one of the most basic features of a story. Although the heroes of the stories were generally fiction (f:63), some of them were personalized and presented using human (f:47) and few animal (f: 5) characters. In terms of the text characteristics of the stories written by the pre-service teachers, almost all of them were determined to be suitable for the grade level (f: 88) and very few advanced words (f: 6) were used. Likewise, the stories can be said to focus on conversations (f: 75), fluent language was used (f: 82) and the descriptions were at a level that could be understood by the students (f: 72).

4. Conclusions and Discussion

After presenting the results, this study sought how pre-service classroom teachers can transfer elementary school mathematics topics to students through stories for a sustainable elementary school mathematics teaching. The participants were asked to choose one of the elementary school mathematics topics for teaching it depending on students' levels. When the stories were analyzed according to the learning domains and sub-learning domains in the curriculum, the stories written by the pre-service teachers can be mentioned to cover all learning and sub-learning domains. In other words, 94 stories referred to each one of the 229 objectives in the Elementary School Mathematics Curriculum. The reason was that the pre-service classroom teachers explained the whole topic in an instructive way while writing a story. This may lead us to conclude that teaching topics through stories is paramount in terms of presenting them in an understandable and more inclusive way.

Pre-service teachers produced a total of 94 stories, 30 of which were in numbers learning domain, 25 in operations learning domain, 18 in geometry learning domain, 14 in measurement learning domain and 7 in data processing learning domain. Considering the elementary school mathematics curriculum, numbers and operations learning domains coat half of the program. However, the data processing learning domain is the one with the fewest objectives. Taking the number of stories into account, the rates are similar to the density in the curriculum in terms of objectives and sub-learning domains.

The findings showed that the stories in the numbers learning domain were mostly related to numbers and digits owing to the first-grade elementary school objectives, and those such as odd-even numbers, rhythmic counting and rounding were narrated towards upper classes. Likewise, a sufficient number of stories were produced about the concept of fraction in the learning domain of numbers. The stories created in the operations learning domain were found to be in relation to addition, subtraction, multiplication and division operations of natural numbers. Among the four operations, the operation with the most stories was determined to be multiplication. This may be due to the fact that multiplication contains different contents such as rhythmic counting and addition. The pre-service classroom teachers were found to write stories regarding all geometric objects and shapes, basic concepts in geometry and geometrical patterns sub-learning domains related to geometry learning domain. These stories included both the basic properties of geometric objects and how they can form patterns by creating an order. The participants were also determined to produce stories regarding various measurement tools and units due to different measurement units within the measurement learning domain. Nevertheless, the pre-service classroom teachers can be said to write stories for all measurement units. Despite a total of 9 objectives in the elementary school mathematics curriculum related to the data processing learning domain, the pre-service teachers were identified to include this learning domain in their stories in the way of using data in

question and problem solving, collecting and evaluating the data and achieving the results. Thus, we can conclude that the stories covered all learning and sub-learning domains.

Another research question of the study was the content and logical fiction of the mathematical stories prepared by the pre-service classroom teachers. Accordingly, the pre-service teachers may be said to generally follow a certain logical sequence in their stories and design the story in accordance with the curriculum. The findings indicated that the stories were made up of sections such as introduction, development and result, using a fluent language, indicating the place and time of the events, and the story heroes were personalized in accordance with the educational content. Upon analyzing the story titles, they mostly appealed to elementary school children, which may be interesting and attract their attention. These positive features may be due to the fact that the pre-service classroom teachers both know the target audience well and have the sufficient knowledge about the field they will teach.

In the study of Cotti & Schiro (2004) on how teachers use children's literature in mathematics teaching, they sought an answer to the question "Can teachers develop a teaching tool by using and formatting children's literature to teach mathematics?". However, teachers reflected different ideological approaches and the stories were written on limited topics, leading to a difference from this study. The findings concluded that teachers could be successful in teaching mathematics through stories. In the study at hand, the results are parallel in terms of referring that classroom teachers can successfully teach mathematics topics to the students through stories.

Schiro & Lawson (2004) concluded that stories can be created to teach various learning stages of algorithm and problem-solving skills so as to improve their mathematical skills. In his study titled "Verbal storytelling and mathematics teaching", verbal storytelling was emphasized to be used as a tool for subjects such as four operations and problem solving, and that the teaching of all mathematics topics could be generalized and a teaching model could be offered with a new perspective. The fact that the pre-service teachers could produce stories including all elementary school mathematics learning and sub-learning domains supported this view.

In another study, Casey, et al. (2008) pointed the effectiveness of the use of story texts in developing preschool children's geometry skills. In this study, the third most produced story domain was geometry. That the stories produced in the subjects of geometry generally contained basic geometry concepts and addressed the first grades of the elementary school was similar to the findings of this study.

Faruk Islim, Ozudogru & Sevim-Cirak (2018) conducted a study to reveal the use of digital stories in mathematics education and the pre-service mathematics teachers' views and experiences on digital story writing, use and evaluation. The results showed that pre-service teachers were successful in writing stories, they were very pleased to produce

stories, and they wanted to implement this in their classes. In another study carried out by Giles and Kent (2016), pre-service teachers were determined to find the process of preparing stories interesting and that it will be a successful application in providing different new learnings about how to teach students.

The in-depth research in the relevant literature (Lemonidis & Kaiafa, 2019) explored the role of storytelling in the teaching of fractions to the third-grade students in Florina (Greece). The research results suggested a significant difference between the experimental and control groups in favor of the experimental group. The researcher emphasized that teaching the topic of fraction through storytelling was mostly effective in students with low and medium success. Besides, the use of storytelling in fraction teaching was identified to have a positive effect on certain mathematical skills such as comparing fractions, finding equivalent fractions, creating representations and problem solving. The findings of the above studies in the literature are in harmony with those of this study in general.

Although story use is generally considered to be related to the social sciences (Robin, 2008; Tsou, Wang & Tzeng, 2006; Yuksel, Robin v & McNeil, 2011), researchers stated that it can be used as an effective and sustainable teaching method in various fields such as mathematics science, art and technology. Apart from elementary school mathematics teaching in the relevant literature, a large body of studies seem to agree that teaching mathematics with stories is an effective teaching method (Lee & Lee, 2013; Naziev, 2018; Suh, 2013; Toor & Mgombelo, 2015; Zazkis & Liljedahl, 2009).

In a nutshell, the research findings revealed that the pre-service classroom teachers could write stories including all of the learning and sub-learning domains in the elementary mathematics curriculum, these were suitable for elementary school class and objective level, storytelling method can be used especially in elementary education for creative, remarkable, permanent and sustainable mathematics teaching.

5. Suggestions

Based upon the findings, the following recommendations were provided:

- a) Pre-service teachers can be provided trainings on subjects such as children's literature and story writing in the education faculties. They may be asked to create a story about numerical course topics such as mathematics.
- b) Math topics can be narrated and used to convey the mathematical concepts and understandings to children that mathematicians have developed over the centuries.
- c) The proliferation of the child-centered stories that are fun and encouraging and that students can explore mathematics in accordance with their development may be recommended especially for elementary school mathematics lessons.

d) Children may be encouraged to perceive the problems in society, live for a better society and be the ones who will improve the lives of all people in order to change society in mathematics lessons with stories.

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