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Full Length Research Paper

Sketch strategy of knowledge in physics learning and its influence on metacognitive

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Metacognitive knowledge is a necessity in starting learning process. Solving physics problems requires metacognitive knowledge which comprises factual, conceptual and procedural knowledge. The purpose of metacognitive knowledge is to train students in developing their abilities in higher order of thinking. The problem is what kind of strategies can be used by teachers to facilitate student's comprehension? This study used "sketch knowledge strategy (SKS)" as a strategy to help students in solving high order of physics problems and its influence on their metacognitive understanding. The target variable strategy was used as a comparison in order to examine its effects. The results showed that the concept of sketch strategy was more significant in solving metacognitive problems than that of the target variable strategy.

Key words: Metacognitive knowledge, sketch knowledge strategy, target variable strategy.

INTRODUCTION

At the beginning of the odd semester of academic year 2014/2015, metacognition knowledge ability test (MKAT) was given to the new physics education students. The intent behind this test is to obtain an idea on how good the ability to understand, implement and integrate knowledge of factual, conceptual and procedural knowledge in solving physics problems. The following is an example of the test given:

Two cars move in the same direction at a constant velocity, Car-B in front of car-A. The velocity of car-A is 20 m/s and car-B is 10 m/s. At t = 0 s, the distance between the two cars is 1000 m. Find the time when car-A takeover car-B.

The results showed that none of the 26 new students that wrote the test answered the problems correctly. This indicates that the students have not been able to optimize their ability in cognition process. This can be seen from the solving procedure of one student (Figure 1). This procedure is similar to the strategy developed by Chi and Van Lenh (2010).

One of the weaknesses of target variable strategy (TVS) is on the stage of translating the problem statement. Accordingly, TVS should be conducted independently. Research by Abdullah (2014) showed that TVS can be done through three stages, namely:

(1) Translating the problem to picture at $t = 0$ and $t = t_1$

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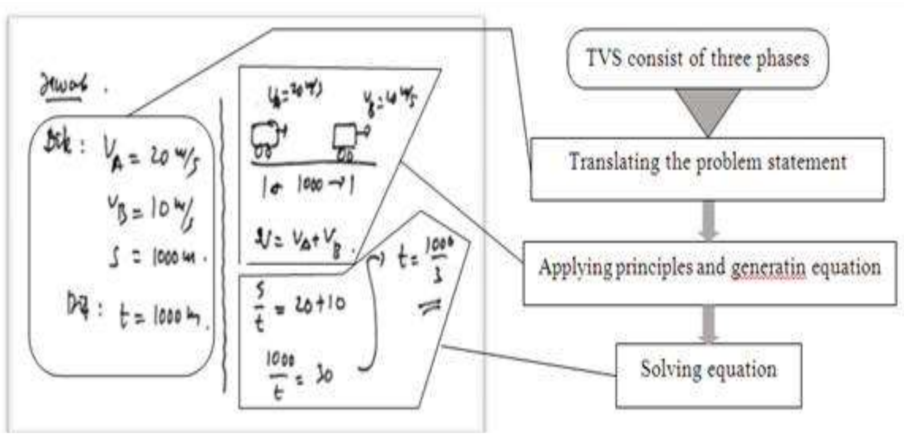

Figure 1. Phases in solving physics problem with TVS.

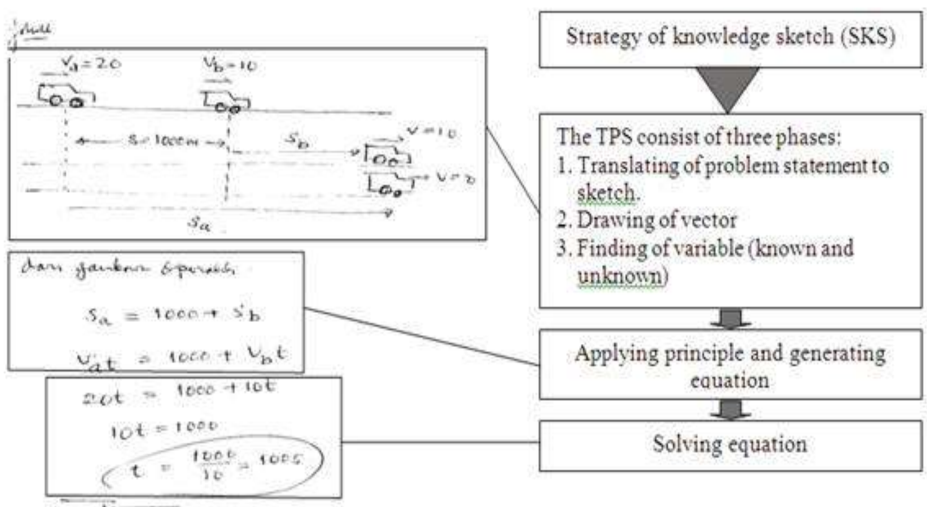

Figure 2. Phases in solving physics problems with SKS.

(2) Drawing the vector's direction
(3) Finding the knowing variable so that the solution can be determined. This kind of diagnostic test is shown in Figure 2.

The inability of students to solve physics problems was a sign that some components of learning were not achieved. There is a possibility that the strategies used by teachers during learning have not been able to fulfill student's need in solving physics problems. Teachers play important roles in the whole process of learning, hence their competence is indispensable.

Based on this finding at the beginning of the first semester of 2015/2016, MKAT tests was performed on 32 physics teachers who attended master degree matriculation program at Universitas Negeri Makassar (UNM). The results showed that eight teachers (21.9%) answered the problems correctly, and the remaining 24 teachers (78.1%) failed to answer correctly. These results provided strong linkage between the failures of new students to solve MKAT problem. It was assumed that the main problems faced by physics teachers in high school was their physics subject capability. This means that teachers simply used low level of factual, conceptual and procedural knowledge (Widodo, 2008), and do not train students using complex procedural and metacognitive knowledge.

However, it was seen previously that teachers do not teach their student using procedural and metacognition knowledge because they were most likely not trained on procedural and metacognitive knowledge. There is a strong linkage between schools that offer new students and LPTK that produce prospective teachers (Figure 1).

According to Suparno (2005), lecture environment in universities do not change academic behavior significantly. It means that the lecture conducted in universities that includes LPTK is predominantly on the "explanation" of the concepts and theories based on the text-book, without attempting knowledge development thinking.

Abdullah and Khaeruddin (2012) opine that the lack of metacognitive knowledge of physics education courses at UNM is as a result of the lack in mastery of strategy in solving physics problems (such as high level physics problems). They know only one strategy namely target variable strategy (TVS). A research by Abdullah (2014) showed that many strategies can be used as guidance in solving problems of physics. One of these strategies is the sketch knowledge strategy (SKS). Therefore, in this study, problem-solving strategies (TVS and SKS) will be given to the 2016 graduate students of physics education in UNM. What does sketch knowledge strategy mean? Sketch knowledge strategy is a procedure in physics questions that consists of three stages:

(1) Making,
(2) Formulating, and
(3) Executing.

Making in sketch of knowledge is a term that describes the process of thinking that visualizes the statement of question and pour into a sketch completed with a description or the quantities given. Formulating is a thought process that uses principle, law and the basic formula to frame a mathematical equation based on sketch of knowledge. Executing is the use of mathematical principles to determine the parameter asked in the question. Physics problem resolution procedure is called SKS.

METHODOLOGY

This research is a quasi-experiment that aims at obtaining information about the effect of sketch knowledge strategy and variable target strategy on metacognitive knowledge understanding. The subjects of this research are master students of Physics Education, State University of Makassar. The selection of subject research was predetermined by a certain group. Furthermore, the number of subjects of this study was 33 graduate students, grouped into two classes: Class A- attended by 17 students and Class-B followed by 16 students. Both classes followed the same methods, the only difference was the strategy to solve the problems. Class-A used SKS, while class-B used TVS. The variable to be studied is the effect of the SKS and TVS on the understanding of metacognitive knowledge. At the end of the teaching, both classes were given metacognitive knowledge test. This test was made in the form of essay test. There were three questions given. The questions included the level of metacognitive knowledge labeled as level-1, level-2 and level-3. The level of problem introduced by Abdullah (2014) aims to distinguish the test difficulty based on the number of equations needed to solve the problem. In this research, linear motion at constant speed and all three metacognitive knowledge was used. The test developed consists of three levels of difficulties. Henderson (2005) explained that metacognitive strategy is an activity that aims to instruct students toward arriving at the solution using the approach of the level of difficulties. Figure 3 shows the diagram level of difficulties, it is called concept scheme.

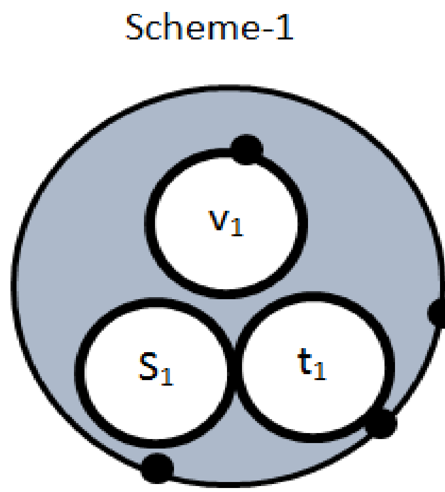

Figure 3. Concept scheme in level 1.

It shows the use of *s* = *v t* equation in different situation and different difficulty.

RESULTS

After teaching (matriculation program) as much as 5 times on the subject of Mechanics, the following topics were considered:

(1) Straight motion with constant acceleration
(2) Parabolic motion, and
(3) Force and motion.

The subjects are based on indicators of metacognitive knowledge which comprise:

(1) The factual knowledge,
(2) Conceptual knowledge, and
(3) Procedural knowledge.

During the teaching process, all students were actively involved. At the end of the teaching, both classes were given comprehension of metacognitive knowledge test. The test was developed specially for this study in the form of essays. Three tests were developed. They are tests knowledge of metacognitive level-1, level-2 and level-3, based on a test developed by Abdullah (2014). The evaluation of the answer sheet was conducted and the results obtained are shown in Table 1. Furthermore, the hypothesis was tested using "t-test to determine the differences between the test scores of class-A and class-B. The results of the t-test are as shown in Table 1.

$$t_h = \frac{\bar{x}_A - \bar{x}_B}{S\sqrt{\left(\frac{1}{n_A} + \frac{1}{n_B}\right)}} = \frac{12{,}29 - 8{,}12}{4{,}06\sqrt{\frac{1}{17} + \frac{1}{16}}} = 2{,}96$$

Table 1. Differences between the test scores of class-A and class-B.

Aspects	Class-A The value for each level PM (n1=17 person)			
	1	2	3	Total
Average score	3	3.65	5.65	12.29
Standard deviation	0	1.41	3.53	4.95
% are true above 75%	100	64.70	64.7	41.17
% true 0%	0	0	0	0
Class B				
Average score	3	2.75	2.375	8.12
Standard deviation	0	1.41	1.41	2.83
% are true above 75%	100	18,79	0	0
% true 0%	0	0	37.50	0

Where:

th = 2.96> t table (0,05) = 2.04

Thus it can be said that the influence of sketch knowledge strategies in teaching physics has a significant difference with the strategy of the target variable. This difference shows that the actual sketch knowledge strategy is better than the target variable strategy, particularly in improving the understanding of metacognitive knowledge of students in teaching physics.

The explanation of the research results obtained is referring to the research questions formulated in the introduction. The results for the PPM test level 1 show that apparently both classes have the same ability. This is possible because the test PPM for level-1 only measured the ability to "remember and use" concepts, formulas, and procedures. The test items PPM level-1 does not require "deep thinking" to tackle the following question:

A child rides a stop escalator. The length of the ladder is 20 m. If the average speed of the child is 0.5 m/s, how long will it take to the child to the top of the stairs? (Problem PPM Level-1)

The type of question aforementioned is usually used to train a very simple formulation. Learners in junior level can easily do it. It can be said that student in research subjects, has formed the concept of velocity (v), the distance (S) and time (t), even the relationship between the three concepts through the formulation S = vt which has been embedded in their mind. The schematic diagram concepts formed in the mind of student to solve the PPM level-1 aforementioned is seen in Figure 3.

It appears from Figure 3 that the relationship between the three concepts earlier mentioned form law, rule, principle, or formulations. The relationship is necessary in solving PPM level-1. PPM level-1 does not require a very deep thought, because these concepts have formed a relationship formulation that can be used to solve the problem. Therefore, the effect of the use of sketch knowledge strategy and variables target strategy to complete the test items PPM level-1 does not have a significant difference in students.

Another case is that of PPM level-2. The scores obtained showed noticeable difference. This is evident from the acquisition of the average score of the two classes. Class-A was taught using sketch knowledge strategy and is better than class-B who was taught using the target strategy variables (Table 1). This indicates that the characteristics of PPM level-2 have a fairly high level of difficulty. In other words, to resolve the problem one needs a fairly deep thought ability to link between concepts, rules, principles and formulations. Problem level-2 is:

A child is riding a moving escalator. Upon arriving on the top, the child came down. The average velocity of child relative to the ladder is 2 times the average speed of the escalator. If the time needed by the child to move upwards is 20 s. How much time is needed if the child comes down the escalator? (Problem PPM Level-2).

From the aforementioned statements about the PPM level-2 there are two cases of the child who walked on moving escalator. Both cases have different conditions. However, both cases may be connected with one another. The level of difficulty of this problem is in the ability to think of the connection between both cases. Such a capability is called "metacognition". PPM-1 level metacognition level is very low compared to PPM level-2. The picture that follows describes the process of thinking to solve the PPM-2 level. In picture-2, there are four relationships between each concept. The number of relationship depends on how many concepts that comes to mind when solving the problem. There are three relationships, namely:

(1) Relationships between concepts within a single scheme
(2) Relationships between concepts similar in the two schemes, and
(3) The relationship between schemes.

The three relationships form a hierarchy in relation with others. That is, if a student does not have knowledge of the relationships between concepts within the scheme, the next relationship will be difficult to occur in the student's thinking. Therefore, the role of teaching strategies is crucial in "training students" to understand the three relationships. In this study, it has been proven that in training students to introduce and to understand these relationships, the sketch knowledge strategy has an advantage compared to the target variable strategy. The PPM test questions that have been tested in this study are PPM-3 level. This problem has a difficulty level that is higher than PPM Level-2. The question is:

A child walks up in an escalator; he arrives at the top in the 90second. If he just stands and the escalator is moving and he arrives at the top in the 90second. How much time is needed when he runs while escalator moves? (Problem PPM Level-3)

Problem PPM level-3 consists of the three cases that have been linked with one another. To resolve this problem we are required the ability to mastery of problems at level-1, level-2 and capabilities in metacognition. Such question can only be solved by students whose level of intelligence is above average. It is not surprising that this kind of problem is used in a selection of National Science Olympiad. For more details about the complexity of this 3-level PPM, the following is shown. A schematic representation of a concept formed in the minds of students to resolve this issue is seen in Figure 3. It is clearly seen in Figure 3 that the relationship between the number of schemes and concepts in the scheme is relatively much. Every relationship requires a very deep thought. From the research results, it was obtained that teaching the concept using sketch knowledge strategy is better than the variable target strategy, especially in solving problems in PPM level-2 and level-3. This is possible because in sketch knowledge strategy, each problem trains students on how to solve the problem per scheme. It is quite reasonable since the sketch knowledge strategy has several advantages over the strategy of the target variable. The benefits of the strategy sketch knowledge in physics teaching are:

(1) To train students to use their imagination

Aspects of the sketch knowledge can train students to imagine the verbal language into a picture sketch. The sketch is not only a "picture" but it is also filled with the

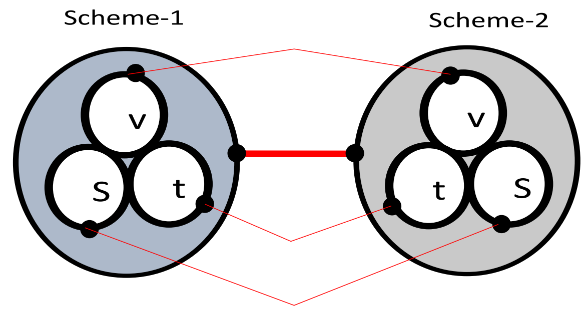

Figure 4. Scheme concept for level 2.

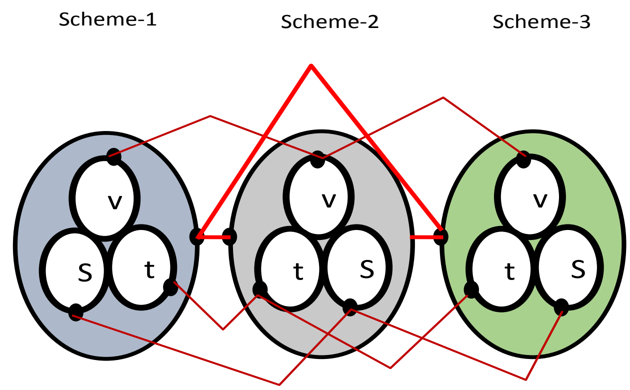

Figure 5. Scheme concepts for level 3.

quantities, concepts and principles of physics. Viewed from the aspect of learning, there are three benefits of sketching knowledge (Figures 4 and 5). The advantages are:

(a) Exercising in complex thinking.
(b) Exercising the connections between facts, concepts, and principles in the mind of students.
(c) Exercising to think abstract thing.

(2) To train students to think imaginatively and then transform it into a realistic thing. Imaginative thinking is the ability to picture something in mind. Many phenomena are produced by experts, simply because of their ability to think imaginatively. Nevertheless, imaginative thinking will not be meaningful if it is not realized in reality. For instance, a painter is able to imagine and put it in the painting. Similarly, Sir Isaac Newton when he saw an apple falling from a tree. What Newton saw was a natural thing. Everyone will say "yes indeed the apple will fall", But out of millions of people at that time, only Newton considered the falling apple as an issue. Newton had ability to think imaginatively. Not only that, Newton tried to pour the imaginative thinking skills into “laws of gravity", this ability is called thinking

imaginative-realistic.
(3) To train students to think logically is based on reality. In addition to the ability to think imaginatively and realistically, other ability that can be trained through sketch strategy of knowledge is "logical thinking".

Furthermore, it can be argued that the real knowledge sketch strategy is the best way to teach physics, especially to train the ability to think. Diagrammatic sketch strategy comprises knowledge of certain aspects in the development of thinking skills. This strategyy can also train students to think critically.

Conclusion

The SKS strategy can be used to solve physics problem. The strategy stresses the process to train student to think through the translation of problems into a form of sketch. This will enhance the ability of students to be imaginative and realistic. The more difficult the problem is, the higher the level of metacognitive knowledge.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Abdullah H, Khaeruddin (2012). Study on Metacognitive Knowledge in Student Physics Education Program, Report of Research. Lembaga Penelitian Universitas Negeri Makassar.
Abdullah H, Daud Malago J, Bundu P, Thalib SB (2013). The Use of Metacognitive Knowledge Patterns to Compose Physics Higher Order Thinking Problem. Asia Pacific Forum on Science Learning and Teaching, 14(2):9.
Abdullah H (2014). Problem solving of Newton’s second law through a system of total mass motion. Asian Pacific Forum on Science Learning and Teaching, 15(2):1. https://www.eduhk.hk/apfslt/download/v15_issue2_files/helmi.pdf
Chi M, Van Lehn K (2010). Meta-Cognitive Strategy Instruction in Intelligent Tutoring System: How, When, and Why. Educ. Technol. Soc. 13(91):25-39.
Henderson C (2005) Strategies for development of student problem solving. Skills in the High School Physics Classroom. Am. J. Physics, 59(10):891-897.
Suparno P (2005). Filsafat Konstruktivisme Dalam Pendidikan, Penerbit Kanisius, Yogyakarta.
Widodo A (2008). Revisi Taksonoomi Bloom dan Pengembangan Butir Soal, Buletin Puspendik, 3(2):18-29.

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Full Length Research Paper

School resources and student achievement: A study of primary schools in Zimbabwe

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This study analyses the effects of school resources on student mathematics achievement in Zimbabwe using a 3-Level Hierarchical Linear Model (HLM). The major findings of the research are that a teacher trained in the relevant subject, class size, having a highly qualified school head and having a generally high resource endowment at school level improve student test scores. However, text book possession was seen as an insignificant predictor of student achievement. The implication of these findings is that resources owned by schools have an important effect on student test scores, suggesting that value and more attention should be given to what goes on in schools; as well as improving quality of human resources at school level. The study however has a limitation in that it does not fully explore all the probable school and class level determinants of student achievement due to data constraints.

Key words: School resources, student achievement, mathematics, hierarchical linear modeling.

INTRODUCTION

Upon attaining independence in 1980, Zimbabwe embarked on an ambitious drive to increase student enrolment particularly in the previously marginalised black communities, and it greatly succeeded over the years[1]. The key drive in this initiative is “the education for all” campaign where primary school fees were waived to encourage massive enrolments and the mobilisation of resources to build more primary schools. For instance by 2007, Zimbabwe had 5560 primary schools compared to 3116 in 1980 (Makopa, 2011). Unfortunately, this increase in both net and gross enrolment has been accompanied by a fall in overall student achievement. This is of great concern, bearing in mind that human capital accumulation is an important resource to a country’s economic growth. An educated labour force is likely to be more productive (Glewwe et al., 2011) than the less learned, hence the need to ensure that resources invested in human capital development are effective. Also, on the issues of poverty alleviation, such investments are vital considering that well-educated people have a better chance of improving their standard of living than the less educated. This kind of investment is particularly important in the rural areas of Zimbabwe, where the majority (60%) of the population resides (World Bank, 2014) and 70% of the people live below the poverty datum line (Nyamanhindi, 2014).

When analysing the composition of the students who

[1]For instance NER was 81.9% in 1994, 96.2% in 2000, and 96.9% in 2005 and in 2009 had increased slightly to 97.7%. Thereafter it fell to 81.4% by 2011, (UN, 2012).

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fail their primary school-leaving examinations, rural primary schools have not been performing well on average compared to those in the urban areas. Research has attributed such low outcomes to inadequacy of school resources to influence student achievement, hence well-resourced urban schools have outperformed their rural counterparts (Nyagura and Riddell, 1993; Makopa, 2011). It is worth mentioning however that, rural areas are not a total right off; there are other rural primary schools which outperform those in urban areas. With such a background, this research sought to investigate whether school resources have an impact on primary school students' performance in the rural areas. It also sought to establish which resources are important in enhancing the students' achievements. Such findings are important in informing policy, considering that resources are scarce, and they have to be spent effectively to achieve the desired goal of educational achievement.

Other than this paper, there are two similar papers identified in Zimbabwe which tend to vary in terms of methodology, focus and data employed. Nyagura and Riddell (1993) adopted a multilevel modelling procedure in ascertaining the percentage variance in primary school achievement attributed to different types of schools found both in rural and urban areas. The study adopts a stratified random sample with a fair representation of the dominant tribes in the country, Shona and Ndebele. Though its methodology is robust, it tends to compare urban and rural schools, where it is visibly evident that urban schools outperform their rural counterparts. Makopa (2011) used SACMEQ III (collected in 2007) data to assess the changes in the availability of the basic teaching and learning provisions in Zimbabwe primary schools as well as establishes how these resources were related to the pupil's achievements. This is a nationally representative research that groups both urban and rural schools, and it uses a descriptive methodology, which is not robust at all. Notwithstanding the fact that Nyagura and Riddell (1993) adopted a rigorous econometric approach, their paper is two decades old, and might no longer be relevant in informing policy, and their objectives are different from those of this paper. On the other hand, Makopa (2011) used a simple descriptive analysis in his study. With the discovery of more sophisticated research methodologies in this current era, this paper does not appeal much to policy (Glewwe et al., 2011).

LITERATURE REVIEW

The principal conceptual framework employed in educational outcome literature is the production function approach. This approach as with the conventional production function has inputs (such as school resources, socio-economic characteristics, and teacher characteristics), schools as 'factories' and outputs (mainly student achievement). Hence, an education production function defines the structural relation between inputs and achievements. In general, it can be depicted as:

$$A=f(S, Q, C, H, I)$$

With A denoting achievement, S years of schooling, Q a vector of school and teacher characteristics, C a vector of child characteristics, H a vector of household characteristics, and I a vector of inputs controlled by the parents (Glewwe et al., 2011). Though researchers in this area might differ in methodologies employed and data source and characteristics, they are guided by this framework.

Many researchers concur that the seminal work of the Coleman et al, (1966) played a significant role in stirring the debate about the impact of school resources on student achievement (Rumberger and Palardy, 2004; Ehrenberg et al., 2001). In this respect, several researches, varying within space, time and methodological approaches have been performed in a bid to validate or reject the findings of the 1966 report.

Though the Coleman report's survey initially focused on measuring the extent of racial segregation of American schools, it collected comprehensive data on students' test scores (aged 8, 11, 14 and 17 years), their family background, their teacher attributes, the schools they attended, and the characteristics of their communities (Ehrenberg et al., 2001). Such data enabled the researchers to learn whether students' achievements were influenced by the variables in question. The research stated that variations in family background and community level characteristics better explain student achievement differentials across schools than were variations in school resources (such as pupil/teacher ratios or expenditures per pupil), and teacher characteristics (such as experience and degree levels).

The Coleman report's findings came under heavy criticisms in the 1980s through the findings of the study by Heyneman and Loxley (1983) study. They bemoaned the tendency of some scholars to assume that findings from one part of the world could be generalised as being applicable to the other part. In particular, the researchers observed that the debates about the significance of school resources in influencing educational outcomes were based on data from developed parts of the world (such as the USA, Europe, and Japan). These were then taken as if they applied even to the less developed nations. Heyneman and Loxley thus examined the Second International Mathematics and Science Study (SIMSS), a data set covering both developed and developing countries and contrary to the Coleman report, school characteristics were observed to be more important than family socioeconomic status in determining student achievement. Students' socio economic status had a weaker impact on their academic achievement, rather the quality of schools and teachers to which children are exposed to affect students' achievement.

Such insightful findings motivated Baker et al. (2002) two decades later to test whether the "Heyneman-Loxley effect" was still valid, considering there had been significant increases in enrolment and provision of school resources and there have not been a systematic review of the "Heyneman-Loxley effect". Baker et al. (2002) examined data from the Third International Mathematics and Science Study (TIMSS)[3] of the 1990s and estimated using Ordinary Least Squares (OLS)[4] and observed that the "Heyneman-Loxley effect" had subsided. The research concluded that what determined student outcomes after such significant developments were factors external to the school. They however did not completely rule out the Heyneman-Loxley effect, as they consent that it could still be valid in those countries still rooted in deep poverty, unrests and epidemics which hampered mass school enrolments[5].

Greenwald et al. (1996) employed meta-analytic methods on a variety of production function researches and revealed that school resources had a positive influence on student outcomes. Variables such as pupil expenditure and teacher remuneration were observed to have a significant positive and consistent influence on student achievement. Also, having small schools, low student-teacher ratios, and teacher quality were seen to positively impact on student outcomes. Hanushek (1997) however maintained that there is no significant or consistent relationship between school resources and student's educational outcomes, at least after variations in family inputs are taken into account, reaffirming the Coleman report's findings. This study employed meta-analytic approaches as used by Greenwald et al. (1996), reviewing 400 educational production literature. He argued that Greenwald et al. (1996) overall sampling was biased on retaining both statistically significant positive and insignificant but positive results, just the direction that leads to supporting their general conclusions. Therefore, Hanushek (1997) argued that simple resource policies held little hopes for improving student outcome.

Using data from the South African Living Standards Survey (SALSS) of 1993, questionnaires on local facilities, and a literacy and numeracy survey, Case and Deaton (1999) examined the relationship between educational inputs (pupil-teacher ratios and school facilities) and school outcomes (including school attendance, educational attainment, and test scores) in South Africa. Their analysis shows that pupil-teacher ratios have a marked impact on black children's outcomes, holding constant a mix of teacher and other resources. They attribute it to the discrimination against the black community by the apartheid regime that which enabled other races to have significantly better school resources and lower pupil-teacher ratio. Hence, they advise of a need to improve resourcing in disadvantaged schools in order to improve student achievement. Such results to an extent conform to the "Heyneman-Loxley effect", considering Baker et al. (2002) suppositions of stating that the severely marginalised communities need schools that are well resourced for them to raise student achievement.

Smith (2011) however argued that policy focus should be wider than just school resourcing levels and facilities in South Africa; as has been embarked on by the current government to narrow the gap between the educational attainments between races. He argues that there is a need to empower deprived neighbourhoods so that they can overcome acute social disadvantages that impact on student achievement. These include having poor nutrition, lower fluency in language of instruction and children having to travel long distances to attend school. To arrive at these results, Smith (2011) developed multilevel models for individual learners of similar socio-economic status to ascertain determinants of their achievement. The data used are grade 6 mathematics and reading scores obtained from SACMEQ II surveys of the year 2000.

With a multilevel modelling technique, Nyagura and Riddell (1993) investigated the causes of primary school achievement variance between different primary school categories in Zimbabwe. In the analysis, the primary schools were placed into 5 categories; high fee paying (private), former group A, former group B[6], low fee paying, and rural district primary schools. Using the official Ministry of Education's final leaving examinations (grade 7), the paper found that for both subjects, group A and high-fee-paying schools performed better than the rest, followed by group B and low-fee-paying schools, and at the bottom, district council schools. District council schools are those located in the rural areas. Primary school student achievement were seen to be influenced by the amount of teacher training and instructional time, and pupil-teacher ratio for both subjects and instructional time particularly for mathematics, and these issues were prevalent in the rural areas.

Makopa (2011) using SACMEQ III reading and mathematics scores of grade 6 pupils, sought to establish the availability of basic classroom resources and their impact on pupils' achievements. The research shows a strong relationship between schools having more resources and increasing achievements in reading and mathematics tests. Relatively well resourced provinces, which happen to be metropolitan provinces in

[3]A newer version of the data employed by Heyneman and Loxley (1983).
[4]Used the same estimation method used by Heyneman and Loxley (1983) for uniformity.
[5]For example Sudan, Myanmar, Chad, Angola and Ethiopia.

[6]Pre independence Zimbabwe had two classes of government funded schools as a result of racial segregation. Group A schools were those catering for the 'European' community, and the group B schools catered for the African urban population. The group A schools were accorded preferential treatment by the government in power such that they were well resourced relative to group B schools. Upon attaining independence, Zimbabwe abolished this type of segregation (Nyagura and Riddell, 1993).

Zimbabwe (Bulawayo and Harare), performed better than their rural counterparts. This research however was a descriptive study without any econometric analysis. This paper recommended future research to focus on within province variations, to see whether resource differentials affected student outcomes.

Glewwe et al. (2011) highlights important issues pertaining to the impacts certain methodologies have on the credibility of such research findings. In their review of educational achievement published between 1990 and 2010, they observed mixed results, which in actual fact are influenced by the quality screening the researchers subject the papers to. In particular, this paper reviews literature that estimates the impact of school infrastructure and pedagogical materials, teacher and principal characteristics as well as the general school organisation on student learning and time in school.

The reviewed researches employed various methodologies such as Randomised Controlled Trials (RCT), Difference in Differences (DD) regression, Regression Discontinuity Design (RDD) and Ordinary Least Squares (OLS). It starts with over 9,000 studies, but scales down to 79, 43, and eventually 13, screening them on the basis of the econometric method employed by the selected studies in what they term a 'quality test'. Most school and teacher characteristics are statistically insignificant, especially when the evidence is limited to the "high quality" studies, thought availability of desks, teacher knowledge of the subjects they teach, and teacher absence do have significant effects. They conclude that having a fully functioning school is conducive for student learning.

The quality of the econometric approach is important in educational research. There is need to ensure that the researcher is aware of the shortcomings of the methodology employed, and most importantly employ a more rigorous model such that the findings are closer to the obtaining situation on the ground. Some reviewed literature such as the Heyneman and Loxley (1983), Baker et al. (2002) and Case and Deaton (1999) adopted the ordinary least squares approach in estimating the determinants of student achievement. This methodology however does not pass the 'Glewwe test' as the paper regards such methodology is inadequate to correctly estimate the impacts such resources have on student achievement.

Though not mentioned by Glewwe et al. (2011), the methodology adopted by Makopa (2011) is equally insufficient. Simple descriptive statistics are not rigorous at all, and would not have passed the Glewwe test. Those which pass the test are Randomised Controlled Trials (RCT), Difference in Differences (DD) regression, Regression Discontinuity Design (RDD) and OLS regressions that further employ more sophisticated methodology to control for potential omitted variable or endogeneity bias. The paper by Nyagura and Riddell (1993) becomes more sophisticated than the simple OLS regression as it takes into account the inherent clustering nature of students into classes, clustered in schools, which are further clustered into districts. Such a methodology in cross sectional data is plausible. However, the other methodologies suggested by Glewwe et al. (2011) prove to be expensive and difficult to employ (such as natural experiments and RCT).

To sum it up, the reviewed literature on estimating the effects of school resources on students' achievement is ambiguous and contested. This however does not render such contrasting results futile; in fact, important lessons are deduced which help improve future research outcomes.

For instance, the realisation by Heyneman and Loxley (1983) that research findings from one part of the world cannot be misconstrued to be universally applicable. Such generalisations are likely to misinform policy, which might lead to a waste of scare resources, negatively impacting economic growth, and livelihood outcomes. Similarly, Baker et al. (2002) effort of testing the validity of the Heyneman-Loxley effect within time is equally relevant. It shows that in this dynamic world, no research findings can withstand time. So much changes as years go by and there is need to constantly invest in updating research findings for policy to remain relevant. Makopa's (2011) recommendation for a further research to test the significance of school resources on within-province achievement differentials is equally valid. This suggestion is in line with the arguments of Heyneman and Loxley (1983).

Also, methodological issues raised by Glewwe et al. (2011) highlight the importance of knowing the limitations of each methodology and make possible corrective measures such that findings do not deviate much from what is factual. Basing on this review, this research sought to establish whether school resources have an influence on primary school students' outcomes in rural Zimbabwe, bearing in mind that the methodology to be employed is of critical importance.

METHODOLOGY

Conceptual model

The schooling process is considered as a multilevel system that processes inputs into outputs. Thus a school is loosely equated to a 'factory', though in this instance the inputs are human, and the outputs are student achievement (Glewwe et al., 2011). The multilevel concept emanates from the realisation that a student's achievement is influenced by factors that can be split into 3 distinct categories, which are student level factors (such as cognitive ability, family socio-economic status, age and gender), classroom level factors (such as teacher characteristics, class size and availability of learning resources), and lastly school level factors (such as the school climate, school size, and the availability of learning resources such as libraries and laboratories) (Rumberger and Palardy, 2004). All these level factors have an influence on the effectiveness of this 'factory' in processing its inputs into outputs. Rumberger and Palardy (2004) present this interaction in Figure 1.

Such conceptual models are important as they guide the design of the study, such as the selection of participants, variables and the

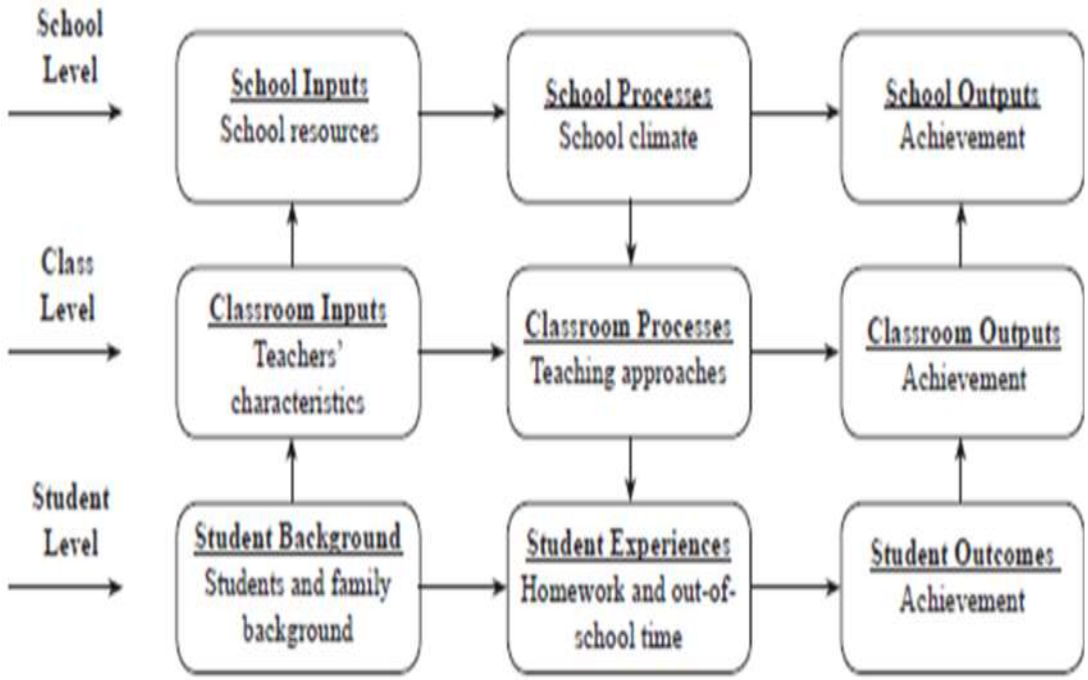

Figure 1. A Multilevel Conceptual Framework for analysing school effectiveness.
Source: Rumberger and Palardy (2004).

model to be employed in data analysis (Rumberger and Palardy, 2004).

Data

Data was obtained from the Southern and Eastern Africa Consortium for Monitoring Educational Quality (2014), a consortium comprising of Southern African educational ministries and other stake holders whose main aim is to monitor educational quality amongst member states. The consortium has embarked on a large scale cross national research study in member states to assess the conditions of schooling and performance levels of learners and teachers in the areas of literacy, numeracy as well as the learners' basic health knowledge. Since Zimbabwe is a member state, this research was made easier by the availability of such rich data, which is costly and almost impossible to collect as an individual due to many impediments.

The study population

In Zimbabwe, the SACMEQ III's study population were all the pupils at the grade 6 level attending registered schools, as well as their teachers and the school heads of such schools. The desired, defined and excluded population statistics are presented in Table 1.

The desired population is the total number of grade 6 pupils, their teachers and school heads at all registered educational institutions. The project excluded grade 6 enrolments of fewer than 20 students, hence the excluded population column on the Table 1.

The study sample

The SACMEQ III project used a 2 stage cluster sampling approach to select a sample of 3021 grade 6 students from 155 schools, 155 heads, and 274 teachers were also selected (Makopa, 2011). To get the winning schools per province, a lottery was drawn, and a simple random sampling approach was employed to select the students per school. The consortium treats urban and rural schools as equals in its sampling approach, which hampers the success of this research to achieve its objectives. But however, since Matabeleland South Province is predominantly rural, there are higher chances that the majority of the selected students hail from rural areas. The researcher assumes that the results obtained by the SACMEQ III in Matabeleland South Province are more a reflection of the rural students as opposed to the urban ones. The SACMEQ's response rate in Matabeleland South is relatively low, and Makopa (2011) attributes such low response rates to administration problems within this province. This further justifies the need to interrogate the effectiveness of these areas in churning out human capital. Table 2 is a summary of the planned and achieved sample as well as the percentage response rate per province.

Method of analysis

This research adopts a HLM or Multilevel Regression Analysis (MRA) in order to achieve its set objectives. This method of analysis is rightly applicable to this kind of research considering the type of data to be analysed, which is nested, or clustered in nature. Previous researchers such as Raudenbush and Bryk (1988), Nyagura and Riddell (1983), and Ker (2014) have applied it to similar researches.

Employing traditional analysis such as the Ordinary Least Squares (OLS) approach was observed to ignore dependence in the data that results from grouping, whereas analysis at the group level did not permit straightforward inferences or predictions at individual level (Ker, 2014). A fundamental assumption of most

Table 1. Desired, defined and excluded population.

Provinces	Desired Population		Excluded Population		Defined Population	
	School	G6 Pupils	School	G6 Pupils	School	G6 Pupils
Bulawayo	126	15108	13	191	113	14917
Harare	204	31587	9	108	195	31479
Mash Central	374	25506	30	528	344	24978
Mash East	583	35778	88	1340	495	34438
Mash West	464	32546	46	784	418	31762
Midlands	658	43600	51	824	607	42776
Manicaland	776	50317	63	979	713	49338
Mat North	435	21019	73	1230	362	19789
Mat South	438	20267	67	1113	371	19154
Masvingo	683	41362	58	861	625	40501
Zimbabwe	**4741**	**317090**	**498**	**7958**	**4243**	**309132**

Source: Makopa (2011)

Table 2. Planned and achieved sample and the response rate per province.

Provinces	Planned Sample		Achieved Sample		Response Rate (%)
	School	G6 Pupils	School	G6 Pupils	
Bulawayo	16	400	16	256	64.0
Harare	16	400	16	294	73.5
Mash Central	16	400	16	349	59.8
Mash East	16	400	16	260	65.0
Mash West	16	400	16	337	84.3
Midlands	16	400	16	289	72.3
Manicaland	16	400	16	308	77.0
Mat North	16	400	15	304	76.0
Mat South	16	400	12	239	59.8
Masvingo	16	400	16	385	96.3
Zimbabwe	**160**	**4000**	**155**	**3021**	**75.5**

Source: Makopa (2011)

statistical models is that observations included in the analysis are ‘independent’ or uncorrelated with one another (Putnam-Hornstein, 2013). It is assumed that educational interventions have a constant effect on all students who are exposed to them, and these effects are invariant across organizational contexts (Bryk and Raudenbush, 1988). It is assumed these structures lead to less efficient parameter estimates, losing the fascinating interrelationships between the different levels (Nyagura and Riddell, 1993) since hierarchical data violates this assumption. The individuals clustered within one group are likely to be more similar to other members of the group than to individuals clustered within another group (Putnam-Hornstein, 2013).

This dependence is prevalent in schools because of the shared experiences among students and because of the non-random assignment of students to schools which is usually based on location. This dependence is also evident in survey research whenever a cluster sample is employed. As is applicable in this research, a sample of students drawn purely at random will provide a more precise base for statistical estimates than would a sample of students drawn through a two-stage procedure of first selecting a set of schools at random and then drawing students at random from within them (Bryk and Raudenbush, 1988).

Moreover, ‘the inherent nesting of educational systems in which students are nested in classes which, in turn, are nested in schools; which themselves are nested in districts or regions, making the covariance within each level of direct interest (Nyagura and Riddell, 1993). Hierarchical linear modelling resolves this problem by incorporating the unique effects of individual schools into the statistical model for the outcome, thus the estimates adjust for the intra-class correlation that emanates from cluster sampling (Bryk and Raudenbush, 1988). Multilevel analysis helps explain student achievement as a function of student school-level or classroom-level characteristics, while taking into account the variance of student outcomes within schools (Webster et al., 1996).

Model specification

These formulations are derived from Subedi (2004) and Stephens (2007).

Level 1 Model: Student variables

$$Y_{ijk} = \pi_{0jk} + \pi_{1jk} A_{pijk} + \varepsilon_{ijk} \quad (1)$$

where Y_{ijk} is achievement score of student *i* in class *j* in school *k;* π_{0jk} is an intercept at fist level (student level); A_{pijk} is a predictor at level 1, such as the age of student or estimated family income; π_{1jk} is the slope/coefficient for a predictor A_{pijk}, and ε_{ijk} represents the random effect for student *i*, class *j* and school *k*, which is normally distributed with mean zero and variance $\sigma^{2.}$

Level 2 Model: Class variables

$$\pi_{0jk} = \beta_{p0k} + \beta_{p1k} X_{qjk} + r_{p0k} \quad (2)$$

$$\pi_{1jk} = \beta_{p1kj} + \beta_{p1k} X_{qjk} + r_{p1k} \quad (3)$$

where Level 1 intercept π_{0jk} and level 1 slope π_{1jk} are now the outcomes, parameters β_{p0k} and β_{p1kj} are level 2 intercepts. Coefficients β_{p1k} and β_{p1k} are level 2 slopes and the error terms r_{p0k} and r_{p1k} are random effects of class *j* and school *k*.

Level 3 Model: School variables

$$\beta_{p0k} = \gamma_{pq0} + \gamma_{pqs} W_{sk} + r_{pqk} \quad (4)$$

$$\beta_{p1k} = \gamma_{pq1} + \gamma_{pqs} W_{sk} + r_{pqk} \quad (5)$$

where Level 2 slopes and intercepts become outcomes, W_{sk} are level 3 predictors and r_{pqk} are random effects associated with school *k*. All these equations can be formulated into a single equation where level 3 is infused into level 2 equations; which are in turn plunged into level 1 equation.

Variables

The variables considered in this research come in 3 levels, conforming to the theoretical framework and the model choice. It is important to note that this study has limited its variable selection, because of time constraints. This does not imply that the SACMEQ III variables are limited to the extent of this paper's analysis.

Student achievement [dependent variable]

The standardised student mathematics test score is taken as a dependent variable to assess the impact of school resources on student achievement.

Student gender

Student's gender: Male =1, Female =0. The impact of gender on student achievement is a contentious issue in the student achievement discourse. It can be argued that depending on the socialisation processes within different cultures, this has an impact on how children view school and hence their achievement. In cases where a boy is considered as a bread winner and a girl as a child and family minder, one would expect that the boy performs better than the girl. However, literature provides mixed results to this effect. This paper, since it dwells on a rural setting which is dominantly patriarchal, would prematurely predict that boys do better than girls.

Student repetition

This variable reveals whether a student has ever repeated in his/her studies. The SACMEQ III questionnaire has a provision for one to respond as either never repeated, repeated once, twice or trice or more times. However, this paper recorded the responses as either yes or no. This limits the analysis, but then such recoding makes it easier to analyse. Usually, students repeat because they will not have progressed well in their studies. This research takes this variable as an indicator of a student's cognitive ability.

Parents' educational status

Parents' highest education level is actually the father's education level (or male guardian). It is compared between those without ordinary level, to those who have attained ordinary level or higher. This research assumes that the ordinary level is a meaningful cut off, comparing the overall impact of a parent's educational level on student outcome.

Class size

This is the number of children attending grade six in a sampled class according to the teacher's register. As discussed in the literature review section, this variable is contentious. Some studies argue that small class sizes enable students to achieve more, whereas some provide evidence that large classrooms enhance student achievement.

Availability of mathematics textbook

SACMEQ III presents a set of questions pertaining to text book availability in the class. These questions interrogate the availability, number, whether shared or not. This study uses information on whether there are mathematics text books allocated to students or not at any given time. Conventional wisdom states that the availability of textbooks goes a long way in empowering a student to achieve good grades as the student is able to follow what he/she is taught, and is able to revise or practice on his/her own. There is however evidence showing that having a textbook does not guarantee that a student will fare well in his/her studies. This could be because of other factors such as the inability of the child to use the book resourcefully or simply a lack of a reading culture in him.

Total school resources

This variable is obtained from the school head's response to questions about the availability of certain facilities within the school. These are ranked out of a maximum of 22, and each school is gauged on this benchmark.

School head qualification

The school head's qualifications are based on the responses pertaining to his/her actual academic training. The responses range from no professional training at all to more than 3 years of training. The researcher believes that such training is critical as the head understands what teachers go through on a daily basis and can easily monitor them to ensure that they are effective.

RESULTS AND DISCUSSION

This paper performed four different regressions, using the Statistical Package for Social Scientists (SPSS) version 22 to better reveal whether school resources had any effect on student achievement. Firstly, a regression was run on Matabeleland South province data, and the behaviour of the school resources were analysed. The second regression was performed on the best performing province in Zimbabwe, which is Harare. This province is predominantly urban, and the behaviour of school resources on student achievement was also noted. Thirdly, we ran a regression on Matabeleland South and Harare data combined, and a dummy variable for being either a student in Matabeleland South (=1) or Harare (=0) is introduced. On the final regression, the researcher took advantage of the richness of the SACMEQ III data which sampled the entire country. Thus a regression on the complete SACMEQ III data was regressed on student maths achievement scores. At this stage, provincial dummy variables for all provinces were introduced to better understand how school resources impacted on student achievement at national level. Here, presents these results and also appropriate tests were performed to ensure that the results are robust.

Descriptive statistics

There were 4 different regressions performed in this analysis: the Matabeleland province (MTS), Harare province (HAR), combined Matabeleland and Harare provinces (MTS HAR) and lastly on the national sample (ZIM). The MTS and HAR data have no dummy variables; hence, no values are inserted on these rows. The MTS HAR data set has a dummy on either being enrolled at a school in MTS or HAR. Lastly, the national sample has provincial dummies indicating from which province a student studies. Table 3 shows the mean, standard deviation and the number of observations for each variable (N).

Diagnostic tests

It is important to examine that the regression analysis does not violate these assumptions. In assessing whether the residual errors are normally distributed, a Normal Probability Plot (P-P) of the Regression Standardised Residual was generated in SPSS. For normality to prevail, the points should be reasonably in a straight diagonal line from the bottom left to the top right of the plot (Boduszek, 2013). Thus, considering the plots in Figure 2, it can be concluded that in all the analyses, the random errors are normally distributed.

To test for multicollinearity in HLM models generated in SPSS, one can observe the values of the tolerance and the Variance Inflation Factor (VIF). If the tolerance values are less than 0.10, and if the VIF value is above 10, one might conclude that there is multicollinearity (Boduszek, 2013). Table 4 shows the collinearity statistics for the regressions. Based on the aforementioned rule of thumb, it can be concluded that there is no multicollinearity in the model regressions. Boduszek (2013) suggests that one of the independent variables should be removed if there is multicollinearity. The variables being examined here are from the 3rd level of the HLM.

Interpreting the coefficients of the independent variables

To evaluate the effect of school resources on student achievement in a 3-level HLM method of analysis, one has to check the standardised coefficient (Beta values) generated under the significance sections of Model 3 in SPSS (Boduszek, 2013). The coefficients were generated for all 3 levels, but the important ones are those generated in Model 3 of the regression output. Table 5 depicts the extracts of the coefficients generated by SPSS for 4 regressions. The first was for Matabeleland South province (MTS), the second one for Harare province (HAR), the third for the combined regression of Matabeleland South and Harare Provinces (MTS HAR) and lastly for Zimbabwe’s 10 provinces. The regression analysis showed that in the case of MTS, a one student increase in class size decreased test scores by 0.167, contrary to the findings of the Coleman et al, (1966) and conforming to the Heyneman and Loxley (1983), though the combined regression (MTS HAR) is showing a positive effect, but not significant in the HAR regression and the 10 province regression.

Furthermore, in the MTS regression, holding other variables constant, a teacher trained to teach mathematics positively impacted on a student’s achievement by as much as 0.161% points relative to untrained teachers, in line with Greenwald et al. (1996) who found teacher quality as having a significant impact on student outcomes, though not significant in the other regressions. It is worrying to find that several years after the Nyagura and Riddell (1993) study, Zimbabwe still had a high number of less qualified teachers.

Students in schools with more facilities according to the SACMEQ III scale of 22, generally achieve higher scores than those with less facilities (beta = 0.809). The significance of school facilities is positive in all regressions, signifying the importance of such facilities irrespective of school location. These findings concur with Case and Deaton (1999) who observed that in South Africa, schools located in predominantly black communities had fewer facilities due to the Apartheid regime. The MTS data also shows that a headmaster with a tertiary qualification made students achieve at

Table 3. Descriptive statistics

Variables	MTS Descriptive Statistics			HAR Descriptive Statistics			MTS HAR Descriptive Statistics			ZIM Descriptive Statistics		
	Mean	Std. Deviation	N	Mean	Std. Deviation	N	Mean	Std. Deviation	N	Mean	Std. Deviation	N
Standardised Maths Scores	2.86	1.137	237	4.37	1.14	293	3.69	1.497	530	3.44	1.47	3018
Male Student	0.44	0.498	239	0.41	0.492	294	0.42	0.495	533	0.44	0.496	3021
Student never repeated	0.74	0.442	236	0.82	0.388	294	0.78	0.414	533	0.69	0.463	3021
Father has sec/higher education	0.26	0.441	239	0.54	0.499	283	0.4143	0.49307	519	0.42	0.494	2955
High Family SES	0.40	0.49	239	0.89	0.312	294	0.67	0.471	533	0.42	0.494	3021
Grade 6 class size	53.82	22.578	239	171.35	60.538	294	118.6473	75.29463	533	87.21	58.774	3021
Maths teacher received training	0.74	0.437	239	0.88	0.32	294	0.8218	0.38307	533	0.88	0.321	2996
Student has access to textbook	0.78	0.416	239	0.92	0.272	287	0.8555	0.35192	526	0.77	0.42	3013
Total School Resources (Max=22)	7.06	4.616	221	13.96	2.715	294	11	5	515	7.69	4.362	2805
Head has tertiary education	0.55	0.499	221	0.92	0.274	294	0.76	0.428	515	0.61	0.488	2805
Harare	--	--	--	--	--	--	0.55	0.498	533	0.1	0.296	3021
Bulawayo	--	--	--	--	--	--	--	--	--	0.08	0.279	3021
Manicaland	--	--	--	--	--	--	--	--	--	0.1	0.303	3021
Mashonaland Central	--	--	--	--	--	--	--	--	--	0.12	0.32	3021
Mashonaland East	--	--	--	--	--	--	--	--	--	0.09	0.281	3021
Mashonaland West	--	--	--	--	--	--	--	--	--	0.11	0.315	3021
Masvingo	--	--	--	--	--	--	--	--	--	0.13	0.334	3021
Matabeleland	--	--	--	--	--	--	--	--	--	0.1	0.301	3021
Midlands	--	--	--	--	--	--	--	--	--	0.1	0.294	3021

Source: Author's calculations.

least 0.132% points more compared to students with a school head who has no tertiary qualification. This variable is also significant in the MTS HAR and national level regressions. However, in the urban province of Harare; a head's qualifications do not significantly influence student achievement. Holding all else equal, a male student is probably likely to score a lower maths score by 0.178% points compared to girls. The research finds a significant positive influence of having a mathematics textbook in the metropolitan province of Harare, contrary to findings in the Matabeleland South case (which finds it insignificant). Thus, a student without a maths text book falls behind with 0.097%, all things being equal.

In the MTS HRE regression, the research introduced a provincial dummy to observe whether learning in any of the provinces made a student have an edge over one who studied in a comparative province. The results show that being in any of the provinces does not explain student achievement; rather what could explain these variations was at the school level. One could suggest that what could make Harare schools perform better than Matabeleland South are not provincial level factors, but rather differences could emanate at school level. At the national level however, it shows that studying in any other province makes a student achieve better maths scores relative to being in the Matabeleland South province.

Studying in the Midlands province enabled a student to achieve as much as 0.216% points (which is the highest), whereas being in Harare made a student achieve at least 0.075% points

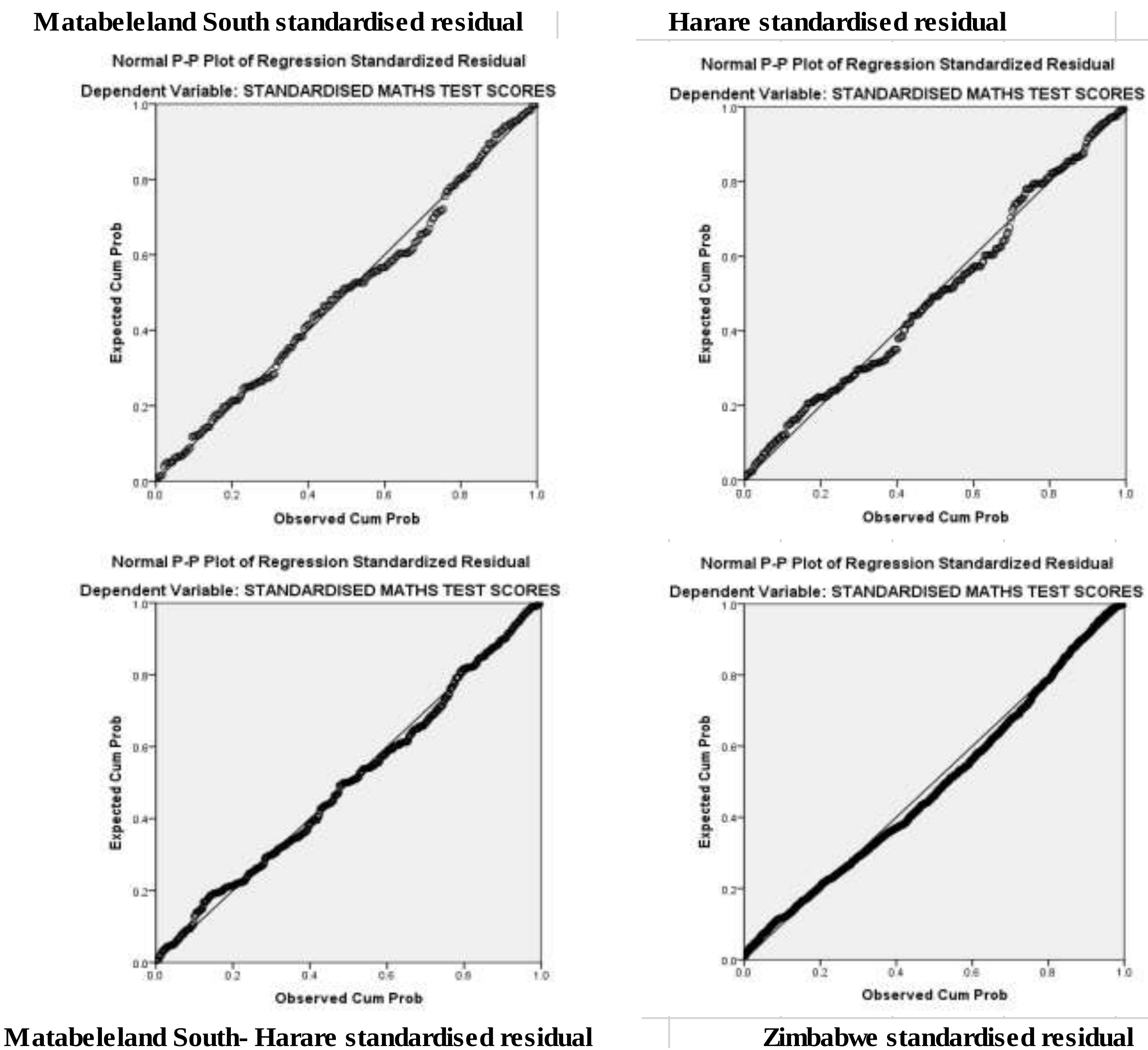

Figure 2. Testing for normality.

better than being in Matabeleland South. It is also important to note that this research aimed at establishing the effects of school resources, particularly school and classroom specific resources on student achievement. Considering that student level variables cannot be ignored, these have been added to this analysis as controls only. This helps address problems of bias considering that student level variables can be correlated with other regressor (Graddy and Stevens, 2003).

Conclusion

This research assessed how school resources have an impact on student achievement in Matabeleland South province of Zimbabwe, which has performed dismally over the years compared to other provinces. In terms of human capital resources in a school, the research reveals the importance of well trained teachers and headmasters for improved test scores. In the same vein, this will impact negatively on student achievement if teachers are made to teach large classes. There are basic facilities that are needed to enhance student achievement. Facilities such as libraries are surely important to this effect. It is therefore recommended that in order to improve student achievement in Matabeleland South, it is important that policy makers pay attention to improving human capital needs in the province (seconding well trained teachers and headmasters), class size as well as improvement of school facilities.

Table 4. Tolerance and variance inflation factor values.

Variables	MTS Coefficients		HAR Coefficients		MTS HAR Coefficients		ZIM Coefficients	
	Collinearity Statistics		Collinearity Statistics		Collinearity Statistics		Collinearity Statistics	
	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Constant								
Male Student	0.961	1.04	0.988	1.012	0.995	1.005	0.981	1.019
Student never repeated	0.885	1.13	0.903	1.108	0.928	1.078	0.946	1.057
Father has sec/higher education	0.897	1.115	0.935	1.069	0.861	1.161	0.908	1.101
High Family SES	0.804	1.243	0.967	1.034	0.657	1.521	0.694	1.442
Grade 6 class size	0.552	1.811	0.933	1.071	0.389	2.57	0.515	1.941
Maths teacher received training	0.71	1.409	0.972	1.029	0.919	1.088	0.926	1.08
Student has access to textbook	0.816	1.226	0.857	1.167	0.895	1.117	0.914	1.094
Total School Resources (Max=22)	0.445	2.246	0.91	1.099	0.472	2.117	0.402	2.486
Head has tertiary education	0.711	1.407	0.82	1.22	0.765	1.308	0.874	1.145
Harare	--	--	--	--	0.248	4.04	0.397	2.521
Bulawayo	--	--	--	--	--	--	0.343	2.912
Manicaland	--	--	--	--	--	--	0.46	2.174
Mashonaland Central	--	--	--	--	--	--	0.42	2.382
Mashonaland East	--	--	--	--	--	--	0.5	2
Mashonaland West	--	--	--	--	--	--	0.457	2.189
Masvingo	--	--	--	--	--	--	0.412	2.424
Matabeleland	--	--	--	--	--	--	0.445	2.249
Midlands	--	--	--	--	--	--	0.481	2.079

Source: Author's calculations.

An important contribution of this research to the student achievement discourse has been the employment of more sophisticated methodology, as recommended by Glewwe et al. (2011). Borrowing from the insights of Raudenbush and Bryk (1988), the HLM was seen appropriate considering that student achievement is impacted by various phenomena which can be grouped into 3 main levels. As earlier highlighted, if the research properly accommodates all variables, it is more likely to bring out a more accurate estimation of the effects of school resources on student achievement.

CONFLICT OF INTERESTS

The author has not declared any conflicts of interests.

REFERENCES

Baker DP, Goesling B, Letendre GK (2002). Socioeconomic Status, School Quality, and National Economic Development: A Cross-National Analysis of the "Heyneman-Loxley Effect" on Mathematics and Science Achievement. Comparative Educ. Rev. 46:3. DOI: 10.1086/341159.

Boduszek D (2013). Multiple Regression Lecture Notes; http://www.danielboduszek.com/documents/Multiple%20Regression%20-%20D.%20Boduszek.pdf.

Bryk AS, Raudenbush SW (1988). Toward a More Appropriate Conceptualization of Research on School Effects: A Three-Level Hierarchical Linear Model. Am. J. Educ. 97(1):65-108.

Case A, Deaton A (1999). School inputs and educational outcomes in South Africa. Q. J. Econ. 114(3):1047-1084.

Coleman JS, Campbell EQ, Hobson CJ, McPartland J, Mood

Table 5. Estimated HLM coefficients of student and school characteristics on student's standardised math test scores.

Variables	MTS Coefficients			HAR Coefficients			MTS HAR Coefficients			ZIM Coefficients		
	Std. Coefficients (Beta)	t	Sig.	Std. Coefficients (Beta)	t	Sig.	Std. Coefficients (Beta)	t	Sig.	Std. Coefficients (Beta)	t	Sig.
Constant		5.481	0.00*		1.143	0.254		3.255	0.001*		9.927	0.00*
Male Student	-0.178	-3.53	0.001*	0.023	0.416	0.677	-0.032	-0.955	0.34	-0.003	-0.17	0.865
Student never repeated	0.075	1.42	0.157	0.242	4.272	0.00*	0.165	4.76	0.00*	0.175	10.617	0.00*
Father has sec/higher education	0.024	0.466	0.641	0.126	2.26	0.025*	0.1	2.788	0.006*	0.094	5.574	0.00*
High Family SES	-0.056	-1.02	0.309	0.093	1.696	0.091	0.055	1.346	0.179	0.062	3.234	0.001*
Grade 6 class size	-0.167	-2.506	0.013*	0.079	1.426	0.155	0.107	1.995	0.047*	0.021	0.931	0.352
Maths teacher received training	0.161	2.751	0.006*	-0.081	-1.489	0.138	-0.047	-1.349	0.178	-0.013	-0.799	0.424
Student has access to textbook	0.077	1.406	0.161	0.097	1.673	0.096	0.097	2.755	0.006*	-0.007	-0.429	0.668
Total School Resources (Max=22)	0.809	10.928	0.00*	0.185	3.288	0.001*	0.456	9.401	0.00*	0.406	16.086	0.00*
Head has tertiary education	0.132	2.251	0.025*	0.115	1.936	0.054	0.139	3.641	0.00*	0.038	2.197	0.028*
Harare	--	--	--	--	--	--	-0.036	-0.542	0.588	0.075	2.753	0.006*
Bulawayo	--	--	--	--	--	--	--	--	--	0.09	3.537	0.00*
Manicaland	--	--	--	--	--	--	--	--	--	0.08	3.395	0.001*
Mashonaland Central	--	--	--	--	--	--	--	--	--	0.15	6.048	0.00*
Mashonaland East	--	--	--	--	--	--	--	--	--	0.06	2.627	0.009*
Mashonaland West	--	--	--	--	--	--	--	--	--	0.123	5.175	0.00*
Masvingo	--	--	--	--	--	--	--	--	--	0.216	8.639	0.00*
Matabeleland	--	--	--	--	--	--	--	--	--	0.157	6.531	0.00*
Midlands	--	--	--	--	--	--	--	--	--	0.179	7.748	0.00*

Source: Author's calculations.

AM, Weinfeld FD York RL (1966) Equality of Educational Opportunity. Washington, DC: US Department of Health, Education & Welfare. Office of Education (OE-38001 and supp.), 1966. 548 p.

Ehrenberg RB, Brewer DJ, Gamoran A, Willms, JD (2001).Class Size and Student Achievement. Psychological Science in the Public Interest. 2:1.

Glewwe PW, Hanushek EA, Humpage SD, Ravina R (2011). School Resources and Educational Outcomes in Developing Countries: A Review of the Literature from 1990 to 2010. NBER Working Paper No. 17554.

Graddy K, Stevens M (2003). The impact of school inputs on student performance: An empirical study of private schools in the United Kingdom, University of Oxford, UK.

Greenwald R Hedges LV, Laine RD (1996). The Effect of School Resources on Student Achievement. Rev. Educ. Res. 66(3):361-396.

Hanushek EA (1997). Assessing the effects of school resources on student performance: An Update. Educ. Evaluation Policy Anal. 19(2):141-164.

Heyneman S, Loxley W (1983).The effect of primary school quality on academic achievement across twenty-nine high and low-income countries. Am. J. Sociol. 88:1162-94.

Ker HW (2014). Application of Hierarchical Linear Models/Linear Mixed-effects Models in School Effectiveness Research. Universal Journal of Educ. Res. 2(2):173-180. DOI: 10.13189/ujer.2014.020209.

Makopa Z (2011).The provision of the basic classroom teaching and learning resources in Zimbabwe primary schools and their relationship with the grade 6 pupils' achievements in the SACMEQ III project.Memoir presented within the framework of the IIEP 2010/2011 Advanced Training Programme in Educational Planning and Management, UNESCO/IIEP.

Nyagura LM, Riddell A (1993). Primary School Achievement in English and Mathematics in Zimbabwe: A Multilevel

Analysis. Education and Social Policy Department Human Resources Development and Operations Policy. The World Bank.
Nyamanhindi R (2014). Zimbabwe, 20 June 2014: UNICEF boosting children's nutrition to prevent stunted growth, UNICEF.
Putnam-Hornstein E (2013). Hierarchical linear modelling: Applications to social work research. J. Soc. Work. 13(6):599-615. Doi/abs/10.1177/1468017312459985.
Raudenbush SW, Bryk AS (1988).Methodological Advances in Analysing the Effects of Schools and Classrooms on Student Learning. Rev. Res. Educ. 15:423-475. D*oi/abs/10.3102/0091732X015001423.*
Rumberger RW, Palardy GJ (2004). Multilevel models for school effectiveness research. In Handbook of quantitative methodology for the social sciences, edited by: Kaplan, D. 235–258. Thousand Oakes, CA: Sage.
Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) (2014). The Southern and Eastern Africa Consortium for Monitoring Educational Quality; http://www.sacmeq.org/.
Smith MC (2011). Which in- and out-of-school factors explain variations in learning across different socioeconomic groups? Findings from South Africa. Comparative Educ. 47(1):79-102. Http://dx.doi.org/10.1080/03050068.2011.541678.
Stephens J (2007). Hierarchical Linear Models. University of Oregon. Accessed at- www.uoregon.edu/~stevensj/HLM.
Subedi BJ (2004). A Demonstration of the Three-Level Hierarchical Generalized Linear Model Applied to Educational Research. The Florida State University. Electronic Theses, Treatises and Dissertations. Paper 1521.
United Nation (UN) (2012). Zimbabwe 2012 Millennium Development Goals Progress Report. http://www.zw.undp.org/content/dam/zimbabwe/docs/MDG/UNDP_ZW_MDG_Zimbabwe%20MDGR%202012.pdf
Webster WJ, Mendro RL, Orsak TH, Weerasinghe D (1996).The Applicability of Selected Regression and Hierarchical Linear Models to the Estimation of School and Teacher Effects.Paper Presented at the American Education Research Association, (AERA). New York City.
World Bank (2014). World Development Indicators; Zimbabwe.http://databank.worldbank.org/data/views/reports/tableview.aspx.

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Full Length Research Paper

Analyzing students' views about mathematics teaching through stories and story generation process

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The purpose of this study is to investigate primary mathematics education students' views about mathematics teaching through stories and the story generation process. To this end, the study attempts to help primary mathematics education students to create stories for teaching middle school students mathematics and to gain experiences through the story generation process. Accordingly, the research question was formulated as follows: "What are the views of 3rd grade primary mathematics education students about mathematics teachings through stories and the story generation process? This study is of importance as it involves the evaluation of the use of stories in mathematics teaching. Additionally, within the scope of the study, mathematics education students made stories of mathematics subjects according to middle school students' level and produced an instructional material that can be used in mathematics classes. The study group consisted of 12 third-grade students studying primary mathematics education. The study used a case study research design which is an interactive qualitative research design. The data were analyzed through content analysis. The views were presented under a set of themes and categories. According to the views of the participating students, mathematics teaching through stories arises interest in topics and provides clarity, promotes love for mathematics and imagination, fosters the reinforcement and retention of mathematics topics, facilitates establishing connections with everyday life, fosters student engagement, can be used as a tool of role-playing and as a technological support, promotes students' mathematics achievement, facilitates understanding abstract and difficult mathematical concepts, and offers such benefits as imagination and retention. The participating students also stated that the story generation process helped them to gain empathy, creativity, and the skills of concretization and level-setting, to reflect on their own story generation processes, to use their imagination, to discuss stories, and to digitize stories and convert them into a book.

Key words: Mathematics teaching, mathematics teaching through stories, primary mathematics education, student views, story generation process, mathematical stories.

INTRODUCTION

More emphasis has recently been placed on students' willingness to learn rather than the structure of knowledge. Thus, students' willingness to learn should be taken into account while organizing learning

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environments. The easiest way to make students willing is to associate subjects with everyday life. The association of concepts with everyday life is not sufficiently addressed in schools. Thus, concepts are only learned by rote as no link is established (Demircioglu et al., 2006).

Mathematics is today a necessity and a high-priority requirement in every area, which requires high-level mathematics teaching practices to facilitate students' permanent and pragmatic learning. Additionally, there is a need for people who know and love mathematics in order to be advanced in mathematics. Negative beliefs about mathematics begin at an early age and grow exponentially. Thus, teachers have great duties (Coskun, 2013). There is a need for more contemporary teaching methods and techniques that enable students to reach only necessary information rather than excess and redundant information (Coskun, 2013). There is also a need for teaching materials that make learning meaningful, associate concepts with everyday life and make students willing to learn and responsible for their own learning (Demircioglu et al., 2006). One of the methods that can be used to this end is mathematics teaching through stories.

Storytelling is an activity based on the narration of truth or fiction as a speech or writing in prose or poetry to inform or entertain listeners and readers. Stories are used to provide an emotional meaning to our lives and to events that are considered quite ordinary. Stories allow people to understand and associate ordinary events with each other, helping to transform them into emotionally meaningful models (Shirley, 2005).

Stories can encourage students' and teachers' ideas and prevent misconceptions. They can also be a powerful way to reveal students' and teachers' mental models of the world, to help them share their understanding of a topic, and to ameliorate the rote-learning based education approach (Demircioglu et al., 2006).

Teachers often try to improve students' logical and analytical skills in the classroom setting. Stories facilitate developing the faculty of imagination as it is the most important strength of students (Balakrishnan, 2008). They also stimulate students' imagination and sense making (Demircioglu et al., 2006). Thus, teaching through stories is a very powerful tool that can provide students with rich, energetic, meaningful and lasting imaginations (Goral and Gnadinger, 2006). Listening to a story stimulates imagining, previous experiences, knowledge, and dreams (Isabelle, 2007).

No matter how often a student encounters a topic throughout his or her life, he or she may not have relevant acquisitions. However, a student remembers a story for a long time when he or she makes sense of it (Coskun, 2013). Thus, stories provide students with a framework for the formation and persistence of concepts (Demircioglu et al., 2006; Isabelle, 2007).

Stories not only inform listeners but also have the power to change them. They also promote interactions between teachers and students that ordinary lessons and activities fail to achieve (Balakrishnan, 2008). Teaching through stories makes students' learning meaningful, contributes to students' taking more responsibility for their own learning, fosters students' willingness to learn and helps to achieve meaningful learning (Demircioglu et al., 2006). Stories are also a unique and powerful way to communicate with people. Students need multiple methods to understand abstract mathematical concepts. In this regard, stories are an educational tool that can help students to learn mathematics that they need (Goral and Gnadinger, 2006).

Storytelling serves both cognitive and affective purposes. Cognitively, students establish connections with previous knowledge and create new knowledge. Thus, storytelling is used as a memory reinforcement tool to help students to transfer stored knowledge to new situations. As for affective benefits, storytelling enlightens and entertains students. Storytelling helps teachers, who serve as a representative and facilitator of meaning creation in the classroom, to fulfill their critical tasks. Through storytelling, educators can focus on strengthening students' skills in the classroom setting, helping them to better understand subjects. Storytelling helps students to organize their knowledge, store it in their minds and then recall them. Storytelling can be used in the classroom setting as an excellent method to present information, to support information with facts and evidence, and to encourage discussions on subjects (Shirley, 2005).

Previous research usually involves a comparison of the storytelling method and other methods for the teaching of various subjects. And there are several experimental studies involving various grade levels and analyzing the teaching of social studies, history, religious culture, science, and mathematics through storytelling.

Gulten and Gulten (2004), Balakrishnan (2008), Kir and Tarim (2011), Albool (2012), Coskun (2013) and Sertsoz and Temur (2017) investigated the use of stories in mathematics teaching. The storytelling method has been reported to have positive effects on learning (Coskun, 2013). Relevant experimental research has reported that the achievement of students taught through stories relatively increased compared to those taught using classical methods or existing curricula (Gulten and Gulten, 2004; Albool, 2012; Coskun, 2013; Sertsoz and Temur, 2017).

However, Kir and Tarim (2011) noted that mathematics teaching through stories did not lead to a high level of academic achievement. On the other hand, teaching through stories was found to promote the retention of learning (Gulten and Gulten, 2004). Research reported that students remained interested throughout the mathematics class taught through the storytelling method and learned by having fun (Kir and Tarim, 2011; Sertsoz and Temur, 2017). Stories were also found to increase students' motivation for mathematics (Albool, 2012).

However, Coskun (2013) found no clear differences between the storytelling method and other existing methods in terms of helping to love mathematics and developing a positive attitude towards mathematics. On the other hand, a story used in mathematics teaching was reported to enhance the ability to understand concepts and the ability to solve mathematical problems (Albool, 2012). Kir and Tarim (2011) suggested that it is more useful to extend storytelling method over a certain period of time and use it occasionally in order to relieve the boredom of the process.

Balakrishnan (2008) noted that stories facilitate generalizing mathematical ideas, presenting mathematical ideas from a different perspective, supporting mathematical ideas as they help students to see great ideas and look for links between story elements and the real life. The author further emphasized that storytelling is a natural way for students to discover connections with everyday life and associate them with mathematical concepts they learn at school and thus; stories should be carefully generated to enhance students' creativity. There are several studies on the use of the method teaching through stories in classes other than mathematics. A relevant study found that stories are effective in eliminating misconceptions (Ayvaci and Coruhlu, 2009).

Storytelling was reported to provide successful outcomes in students' level of knowledge and comprehension and their total gains for the history subjects in Social Studies classes (Simsek, 2004). Students had a positive attitude towards and a growing interest in historical stories (Simsek, 2006). However, Golcuk (2017) reported that science education supported by stories led to no clear differences in students' creativity and attitudes towards science. According to preschool teachers, stories are an effective source of children's development. As important educational tools for children, story books present examples of real-life events and help children to recognize themselves and their environment and to establish healthy relationships with their environment. They also play an important role in enhancing their ability to perceive and interpret (Bagdas and Demir, 2016).

In line with students' views in Golcuk's (2017) research, science education supported by scientific stories is fun, intriguing, imagination-stimulating, and informative; it also increases curiosity about and interest in science classes, raises students' awareness of events in their surroundings, enhances the comprehension and retention of abstract concepts, gives students a chance to observe science subjects in real-life settings, provides a pleasant and positive learning environment, and allows students to express themselves easily.

Pakdemirli (2011) tried to justify the need for using stories in religion and ethics classes, referring to students' developmental characteristics and learning theories. She noted that students aged 9 to 12 can make sense of abstract religious concepts through stories and that showing positive examples through stories facilitates the correct formation of religious and moral attitudes among students' aged 13 to 15. She also emphasized that storytelling activities contributed to the promotion of students' motivation and the achievement of acquisitions covered in the religion and ethics curriculum.

The present study is of importance since, within the scope of the study, mathematics education students made stories of mathematics subjects taking into account the level of middle school students and produced an instructional material that can be used in mathematics classes. Additionally, this study is also important as students thoroughly experienced the stages of story generation week by week, reflected on and discussed both their own stories and their friends' stories and had an experience of how to teach various mathematics topics to middle school students.

Thus, as pre-service teachers, mathematics education students reflected on how to help students to concretize abstract mathematical concepts; they also exchanged ideas with friends. Therefore, this study served as a preparation for the teaching profession. A literature review yielded no previous equivalent study. Previous research often involves the effects of stories on students and teachers' views about stories. However, the present study involves a stage-by-stage experience of story generation process and seeking mathematics education students' views. In this regard, the study contributes to the literature.

The purpose of this study is to investigate primary mathematics education students' views about mathematics teaching through stories and the story generation process. To this end, the study attempts to help primary mathematics education students to create stories for teaching middle school students mathematics in accordance with the current mathematics curriculum and to gain experiences through the story generation process. Accordingly, the research question was formulated as follows: "What are the views of 3rd grade primary mathematics education students about mathematics teachings through stories and the story generation process? The research sub-questions are as follows:

(1) What are the views of students about mathematics teaching through stories?
(2) What are the views of students about the integration of mathematics teaching through stories into courses?
(3) What are the views of students about competences that they acquire through story generation process?
(4) What are the views of students about the effects of mathematics teaching through stories on students' mathematics achievement?
(5) What are the views of students about their own story generation processes?

(6) What are the views of students about the effects of mathematics teaching through stories on the concretization of mathematics?
(7) What are the views of students about benefits that mathematics teaching through stories offers to students?

METHODOLOGY

Research model

Qualitative research involves an in-depth investigation of a situation to find answers to questions such as why and how (Sozbilir, 2009). It is an approach that mainly focuses on investigating and understating social phenomena in their environment with a theorization-based understanding (Yildirim, 1999). The present study used a case study research design which is an interactive qualitative research design. A case study involves a holistic investigation of factors related to a situation and focuses on how these factors influence or are influenced by this situation (Sozbilir, 2009). Every situation can be better understood in its own context; thus, a case study should analyze a situation in its own context and focus on the reality to investigate social phenomena; results should not be interpreted independently of the context (Yildirim, 1999). Content analysis provides an in-depth analysis of collected data and the formation of non-predetermined themes and dimensions (Sozbilir, 2009). For the purpose of this study, mathematics education students' views about mathematics teaching through stories were analyzed through content analysis and presented under a set of themes and categories using codes representing student views. The data were presented using the themes including common categories created. Thus, the researcher presents the data in a processed form (Yildirim and Simsek, 2011).

The study group

This study was conducted at the Faculty of Education, Kafkas University, located at Turkey's Eastern Anatolia Region in the spring term of the 2016 to 2017 academic year. The study surveyed 12 third-grade students studying primary mathematics education. The study group was selected through convenience sampling which is purposive sampling method in which a sample is selected from a close and accessible case, acquaintance people. This sampling brings speed and practicability to researcher (Yildirim and Simsek, 2008).

Data collection

This research was conducted within the scope of the community service practices course taught under the supervision of one of the researchers. The application took 14 weeks. The participating students were first asked to find out mathematics subjects about which story to tell and to identify relevant acquisitions. They were reminded to consult with each other and think of different subjects instead of writing about the same subjects. Thus, as it was planned, each student generated five stories about various mathematics subjects by the end of the term. After being completed, each story was presented in the classroom, discussed by the lecturer and students, and accordingly revised. A three-hour class was held with the students every week; the students were given the opportunity to present their own stories and evaluate their friends' stories throughout 14 weeks; they were asked to evaluate the stories in terms of content, cohesion and coherence, and the conformity to acquisitions and to writing rules. Thus, the students were helped to experience the process of writing and evaluating mathematical stories. Additionally, questions about each mathematical story were prepared to measure readers' reading comprehension and included at the end of each story. Then, the students created a book titled "Mathematics Teaching Through Stories" that includes all stories. Finally, the students were given a 7-question opinion form and asked to tell their views about mathematics teaching through stories in general, the integration of mathematics teaching through stories into classes, competences they gain through the story generation process, the effects of mathematics teaching through stories on students' mathematics achievement, their own story generation processes, the effects of mathematics teaching through stories on the concretization of mathematics, and the benefits of mathematics teaching through stories for students.

Data collection tools

A 7-question opinion form was administered to the participating students. The form includes the following questions:

(1) What are your opinions about mathematics teaching through stories?
(2) How do you think mathematics teaching through stories should be integrated into courses?
(3) Tell about competences that the story generation process helped you to gain.
(4) What effects do you think mathematics teaching through stories has on students' mathematics achievement?
(5) Tell about your story generation process.
(6) What effects does mathematics teaching through stories have on the concretization of mathematics?
(7) What benefits does mathematics teaching through stories offer to students?

Expert opinions on the validity of the opinion form were taken and the opinion form was accordingly given its final shape.

Data analysis

Within the scope of this study conducted with third-grade primary mathematics education students, an opinion form including 7 open-ended questions was designed to seek students' views. Students' responses were analyzed through content analysis. Responses were first divided into categories and themes by the researchers and then presented in tables with percentage and frequency values. Expert opinions were taken for the categorization and thematization of students' responses; the categories and themes were accordingly finalized. The data were coded through dual coding to ensure intercoder reliability. The intercoder reliability was found to be 0.82 through the formula proposed by Miles and Huberman (1994). Accordingly, students' opinion forms were first shared between the researchers and then exchanged for reassessment; the consistency value was thus measured. The consistency value indicates an agreement between the intercoders. The verifiability of the data was ensured through intercoder reliability. In order to verify the transferability of results and to document that the participants reflected their own views, direct quotations of students' views were presented after the explanations of the results of each sub-question. In order to prove credibility, researcher triangulation and expert reviews were used.

RESULTS

Results of the first sub-question

This section includes students' responses to the

Table 1. The distribution of students' responses to the question "What are your opinions about mathematics teaching through stories?" according to themes and categories

Themes	Categories	Frequency	Percentage
	Making practical	2	16.7
	Easy learning	5	41.7
	Concretization	8	66.7
	Interesting	12	100
Academic	Fun	5	41.7
	Achievement	5	41.7
	Clarity	10	83.3
	Class participation	6	50
	Exploration	2	16.7
	Love for mathematics	4	33.3
Personal	Imagination	4	33.3

questions in the opinion form. Responses were divided into categories and themes, and presented in tables with frequency and percentage values. The distribution of students' responses to the question "What are your opinions about mathematics teaching through stories?" according to themes and categories were shown in Table 1. As seen in Table 1, students' responses to the question "What are your opinions about mathematics teaching through stories?" were divided into two themes including academic and personal. The categories under the academic theme include making practical, easy learning, concretization, interesting, fun, achievement, clarity, class participation, and exploration. The categories under the personal theme include love for mathematics and imagination.

Listed below are examples of students' responses to the question "What are your opinions about mathematics teaching through stories?":

"Imagination develops with math stories. Stories make subjects interesting and attractive. They make learning fun. They bring the principle of clarity."

"It concretizes subjects and makes them interesting. It increases students' participation in classes. It increased achievement."

Results of the second sub-question

The distribution of students' responses to the question "How do you think mathematics teaching through stories should be integrated into courses?" according to themes and categories were shown in Table 2. As seen in Table 2, students' responses to the question "How do you think mathematics teaching through stories should be integrated into courses?" were divided into five themes including visual, mental, physical, social, use in subjects. The categories under the visual theme include video and technological support. The categories under the mental theme include appealing to thoughts, promoting retention, and reinforcement. The categories under the physical theme include role-playing and drama. The categories under the social theme include associating with everyday life and student engagement. The categories under the use in subjects theme include before subjects and boring subjects. Listed below are examples of students' responses to the question "How do you think mathematics teaching through stories should be integrated into courses?":

"Visually supporting stories helps students to imagine in their minds. If we include students in stories, then they have higher motivation for the class."

"It promotes retention and it can be integrated through in-class role-playing and drama techniques."

Results of the third sub-question

The distribution of students' responses to the item "Tell about competences that the story generation process helped you to gain" according to themes and categories were shown in Table 3. As seen in Table 3, students' responses to the item "Tell about competences that the story generation process helped you to gain" were divided into two themes including academic and personal. The categories under the academic theme include acquisitions, concretization, and combining mathematics with stories. The categories under the personal theme include level-setting, empathy, creativity, and strength of expression. Listed below are examples of students' responses to the item "Tell about competences that the story generation process helped you to gain":

"It develops the ability to establish empathy. It allows a

Table 2. The distribution of students' responses to the question "How do you think mathematics teaching through stories should be integrated into courses?" according to themes and categories.

Themes	Categories	Frequency	Percentage
Visual	Video	2	16.7
	Technological support	2	16.7
Mental	Appealing to thoughts	3	25
	Promoting retention	8	66.7
	Reinforcement	7	58.3
Physical	Role-playing	7	58.3
	Drama	3	25
Social	Associating with everyday life	9	75
	Student engagement	9	75
Use in subjects	Before subjects	2	16.7
	Boring subjects	4	33.3

Table 3. The distribution of students' responses to the item "tell about competences that the story generation process helped you to gain" according to themes and categories.

Themes	Categories	Frequency	Percentage
Academic	Acquisitions	4	33.3
	Concretization	5	41.7
	Combining mathematics with stories	3	25
Personal	Level-setting	12	100
	Empathy	12	100
	Creativity	10	83.3
	Strength of expression	4	33.3

teacher to develop a perspective similar to students' perspective."
"In this process, we developed empathy with students and act according to their thoughts. The language we used in the stories was chosen as a language that would not be difficult to read, which helped us get down to their level."

Results of the fourth sub-question

The distribution of students' responses to the question "What effects do you think mathematics teaching through stories has on students' mathematics achievement?" according to themes and categories are shown in Table 4. As seen in Table 4, students' responses to the question "What effects do you think mathematics teaching through stories has on students' mathematics achievement?" were collected under one theme as academic. The categories under the academic theme include willingness, facilitating the process, perspective on mathematics, reinforcement, connection with daily life, retention, subject integrity, and problem-solving skill. Listed below are examples of students' responses to the question "What effects do you think mathematics teaching through stories has on students' mathematics achievement?":

"As stories promote memorability, they facilitate learning mathematics and increase willingness to learn mathematics. Thus, they have positive effects."
"As stories concretize, students better understand and comprehend. They foster students' problem-solving skills. It provides subject integrity."

Results of the fifth sub-question

The distribution of students' responses to the item "Tell

Table 4. The distribution of students' responses to the question "What effects do you think mathematics teaching through stories has on students' mathematics achievement?" according to themes and categories.

Themes	Categories	Frequency	Percentage
Academic	Willingness	6	50
	Facilitating the process	10	83.3
	Perspective on mathematics	5	41.7
	Reinforcement	6	50
	Connection with daily life	7	58.3
	Retention	9	75
	Subject integrity	4	33.3
	Problem-solving skill	7	58.3

Table 5. The distribution of students' responses to the item "Tell us about your story generation process" according to themes and categories.

Themes	Categories	Frequency	Percentage
Introduction	Subject selection	6	50
	Acquisition selection	8	66.7
	Use of expressions	4	33.3
	Teaching through invention	6	50
	Teaching plan	8	66.7
	Pre-learning	6	50
	Interdisciplinary	7	58.3
	Use of imagination	10	83.3
	Putting yourself in students' place	9	75
Body	Digitize	10	83.3
	Writing style	6	50
	Use of pictures	7	58.3
	Discussion of stories	11	91.7
	Producing questions	9	75
	Headlining	8	66.7
Conclusion	Converting to a book	10	83.3

us about your story generation process" according to themes and categories were shown in Table 5. As seen in Table 5, students' responses to the item "Tell us about your story generation process" was divided into introduction, body and conclusion themes. The categories under the introduction theme include subject selection, acquisition selection, use of expressions, teaching through invention, teaching plan, pre-learning, interdisciplinary, use of imagination, and putting yourself in students' place. The categories under the body theme include digitize, writing style, use of pictures, discussion of stories, producing questions, and headlining. The category under the body theme is converting to a book. Listed below are examples of students' responses to the item "Tell us about your story generation process":

"Subjects were determined. An acquisition for each subject was determined. Stories were created in line with these acquisitions."

"First, I decided which subject to choose according to students' level. Because students should have the willingness to read. After determining the subject, I decided to what kind of style to select and what expressions to use in this subject. I planned what steps to use and how to give examples as the story would be through invention. I decided which font size, spacing and widths to use. I selected pictures that would not distract attention according to students' level."

Results of the sixth sub-question

The distribution of students' responses to the question "What effects does mathematics teaching through stories have on the concretization of mathematics?" according to themes and categories were shown in Table 6. As seen

Table 6. The distribution of students' responses to the question "What effects does mathematics teaching through stories have on the concretization of mathematics?" according to themes and categories.

Themes	Categories	Frequency	Percentage
Concretization	Understanding abstract and difficult concepts	10	83.3
	Linking to everyday life	10	83.3
	Mental representation	8	66.7
	Visualization	9	75

Table 7. The distribution of students' responses to the question "What benefits does mathematics teaching through stories offer to students?" according to themes and categories.

Themes	Categories	Frequency	Percentage
Personal	Empathy	8	66.7
	Creativity	12	100
Academic	Subject integrity	6	50
	Mental development	10	83.3
	Solving problems	11	91.7
	Retention	12	100
	Concretization of abstract concepts	12	100
	Role-playing	6	50
	Interest in mathematics	12	100
	Making a story of events	8	66.7
	Feeling the necessity of mathematics	7	58.3
	Applying to similar situations	6	50
	Fun mathematics	10	83.3

in Table 6, students' responses to the question "What effects does mathematics teaching through stories have on the concretization of mathematics?" were collected under the concretization theme. The relevant categories include understanding abstract and difficult concepts, linking to everyday life, mental representation, and visualization. Listed below are examples of students' responses to the question "What effects does mathematics teaching through stories have on the concretization of mathematics?":

"It makes subjects interesting and attractive. It facilitates retention through the application of subjects in real life."
"Stories created according to students' age and development help to overcome challenges in the comprehension of abstract and difficult topics. Because students used their imagination and creativity through stories and integrated mathematics learning into real life; this facilitated concretization."

Results of the seventh sub-question

The distribution of students' responses to the question "What benefits does mathematics teaching through stories offer to students?" according to themes and categories were shown in Table 7. As seen in Table 7, students' responses to the question "What benefits does mathematics teaching through stories offer to students?" were divided into personal and academic themes. The categories under the personal theme include empathy and creativity. The categories under the academic theme include subject integrity, mental development, solving problems, retention, concretization of abstract concepts, role-playing, interest in mathematics, making a story of events, feeling the necessity of mathematics, applying to similar situations, and fun mathematics. Listed below are examples of students' responses to the question "What benefits does mathematics teaching through stories offer to students?":

"Students learn mathematics having fun. When they encounter an event, they create a story in their mind. It improves empathy skills."
"It shows that abstract mathematics subjects can be used in students' lives through stories. Students recognized the need for mathematics by experiencing and adapting stories to their lives. When they face similar situations in their real lives, they learn what they should do so that they can go through it more painlessly and solve problems

they face. Indeed, students see that mathematics they do not care or deem necessary is involved in all areas of life. As they experience while learning, it provides the retention of learning."

DISCUSSION

In this study, while expressing their views about mathematics teaching through stories, the students focused more on the categories concretization, interesting, clarity and class participation under the academic theme. The categories under the personal theme were equally expressed. The students reported that mathematics teaching through stories makes mathematics teaching more practical, helps students to more easily adapt to (learn) subjects, concretize subjects, arises students' interest in topics, makes subjects more fun, increases the level of achievement, clarify subjects, promotes students' participation in classes, helps students to love mathematics, enhances imagination and helps students to explore subjects.

According to the students' views about the integration of mathematics teaching through stories into classes, promoting retention and reinforcement under the mental theme were particularly emphasized, role-playing under the physical theme was particularly emphasized, and associating with everyday life and student engagement under the social theme were particularly emphasized. The expressions under the visual theme were equally emphasized. The students held the following views: the method of mathematics teaching through stories should be used to address students' abstract and concrete ideas, stories can be supported by visual images, students can be included in stories, stories can be used for boring subjects and in association with everyday life, stories can be applied using role-playing and drama, technology can be utilized while telling stories, stories can be used as a means of reinforcement at the end of subjects, stories can be digitized and converted to a video, and relevant stories can be read before teaching a subject.

Considering the students' views about competences that the story generation process helped them to gain, they mostly expressed concretization under the academic them, while they mostly reported level-setting, empathy, and creativity under the personal theme. The students reported that they were informed of how subject acquisitions, comprehension and expression change by grade level. They tried to develop empathy with students and act in accordance with their viewpoints. The students believe that stories can help them to get down to students' level and to better communicate with students, they learned how to combine mathematics with stories, stories fostered their imagination and creativity, they learned how to teach a subject in more clear and understandable manner, stories promoted their strength of expression, and stories helped to concretize difficult subjects and render them in a more intelligible form.

Considering the students' views about the effects of mathematics teaching through stories on students' achievement, they primarily focused on facilitating the process, reinforcement, connection with daily life, and retention under the academic theme. The students held the following views: mathematics teaching through stories helps to minimize students' learning difficulties, it increases students' willingness to learn, it makes learning process more easy and productive, the integration of colors and pictures into stories makes learning more fun, students' perspective on mathematics can be changed, it helps students to overcome prejudices about mathematics, it facilitates the reinforcement of subjects, it promotes students' interest in mathematics and thus have positive effects, it helps to make subjects more memorizable through the connections with everyday life, students can better understand a mathematics subject by establishing links with everyday life and this subject thus becomes more simple and clear, it helps to learn other subjects when a subject is learned, it ensures subject integrity, it helps students to observe mathematics in real life, and it helps to develop students' problem-solving skills.

According to the students' views about their story generation process, they mostly focused on subject selection, acquisition selection, teaching through invention, teaching plan, pre-learning, interdisciplinary, use of imagination, and putting yourself in students' place under the introduction theme. All expressions under the body and conclusion themes were more generally addressed. The students stated that they started to write when they had an idea, they selected subjects, they decided which expressions to use while telling about their subjects, they planned what to do and what kind of examples to show as it involves teaching through invention, they planned what students would learn at the end of the story, they decided which font size, spacing and widths to use, they selected non-distracting pictures, they determined subject acquisitions, they identified pre-learning components of subject acquisitions, they did interdisciplinary work, they discussed the deficient aspects of stories in the classroom, they digitized their stories and converted to a book, they generated questions about stories, they headlined their stories, they used their imagination to write stories, and they tried to plan how to help students to better understand.

Considering the students' views about the effects of mathematics teaching through stories on the concretization of mathematics, they mainly focused all expression under the concretization theme. The students held the following views: stories can help to overcome problems in understanding abstract and difficult mathematical concepts, the association of mathematics subjects with everyday life through stories facilitates concretization, mathematics teaching through stories helps students visualize mathematics subjects in their minds, information is made more permanent when supported by visual elements, especially subjects difficult to comprehend can be converted to stories and can thus be concretized, and students can observe and concretize mathematical concepts in stories as stories better clarify subjects.

Considering the students' views about the benefits of mathematics teaching through stories, all expression under the personal and academic themes were highly emphasized. The students reported that abstract concepts can be made usable in real life through mathematics teaching through stories, students can recognize the necessity of mathematics, they can know what to do when they are involved in a situation similar to that in stories, they can more easily solve problems about the subjects included in stories, students' interest in mathematics grows, students observe mathematics in every area of life, they can make a story of events and visualize in their minds, stories facilitate the retention of learning, they foster visual, mathematical and verbal intelligence, they help to learn mathematics by having fun, they provide subject integrity, and stories develop empathy, role-playing skills, imagination, and creativity.

The students stated that mathematics teaching through stories helps students to better adapt to subjects, that is, to more easily learn subjects. Thus, this result is consistent with that of Coskun (2013) and Bagdas and Demir (2016) as it indicates the significant positive effects of teaching through stories on learning. The students also held the view that mathematics teaching through stories increases students' level of achievement. This result runs parallel with previous research results showing that teaching through storytelling increased students' mathematics achievement compared to other methods (Gulten and Gulten, 2004; Simsek, 2004; Pakdemirli, 2011; Albool, 2012; Coskun, 2013; Sertsoz and Temur, 2017).

However, it contradicts with Kir and Tarim's (2011) research. According to the students' views, teaching through stories helps to clarify and concretize especially abstract and difficult subjects and makes mathematics classes more fun and enjoyable; thus, it promotes students' achievement. This result is consistent with those reported by Simsek (2006), Kır and Tarım (2011), Sertsoz and Temur (2017), and Golcuk (2017). The students' expressions including concretization, interesting and fun, class participation, and love for mathematics indicate that stories promote students' motivation for mathematics. Thus, the present study runs parallel with that of Pakdemirli (2011) and Albool (2012). However, it contradicts with that of Coskun (2013) and Golcuk (2017).

The present study also runs parallel with that of Balakrishnan (2008) as it indicated that teaching through stories helps students to explore subjects and develops creativity. It also runs parallel with that of Golcuk (2017) as it indicated that teaching through stories promotes curiosity and imagination. However, Golcuk (2017) reported no difference in creativity, which contradicts with the result of the present study. According to the students' views, when students are told stories about a set of abstract boring subjects and concepts, it enhances their imagination, helps students to generate stories over time and to establish connections, and eventually promotes their creativity.

The results of the present study are consistent with those reported by Pakdemirli (2011) in terms of stories' appealing to students' thoughts and with those reported by Gulten and Gulten (2004) and Golcuk (2017) in terms of stories' facilitating retention. While the students recommended to use stories before teaching subjects or to teach boring subjects, Kir and Tarim (2011) suggested that it is more helpful to extend stories over a certain period of time and to use them occasionally in order to relieve the boredom of the process. The category associating with everyday life in the present study is consistent with previous research results indicating that storytelling is a natural way for students to look for connections between real life and story elements and to associate them with mathematical concepts they learn at school.

Thus, the present study runs in parallel with the research of Balakrishnan (2008) and Golcuk (2017). It also runs in parallel with the research of Albool (2012) as it revealed that mathematics teaching through stories helps to acquire problem-solving skills. The present study also found that mathematics teaching through stories provides a positive learning environment allowing students to easily express themselves. This result is consistent with that of Golcuk (2017).

In line with what has been discussed so far and based on the results of the present study, the following suggestions are offered:

(1) Stories generated within the scope of this study can be applied in schools and the extent to which this application is consistent with the students' views can be examined.

(2) Stories generated within the scope of this study can be read, reviewed and evaluated by in-service teachers in schools and they can also be applied to students and evaluated by students.

(3) An application similar to the one carried out within the scope of this study can be provided as in-service training to teachers in schools.

(4) The Ministry of National Education can plan several projects on mathematics teaching through stories or storytelling in mathematics in order to help students develop a positive attitude towards mathematics.

(5) Mathematics education programs in faculties of education can include an elective course on the generation of mathematical stories for pre-service mathematics teachers to prepare them for mathematics

teaching through stories.
(6) Subjects that are covered in the current mathematics curriculum and particularly considered difficult by students can be identified and various stories can be created about these subjects.
(7) It should be ensured that each student actively participates in the story generation process within the scope of this study, evaluates and reviews each other’s stories. Great care should be taken so that each student can be informed of not only the teaching of their own topics and acquisitions but also the teaching of topics and acquisitions selected by others.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Albool R (2012). The effect of utilizing storytelling strategy in teaching mathematics on grade four students’ achievement and motivation towards learning mathematics. International Conference The Future of Education 2nd Edition Retrieved from https://fada.birzeit.edu/bitstream/20.500.11889/2451/1/8466.pdf

Ayvaci HS, Coruhlu TS (2009). Fiziksel ve kimyasal degisim konularındaki kavram yanilgilarinin duzeltilmesinde aciklayici hikâye yonteminin etkisi. Ondokuz Mayis Universitesi Egitim Fakultesi Dergisi, 28(1):93-104. Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/TezGoster?key=WY5CM7tPNE2z_YM6pBu0tzArKugCmCWlrrGtYHHo4td_ngHe0bIkKz9xfqG5EGu0

Bagdas CK, Demir E (2016). Okul oncesi ogretmenlerinin hikâye ve hikâye kitaplari hakkindaki goruslerinin incelenmesi (Erzincan Orneklemi). Erzincan Universitesi Sosyal Bilimler Enstitusu Dergisi, Special Edition III: 219-230.

Balakrishnan C (2008). Teaching secondary school mathematics through storytelling. (Unpublished master dissertation). Simon Fraser University, Canada. Retrieved from http://www.peterliljedahl.com/wp-content/uploads/Thesis-Chandra-Balakrishnan.pdf

Coskun M (2013). Matematik kavramlari ogretiminde oykulestirme yonteminin tutuma ve basariya etkisi (Unpublished master dissertation). Ahi Evran University, Kır sehir.

Demircioglu H, Demircioglu G, Ayas A (2006). Hikayeler ve kimya ogretimi. H.U. Egitim Fakultesi Dergisi, 30:110-119. Retrieved from http://dergipark.ulakbim.gov.tr/hunefd/article/view/5000048591

Golcuk A (2017). Bilimsel hikayelerle desteklenen fen egitiminin ogrencilerin yaraticiliklari ve duyussal ozellikleri uzerindeki etkileri (Unpublished master dissertation). Hacettepe University, Ankara. Retrieved from http://www.openaccess.hacettepe.edu.tr:8080/xmlui/bitstream/handle/11655/3912/Asli_Golcuk_Yuksek_Lisans_Tezi.pdf?sequence=1&isAllowed=y

Goral MB, Gnadinger CM (2006). Using storytelling to teach mathematics concepts. APMC, 11(1):4-8. Retrieved from https://files.eric.ed.gov/fulltext/EJ793906.pdf

Gulten DC, Gulten I (2004). Binom acılımı ogretimine farkli bir yaklasim. İlkogretim-Online, 3(2):60-66, Retrieved from http://ilkogretim-online.org.tr

Isabelle AD (2007). Teaching science using stories: the storyline approach. Sci. Scope 31(2):16-25.

Kır D, Tarım K (2011). Hikayelerle matematik ogretiminin ogrencilerin sozel problem cozme becerileri uzerindeki etkileri. 1st International Congress on Education Programs and Education. Anadolu University. Eskisehir. Retrieved from https://www.pegem.net/Akademi/kongrebildiri_detay.aspx?id=128381

Miles MB, Huberman AM (1994). An Expanded Source Books Qualitative Data Analysis. (2nd edition). London: SAGE publications.

Pakdemirli MN (2011). Ilkogretim dkab derslerinde hikâye kullaniminin onemi: egitim psikolojisi acisindan bir yaklasim. Degerler Egitimi Dergisi, 9(21):99-129. Retrieved from http://dergipark.gov.tr/download/article-file/302460

Sertsoz A, Temur OD (2017). 6 yas cocuklarina oykulestirme yontemi ile verilen matematik egitiminin cocuklarin matematik basarilarina etkisinin incelenmesi. Acad. J. Educ. Sci. 1(1):1-20.

Shirley J (2005). Storyteller, story-teacher: A portrait of tree teachers’ use of story in elementary classes (Unpublished doctoral dissertation). Georgia State University, Atlanta.

Simsek A (2004). İlkogretim okulu sosyal bilgiler dersi tarih konularinin ogretiminde hikaye anlatim yonteminin etkililigi. Turk Egitim Bilimleri Dergisi, 2(4):495-509. Retrieved from http://dergipark.gov.tr/tebd/issue/26126/275211

Simsek A (2006). İlkogretim sosyal bilgiler dersinde tarihsel hikâyeye yonelik ogrenci gorusleri. Gazi Egitim Fakultesi Dergisi, 26(1):187-202. Retrieved from http://dergipark.gov.tr/download/article-file/77220

Sozbilir M (2009). Nitel veri analizi. Retrieved from https://fenitay.files.wordpress.com/2009/02/1112-nitelarac59ftc4b1rmada-veri-analizi.pdf 20.01.2018.

Yildirim A (1999). Nitel arastırma yontemlerinin temel ozellikleri ve egitim arastirmalarindaki yeri ve onemi. Egitim ve Bilim, 23:7-12.

Yildirim A, ve Simsek H (2008). Sosyal Bilimlerde Nitel Arastırma Yontemleri. Ankara:Seckin.

Yildirim A, Simsek H (2011). Sosyal bilimlerde nitel arastirma yontemleri. (8th edition). Ankara: Seckin.

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Educational Research and Reviews

Full Length Research Paper

Perceptions and opinions of students studying at primary school mathematics teaching department about the concept of mathematics

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The purpose of this study is get opinions of students on the subject of mathematics. It is thought that determining the meaning of mathematics in students' minds, the things that students associate mathematics with and the things that come to their minds when you say mathematics is vital. In this way, it is thought that it can be possible to take some precautions for enabling students to develop positive attitudes towards mathematics, making mathematics more popular among students and reducing mathematics anxiety. This study is particularly important in terms of taking the opinions of students who will be responsible for teaching mathematics and making students become more interested in mathematics so that they can take necessary precautions before they start teaching at schools. This study is a qualitative research and the data obtained through coding the answers provided by students from the Department of Teaching Primary School Mathematics. Two questions in the opinion form were divided into categories and themes were displayed in tables by given percentages and frequencies. In this sense, content analysis from qualitative data approaches and phenomenology from qualitative research designs were used. The study group consisted of 153 students (from freshman to senior) who are studying at Kafkas University, Faculty of Education, Department of Teaching Primary School Mathematics. It was concluded that students mentioned 'nature', 'life', 'oxygen', 'everything complicated' and 'puzzle' for "mathematics, and they provided answers such as 'concepts related to mathematics', 'middle school mathematics teacher' and 'everything' for the question stated as "What is the first thing that comes to your mind when we say mathematics?"

Key words: Metaphor, opinion, perception, primary mathematics education, the concept of mathematics.

INTRODUCTION

Every person uses mathematics to solve the problems that are seen in everyday life. The success and development of a country depends on providing quality education to its citizens. It is thought that when we start doing some collective things for education rather than individual initiatives, there will be positive and fruitful

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results. Mathematics has significant importance for the society and the students as well because having and developing scientific thinking skills and implementing these skills when necessary in our lives is utmost important (Isık et al., 2008).

When we are able to answer the questions about why we have difficulties to learn mathematics, how we can make learning mathematics easier and how we can overcome our anxieties against mathematics, we can create a developed society and can employ its positive skills by transferring mathematical conscious to the students and public. Mathematics is necessary for everybody. However, learning occurs through loving. Mathematics has a place in all other disciplines. For this reason, it is important to take a look at how we can develop positive attitudes towards mathematics, how we can raise interest in mathematics and how we can help our students to have the habits of analysing and researching (Isik et al., 2008).

In accordance with the general objectives that Teaching Mathematics Program tries to achieve, the Basic Law of the National Education no.1739 aims for students to be able to improve their skills regarding mathematics literacy and to have students who can actively use these skills, who can understand and use mathematical concepts, who can use mathematical language and terminology properly to explain and share their mathematical thoughts logically, who can make sense from the correlation between objects and between human beings and objects by using the meaning and language of mathematics, who can create a confident approach to the mathematical problems by developing positive attitudes towards mathematics, who can realize the correlation of mathematics to art and aesthetics and who values mathematics in the knowledge that mathematics is a common value for the mankind (MEB, 2018).

In order to reach all of these goals, it is necessary to put forward students' thoughts about mathematics and to take some precautions in line with these considerations. When we check students' opinions about what mathematics is like or what is the first thing that comes to their mind in terms of mathematics, they can reveal some positive or negative thinking about mathematics. It is thought that we will have the opportunity to make various arrangements in accordance with the way students suggested with their opinions and some arrangements can also be made for mathematics courses. In this context, it is thought that mathematics teachers will also fulfill their responsibilities and make various plans about how they can make mathematics more effective and fun in the eyes of their students.

Today, many countries have serious studies in their education programs to remove the perception that mathematics is difficult. As a result of these studies, success and interest in mathematics courses are increasing in parallel. Besides, their perceptions about mathematics and mathematics courses are also changing. Today, in order to find out how mathematics is perceived, perception studies on mathematics and concepts related to mathematics are being made. Concrete concepts are used to show how we perceive an abstract feature. Metaphors are one of the types of perception used for this purpose (Sahin, 2013). The word metaphor stems from the Greek metapherein. Meta meaning “to change” and pherein meaning “to bear”. This notion of using the metaphor as a “change bearing” agent can help students transform what they know into new understandings (Levine, 2005).

Metaphor is used as a bridge between two cases. The first case is generally a phenomenon that everyone knows its properties very well. By using a known feature of this phenomenon, it is tried to explain the other people that the new phenomenon has also the same characteristics (Guner, 2013) and to help the students to express abstract concepts with concrete concepts (Aubry, 2009; Sosyal and Afacan, 2012). In this way, metaphors can be seen in formal and informal learning when the difficult concepts are understood by means of analogy with known concepts (Gecit and Gencer, 2011).

Understanding new images of mathematics is very challenging and can contribute to teacher resistance. Personal views of mathematics may be necessary for pedagogical change. Mathematical metaphors are the possible ways for exploring these images. Because metaphors focus on similarities, they can be used to express already-held perceptions about the nature of mathematics. The analogous dimensions of metaphors can prompt new ways of thinking about current views of mathematics (Sterenberg, 2008).

The following conclusions were reached as a result of the literature scan carried out within the scope of this study: In the studies carried out with prospective teachers and students metaphors expressing that mathematics is fun, joyful and enjoyable activity, in other words, mathematics provides enjoyable learning (Guner, 2013; Sahin, 2013; Kilic and Yelken, 2013; Erdogan et al., 2014; Keles et al., 2016; Sevindik and Cenberci, 2016; Kaba and Sengul, 2017; Latterell and Wilson, 2017). It was concluded in a study carried out with prospective mathematics teachers and prospective pre-school teachers that mathematics is the life itself, in other words mathematics is the source of life (Guner, 2013; Keles et al., 2016; Kaba and Sengul, 2017), in another study carried out with prospective mathematics teachers themes expressing that mathematics make our lives more difficult were found (Guner, 2013).

Prospective mathematics teachers and prospective teachers from other branches (Science, classroom, pre-school, German, English, Turkish, music, art and social sciences teachers) related the concept of “mathematics” to difficult metaphor that makes learning difficult (Guveli et al., 2011; Sahin, 2013; Erdogan et al., 2014; Keles et al., 2016; Latterell and Wilson, 2016; Kaba and Sengul, 2017; Latterell and Wilson, 2017). In addition to this, prospective teachers (Mathematics, Science, Class, Pre-school, German, English, Turkish, music, art and social sciences teachers) and class teachers related mathematics to intelligence metaphor that is something which is mind-developing, a brain box (Sahin, 2013; Erdogan et al., 2014; Tarim et al., 2017).

Teachers from different branches (Science, Class, Pre-School, German, English, Turkish, Music, Art, and Social Sciences Teachers) associated the concept of “mathematics” with “ability” and “success” metaphors. The least preferred metaphors were “unnecessary” and “authority” (Sahin, 2013). Teachers from different branches (Science, Class, Pre-School, German, English, Turkish, Music, Art, and Social Sciences Teachers) associated the concept of “Mathematics” with “Easy” metaphor (Sahin, 2013; Kaba and Sengul, 2017; Latterell and Wilson, 2017).

Prospective mathematics teachers perceive mathematics as infinite (Erdogan et al., 2014; Kaba and Sengul, 2017), related to one another, cumulative, obligatory and the basis of other disciplines. Some of the prospective mathematics teachers perceive mathematics as something which guides, which requires continuity, which is about to be solved and which has only one correct answer (Erdogan et al., 2014). In addition to this, mathematics is expressed as a language (Erdogan et al., 2014; Latterel and Wilson, 2016; Latterell and Wilson, 2017).

Pre-school teachers categorized mathematics as something which uses mental process skills (Keles et al., 2016) and pre-school, primary school and mathematics prospective teachers categorized mathematics as boring (Guveli et al., 2011; Kilic and Yelken, 2013; Keles et al., 2016; Latterell and Wilson, 2017; Kaba and Sengul, 2017). Primary class teachers produced sing language and emotion metaphors for mathematics (Kilic and Yelken, 2013). “Mathematics as an exciting lesson” is among perceptions of primary school class and middle school mathematics prospective teachers’ perceptions about mathematics (Guveli, Ipek, Atasoy and Guveli, 2011; Kaba and Sengul, 2017) and primary school class teachers perceive mathematics as “something which consists of many different topics” (Guveli et al., 2011).

Middle school mathematics prospective teachers and primary school class teachers produced life metaphor for the concept of mathematics (Kaba and Sengul, 2017; Tarim et al., 2017). One of the metaphors produced by middle school mathematics prospective teachers are the universe metaphor. Generally, it was concluded that “prospective teachers perceive mathematics as intense, cruel, challenging, requiring memorization and the source of stress” and “the others have prejudices against mathematics”. It appeared that mathematics is a lesson which requires one to have interest and pay attention, and one need to spend some time thinking of ways to solve it. It was revealed that prospective teachers also made mentioned of loving some of their previous mathematics teachers, but not loving some others. They think that not all the mathematics teacher can explain topics of mathematics properly. The conclusion which was stated as “There are some students who hate mathematics” was obtained (Kaba and Sengul, 2017).

More than half of the vocational high school students think that mathematics is something negative. Mathematics was categorized as terrible, aesthetics, identified with human beings, necessity and an incomprehensible topic (Sevindik and Cenberci, 2016). “Puzzle and computer” metaphors were used for the concept of mathematics (Guner, 2013). When we analyse metaphors; it is understood that mathematics is perceived as something which makes our lives easier, in other words necessary after seeing the expressions of “process” (Tarim et al., 2017) and “necessity” (Guner, 2013; Sahin, 2013; Erdogan et al., 2014; Keles et al., 2016; Latterell and Wilson, 2016; Tarim et al., 2017; Latterell and Wilson, 2017) in the perception list.

Mathematics was defined as a game (Tarim et al., 2017; Brady and Winn, 2014). It was stated that mathematics requires effort, interest and hard-work (Brady and Winn, 2014; Latterell and Wilson, 2017; Kaba and Sengul, 2017). It was expressed that mathematics is seen as a puzzle (Brady and Winn, 2014; Latterell and Wilson, 2016; Latterell and Wilson, 2017). It was mentioned that mathematics is discouraging/obstructive and something which is not desired but inevitable situation. It was seen that there are no positive metaphors for mathematics. Mathematics was defined as a structure, a skill, sports or an environmental feature (Brady and Winn, 2014). Besides, it was stated that there are ups and downs in mathematics and students experienced being uncontrolled (Brady and Winn, 2014; Latterell and Wilson, 2016; Latterell and Wilson, 2017). Mathematics is a form of thinking and it is a fight (Latterell and Wilson, 2017). Participants expressed mathematics as dangerous, impossible and nasty (Latterell and Wilson, 2016).

It important to determine the meaning of mathematics for students and with what students associate mathematics and what comes to their minds when you say mathematics. In this way, it can be possible to take some precautions for making students love mathematics and helping them to develop positive attitudes towards mathematics and reducing their anxieties about mathematics. This study is particularly important in terms of taking the opinions of students who will be responsible for teaching mathematics and making students become more interested in mathematics so that we can take necessary precautions before they start teaching at schools.

The purpose of this study is to ask students who are studying at the department of Teaching Primary school Mathematics to state their explanations regarding their metaphors about what mathematics is like together with their justifications and in terms of making this study more comprehensive to express their thoughts about the first thing which comes to their minds when you say mathematics. In this sense, the problem sentence of the study is as follows: What are the metaphors of students who are studying mathematics and what are their thoughts about the first thing that comes to their minds when you say mathematics? In accordance with this problem, the answers of the following sub-problems are also examined:

(1) What are the metaphors of students who are studying at Departments of Teaching Mathematics about what mathematics is like?
(2) What are the thoughts of students who are studying at Departments of Teaching Mathematics about the first thisn that comes to their minds when you say mathematics?

METHODOLOGY

The study model

Qualitative researches are studies in which a qualitative process is followed to present perceptions and events in a natural environment and in a realistic holistic way (Yildirim and Simsek, 2008). This study is a qualitative research and the data obtained through coding the answers provided by students from teaching primary school mathematics departments were divided into categories and themes were displayed in tables by given percentage and frequency values.

In this context, content analysis is used in qualitative data analysis approaches. The main goal in content analysis is to reach the concepts and associations that can explain the collected data. For this purpose, similar expressions are grouped together on the basis of certain concepts and themes, and then interpreted in a way that readers can understand (Yildirim and Simsek, 2008).

Within the scope of the current study, phenomenology was used from qualitative research designs. Phenomenology focuses on phenomena which we are aware of, but we do not have an in-depth and detailed understanding. We can encounter various forms of these phenomena in our everyday life. Phenomenology constitutes an appropriate research area for studies aiming to investigate phenomena that are not completely foreign to us, but which we cannot fully understand (Yildirim and Simsek, 2008).

The study group

The study was carried out in 2017 to 2018 academic years. The study group of this research consists of 153 students (from freshman to senior students) who were studying at Kafkas University, Faculty of Education, Department of Teaching Primary School Mathematics. Within the scope of the present study, convenience sampling was used for non-random sampling methods. Researchers are working in the same faculty and the same department as the study group. Within the scope of the convenience sample, because of the limitations in terms of time, money and labour, the sample is selected from easily accessible and practicable units (Buyukozturk, 2012).

Data collection

We ask primary school mathematics prospective teachers to state what mathematics is like with their justifications and to express the first thing that comes to their minds when you say mathematics. Students had 15 minutes to answer the questions used in the opinion form. The participants of the study are 2 lecturers and 153 students who are studying at the Department Teaching Mathematics.

Data collection instruments

Within the scope of this study, students (from freshman to senior students) who are studying at the Department of Teaching Primary School Mathematics answered an opinion form consisting of 2 questions. The questions were a s follows:

(1) Mathematics is like …………….. because……………………
(2) What is the first thing that comes to your mind when you say mathematics?

The opinions of an expert were taken for the validity of the opinion form, and the form was finalized after doing necessary changes.

Data analysis

We used an opinion form consisting of two questions to learn the metaphors and thoughts of students who are studying at teaching primary school mathematics about mathematics. The content analysis was used with the answers of the students in terms of qualitative analysis. While the researchers were analysing the students' answers, they divided the answers into categories and themes, and they tabularised the results by showing their percentage and frequency values. Double coding was used in this study while analysing the data in this study, and the purpose of doing this is to ensure reliability between researchers. The consistency value was found as 0.78 by using the method developed by Miles and Huberman (1994). The researchers shared and evaluated the opinion forms of the students after that they exchanged the forms and re-evaluated the forms. Finally, the consistency value was calculated. The consistency value obtained showed that there is cohesion between the raters. The conformability was ensured by employing interrater reliability. The transferability was proved by citing from students' opinions to prove that they reflect the opinions of the participants after the explanations about the findings of each question. In order to prove cogency, we employed expert analysis and tried to take the opinions of different experts.

FINDINGS

The findings of the first sub-problem

When we analyse Table 1, it is seen that the metaphors used by students studying at the Department of Teaching Primary School Mathematics for "mathematics is like ………………… because …………" was grouped under 14 themes. The themes are: Environment, Individual, Features of People, About Life, Organ, About Food, Universe, Emotion, Thinking, Every-No, Game, Time, Science-Art, Tools and Equipment. The categories under environment theme are: Nature, Flat, Climate events, Water, The Sun, Sea, Air, Lake, Flower, Tree, The Sun in Kars and Oxygen. The categories under individual theme are: Person, Kid, Woman, Family. The categories under features of people theme: Breathing, Dead, Hobby,

Table 1. The Distribution of the metaphors used by students for "mathematics is like …………because…………………" according to themes and categories.

Themes	Categories	Frequency (f)	Percentage
Environment	Nature	20	13.07
	Flat	2	1.31
	Climate events	2	1.31
	Water	5	3.26
	The sun	3	1.96
	Sea	2	1.31
	Air	2	1.31
	Lake	2	1.31
	Flower	2	1.31
	Tree	2	1.31
	The sun in Kars	2	1.31
	Oxygen	9	5.88
Individual	Person	3	1.96
	Kid	1	0.65
	Woman	1	0.65
	Family	2	1.31
Features of people	Breathing	2	1.31
	Dead	1	0.65
	Hobby	1	0.65
	Counting money	1	0.65
About Life	Life	20	13.07
	Understanding life	2	1.31
Organ	Brain	2	1.31
	Heart	1	0.65
About food	Sweet	1	0.65
	Soup	1	0.65
	Apple	1	0.65
	Sour-sweet	1	0.65
	Eating	1	0.65
Universe	Space	10	6.53
	Earth	5	3.26
Emotion	Self-expression ability	2	1.31
	Enjoy	1	0.65
	Fun	1	0.65
	Love	4	2.61
	Romance	1	0.65
Thinking	Thinking	2	1.31
	Philosophy	3	1.96
Every-No	Everything	2	1.31
	Everything complicated	5	3.26
	Everything that can be seen	1	0.65
	Nothing	1	0.65

Table 1. Contd.

Game	Playing games	2	1.31
	Puzzle	5	3.26
	Brain box	1	0.65
	Playing with numbers	1	0.65
Time	Time	1	0.65
	Time machine	1	0.65
Science-art	Science	1	0.65
	Art	1	0.65
	Painting	1	0.65
	Opposite pole	1	0.65
	Foreign language	1	0.65
	Numbers and symbols	1	0.65
	Korean TV series	1	0.65
Tools and equipment	Key	1	0.65
	Basic tool necessary for a job	1	0.65

Counting money. The categories under about life theme are: Life, Understanding Life. The categories under organ theme are: Brain, Heart. The categories under about food theme are: Sweet, Soup, Apple, Sour-Sweet, Eating. The categories under universe theme are: Space, Earth. The categories under emotion theme are: Self-expression ability, Enjoy, Fun, Love, Romance. The categories under thinking theme are: Thinking, Philosophy. The categories under every-no theme: Everything, everything complicated, every that can be seen, Nothing. The categories under game theme are: Playing games, Puzzle, Brain box, Playing with numbers. The categories under time theme are: Time, Time machine. The categories under science-art theme are: Science, Art, Opposite Pole, Foreign Language, Numbers and symbols, Korean TV series. The categories under tools and equipment theme are: Key, The basic tool necessary for a job.

It is seen that students mentioned nature and oxygen categories under environment theme, breathing category under features of people theme, life category under about life theme, brain category under organ theme, space category under universe theme, love category under emotion theme, philosophy category under thinking theme, everything complicated category under every-no theme and puzzle category under game theme. The samples from the answers of the students provided about what mathematics is like are stated below:

“Mathematics is like the sun because if there is sun, you can benefit its light, or you are plunged into darkness.”
“Mathematics is like life because you can see it everywhere in life.”
“Mathematics is like a woman because if you do not care, she will dump you.”
“Mathematics is like heart because it has a significant importance for both itself and other parts”
“Mathematics is like eating because we cannot give up eating and so is mathematics.”
“Mathematics is like the experiment about the rice in the water because it becomes white as you love it.”

The findings about the second sub-problem

When we analyse Table 2, it is seen that the responses provided by students who are studying at the Department of Teaching Primary School Mathematics for “What is the first thing that comes to your minds when you say mathematics?” were grouped under 11 themes. The themes are; Numbers and Operations, Mathematical Expressions, Teacher, Cognitive, Anxiety, Environment, About Life, Problem, Science-Art, Emotion and Personal. The categories under the numbers and operations theme are: The Magic of Numbers, Operations requiring Long Time, Zero and Numbers. The categories under the mathematical expressions theme are: Topics related to Mathematics, Concepts related Mathematics, Courses related to Mathematics and Famous Mathematicians. The categories under the teacher theme are: High school mathematics teacher and middle school mathematics teacher. The category under the cognitive theme is: the whole of the mind studies. The categories under the anxiety theme are: Mathematics Fear in People, How

Table 2. The distribution of the students responses to "What is the first thing that comes to your minds when you say mathematics? According to Themes and Categories.

Themes	Categories	Frequency (f)	Percentage
Numbers and operations	The magic of numbers	2	1.31
	Operations requiring Long Time	2	1.31
	Zero	2	1.31
	Numbers	3	1.96
Mathematical expressions	Topics related to mathematics	13	8.49
	Concepts related mathematics	12	7.84
	Courses related to mathematics	8	5.22
	Famous mathematicians	3	1.96
Teacher	High school mathematics teacher	3	1.96
	Middle school mathematics teacher	10	6.53
Cognitive	The whole of the mind studies	1	0.65
Anxiety	Mathematics fear in people	4	2.61
	How can I pass my lessons	1	0.65
	The difficulty of mathematics	1	0.65
	Examination	1	0.65
	Summer school	1	0.65
Environment	The balance of the nature	1	0.65
	Market	1	0.65
About life	Everything	10	6.53
	Vital Need	7	4.57
	Explaining everything in life with some certain suppositions	1	0.65
	The existence of human beings	4	2.61
	The act of abstracting life	1	0.65
	Reality	1	0.65
	Universe	7	4.57
	Order	1	0.65
Problem	A huge question mark	1	0.65
	Problems	6	3.92
	Finding solutions for the problems	6	3.92
	Unknowns	6	3.92
Science-art	Art	5	3.26
	A discipline which helps us to interpret life	5	3.26
	The necessary language to understand universe	5	3.26
	The discipline which is related to life	1	0.65
Emotion	Fun	3	1.96
	Enjoyable but difficult	1	0.65
	An Indispensable thing	1	0.65
	A good activity	1	0.65
Personal	The target to be a good mathematician	1	0.65
	Patience	1	0.65
	The talent inside the human beings	1	0.65
	Imagination	5	3.26
	The section I am reading	1	0.65
	Dealing with	1	0.65

Can I Pass my Lessons, The Difficulty of Mathematics, Examination and summer school. The categories under the environment theme are: the balance of the nature and market.

The categories under the about life theme are: Everything, Vital Need, Explaining Everything in Life with Some Certain Suppositions, The Existence of Human Beings, The Act of Abstracting Life, Reality, Universe and Order. The categories under the problem theme are: A huge Question Mark, Problems, Finding Solutions for the Problems and Unknowns. The categories under the science-art theme are: Art, A Discipline which helps us to interpret Life, The Necessary Language to Understand Universe and The Discipline which is related to Life. The categories under the emotion theme are: Fun, Enjoyable but Difficult, An Indispensable Thing and A Good Activity. The categories under the personal theme are: The Target to be a Good Mathematician, Patience, The Talent inside the human beings, Imagination, The Section I am reading and Dealing with. Students gave the following responses especially under the Mathematical expressions theme: road calculations, equations, integral and derivative, number systems, fractions, complex numbers, matrices, functions, Pythagorean relation and calculations. They provided the following responses for the concepts related to the mathematics category: money, change, Pi number, time, symbols, proofs, paradoxes, formulas, proof, eternity and concretes that can be abstracted. They provided the following responses for the Courses related to Mathematics category: general mathematics, geometry (square, angles), the futility of algebra and codes for computers. For the famous mathematicians they named Cahit Arf and Omer Bin Hayyam as the famous mathematicians.

It is seen that students especially mentioned numbers category most under Numbers and Operations theme, topics related to mathematics under mathematical expressions theme, middle school mathematics teacher category under teacher theme, mathematics fear in people category under anxiety theme, everything category under about life theme, problems, finding solutions to problems and unknowns categories under problems theme, art, a discipline which helps us to understand life, language which is necessary to understand universe categories under science-art theme, fun category under emotion theme and imagination category under personal theme.

RESULT AND DISCUSSION

It is seen that students who are studying at teaching primary school mathematics have frequently referred to “nature” under “environment” theme, “person” under “individual” theme, “breathing” under “features of people” theme, “life” under “about life” theme, “brain” under “organ” theme, “sweet” “soup”, “sour-sweet” “eating” under “about food” theme, “space” under “universe” theme, “love” under “emotion” theme, “philosophy” under “thinking” theme, “everything complicated” under “every-no” theme, “puzzle” under “game” theme, “time” and “time machine” under “time” theme, “science, art, painting, opposite pole, foreign language, numbers and symbols and Korean TV series” under “science-art” theme and “key and basic tool which is necessary for a job” under tools-equipment” theme for the expression of “ Mathematics is like ……. Because ………”.

For the question “What is the first thing that comes to your minds when you say mathematics?”, students have frequently referred to “numbers” under “Numbers and Operations” theme, “topics related to mathematics” under “mathematical expressions” theme, “middle school mathematics teacher” under “teacher” theme, “the whole of the mind studies” under “cognitive” theme, “mathematics fear in people” under “anxiety” theme, “the balance of the nature and market” under “environment” theme, “everything” under “about life” theme, “problems, finding solutions to problems and unknowns” under “problems” theme, “art, a discipline which helps us to understand life, language which is necessary to understand universe” under “science-art” theme, “fun” under “emotion” theme and “imagination” under “personal” theme.

Similar results were obtained with Guner (2013), Sahin (2013), Kilic and Yelken (2013), Erdogan et al. (2014), Keles et al. (2016), Sevindik and Cenberci (2016), Kaba and Sengul (2017) and Latterell and Wilson (2017) due to the idea that mathematics is a fun and entertaining activity. The ideas that mathematics is like life, it is everywhere in our lives and everything about life are the first things that comes to students’ minds when you say mathematics is in line with the studies of Guner (2013), Keles et al. (2016), Kaba and Sengul (2017) studies. Although a metaphor about the difficulty of mathematics have not appeared, one of the first things that comes to students’ minds about mathematics are the difficulty of mathematics category under anxiety theme, and enjoyable but difficult category under emotion theme.

In this case, we can talk about the existence of students who find mathematics difficult at various levels. In this sense, this study is in line with the studies of Guveli et al. (2011), Sahin (2013), Erdogan et al. (2014), Keles et al. (2016), Latterell and Wilson (2016), Kaba and Sengul (2017) and Latterell and Wilson (2017). One of the metaphors that students produced for mathematics is brain box. In this sense, this study is similar to the studies of Sahin (2013), Erdogan et al. (2014) and Tarim et al. (2017). While students were stating the first thing that comes to their minds about mathematics, they used the expression like “the talent inside the human beings”. In this case, we can say they that they thought the concept of mathematics together with the concept of “talent”. This is in line with the study of Sahin (2013). However, they expressed that they did not think that mathematics is unnecessary, on the contrary they thought that mathematics is needed in every part of our lives and when you say mathematics they first think it is a vital need. It is seen that in Sahin (2013) study, students used the expression of unnecessary very little though. It is seen that students did not think that mathematics is easy, and they uttered everything complicated expression for mathematics. In this case, this study contradicts with Sahin (2013), Kaba and Sengul (2017) and Latterell and Wilson (2017). Even, when you say mathematics, the first thing that comes to their minds is an enjoyable but difficult activity.

Students expressed eternity by correlating mathematics with space and universe metaphors, and they stated that eternity is the first thing that comes to their minds when you say mathematics. In this way, this study is in line with the studies of Erdogan et al. (2014) and Kaba and Sengul (2017). Having the idea that mathematics is a discipline that helps us to interpret life as the first thing when you say mathematics shows that mathematics is seen as the basis of other disciplines. For this reason, this study is in line with Erdogan et al. (2014). When you say mathematics, thinking the idea is necessary for understanding the universe and using foreign language metaphor shows us that mathematics is perceived as a language. In this way, this study is in line with the studies of Erdogan et al. (2014), Latterel and Wilson (2016) and Latterell and Wilson (2017).

The whole mind studies come to students minds when you say mathematics. In this sense, this study is in in line with Keles et al. (2016). Thinking mathematics as fun and as an indispensable and good activity, the idea that students enjoy doing mathematics, and reveal that students are not getting bored from mathematics. In addition to this, students did not use boring metaphor. In this sense, this study contradicts with the studies of Guveli et al. (2011), Kilic and Yanpar Yelken (2013), Keles et al. (2016), Latterell and Wilson (2017) and Kaba and Sengul (2017). Seeing mathematics as a foreign language and using necessary language for understanding universe metaphor and due to producing various metaphors about emotions, this study is parallel with the study of Kilic and Yelken (2013).

Because of the metaphors that say mathematics includes many topics, concepts and courses, this study is in line with Guveli et al. (2011). Due to expressing the first thing when you say mathematics is everything about life, accepting mathematics as a vital need, having understanding life and life metaphors, this study is similar to that of Kaba and Sengul (2017) and Tarim et al. (2017).

As students produced universe metaphor and having the universe expression first when you say mathematics, this study is in line with Kaba and Sengul (2017). Having students who perceive mathematics as a huge question mark even a little and who have some worries (such as mathematics fear in people, how can I pass my lessons, the difficulty of mathematics, examination, summer school etc.) shows us that they see mathematics as a source of stress a bit. For this reason, this study is in line with the study of Kaba and Sengul (2017). Besides, it is seen that students made mentioned of their mathematics teachers whom they had in their teaching experiences, and they did not forget their middle school mathematics teachers. In this sense, it is thought that this study is in line with Kaba and Sengul (2017).

Students here generally do not have negative feelings about mathematics. Maybe, this is because of the fact that they preferred mathematics as their professions and they are studying at the Department of Teaching Primary School Mathematics. This side of the study contradicts with the studies of Sevindik and Cenberci (2016). However, the opinions of vocational high school students were taken in their studies. Because of having puzzle metaphor, this study is in line with Guner (2013). Because of the expressions like mathematics help us to interpret life and makes us understand life, it can be said that mathematics is a necessity. For this reason, the idea that mathematics makes our lives easier was seen. Because of all these results, this study is in line with Guner (2013), Sahin (2013), Erdogan et al. (2014), Keles et al. (2016), Latterell and Wilson (2016), Tarim et al. (2017) and Latterell and Wilson (2017).

The metaphors like playing games, brain box, playing with numbers show that mathematics is seen as a game. In this sense, this study is similar to the studies of Tarim et al. (2017) and Brady and Winn (2014). There are some contradictory parts with the studies of Brady and Winn (2014) as they did not find any positive metaphors about mathematics because in our study metaphors are mostly positive. It is appeared that mathematics is seen as a thinking system because of the metaphors for example, thinking and philosophy. For this reason, similar results were obtain in the study of Latterell and Wilson (2017). The results of this study contradict with that of Latterell and Wilson (2016) because students in this study did not produce negative metaphors like dangerous and nasty.

SUGGESTION

How metaphors change by the grade levels of the students:

(1) Students can be asked to state solution strategies especially for their negative metaphors.
(2) Students can be asked to produce metaphors for each topic or course of mathematics.

One can conduct semi-structured interviews with the students about their metaphors. In this way, you can have more in-depth information. A similar study can be carried out regarding mathematics teachers and you can have a comparison between two groups. In particular, a comparison can be made between senior students who are studying mathematics and teachers who have just started teaching.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Aubry M (2009). Metaphors in mathematics: introduction and the case of algebraic geometry. Retrieved from SSRN: https://ssrn.com/abstract=1478871 or http://dx.doi.org/10.2139/ssrn.1478871

Brady K, Winn T (2014). Using metaphors to ınvestigate pre-service primary teachers' attitudes towards mathematics. *Double Helix*, *2*.

Buyukozturk S (2012). Ornekleme Yontemleri. http://w3.balikesir.edu.tr/~msackes/wp/wp-content/uploads/2012/03/BAY-Final-Konulari.pdf

Erdogan A, Yazlik D, Erdik C (2014). Mathematics teacher candidates' metaphors about the concept of "mathematics". Int. J. Educ. Mathematics Sci. Technol. 2(4):289-299.

Gecit Y, Gencer K (2011). Sınıf ogretmenligi 1. sınıf ogrencilerinin cografya algılarının metafor yoluyla belirlenmesi (Rize Universitesi ornegi). Marmara Cografya Dergisi, 23:1-19.

Guner N (2013). Ogretmen adaylarının matematik hakkında olusturdukları metaforlar. Educ. Sci. 8(4):428-440.

Guveli E, Ipek A, Atasoy E, Guveli H (2011). Sınıf ogretmeni adaylarının matematik kavramına yonelik metafor algıları. Turk. J. Comput. Mathematics Educ. (TURCOMAT), 2(2):140-159

Isık A, Ciltas A, Bekdemir M (2008). Matematik egitiminin gerekliligi ve onemi. Ataturk Universitesi Kazım Karabekir Egitim Fakultesi Dergisi, 17:174-184.

Kaba Y, Sengul S (2017). Ortaokul matematik ogretmeni adaylarının" matematik" ile ilgili dusuncelerinin incelenmesi. Ozkan Demirel ve Serkan Dincer (Eds.), In Kuresellesen dunyada egitim. Pegem Academy pp. 833-848.

Keles O, Tas I, Aslan D (2016). Metaphor perceptions of pre-service teachers towards mathematics and mathematics education in preschool education. Educ. Res. Rev. 11(14):1338-1343.

Kilic C, Yanpar Yelken T (2013). Belgian and Turkish pre-service primary school teachers' metaphoric expressions about mathematics. Eurasian J. Educ. Res. 50:21-42.

Latterell CM, Wilson JL (2016). Math Is Like a Lion Hunting a Sleeping Gazelle: Preservice Elementary Teachers' Metaphors of Mathematics. Euro. J. Sci. Maths. Educ. 4(3):283-292.

Latterell CM, Wilson JL (2017). Metaphors and Mathematical Identity: Math is Like a Tornado in Kansas. J. Humanistic Mathematics, 7(1):46-61.

Levine PM (2005). Metaphors and images of classrooms**.** Kappa Delta Pi Record, 41(4):172-175.

MEB (Milli Egitim Bakanlıgı) (2018). Matematik dersi ogretim programı (ilkokul ve ortaokul 1, 2, 3, 4, 5, 6, 7 ve 8. Sınıflar). Retrieved from http://mufredat.meb.gov.tr/Dosyalar/201813017165445-MATEMAT%C4%B0K%20%C3%96%C4%9ERET%C4%B0M%20PROGRAMI%202018v.pdf

Miles MB, Huberman AM (1994). An Expanded Source Books Qualitative Data Analysis. (2nd edition). London: SAGE publications.

Sahin B (2013). Ogretmen adaylarının "matematik ogretmeni", "matematik" ve "matematik dersi" kavramlarına iliskin sahip oldukları metaforik algılar. Mersin Universitesi Egitim Fakultesi Dergisi 9(1):313-321.

Sevindik F, Cenberci S (2016). Metaphors about mathematics of industrial vocational high schol students. J. Educ. Instructional Stud. World 6(1):13-22.

Sosyal D, Afacan O (2012). İlkogretim ogrencilerinin "fen ve teknoloji dersi" ve "fen ve teknoloji ogretmeni" kavramlarına yonelik metafor durumları. Mustafa Kemal Universitesi Sosyal Bilimler Enstitusu Dergisi 9(19):287-306.

Sterenberg G (2008). Investigating teachers' images of mathematics. J. Mathematics Teach. Educ. 11(2):89-105.

Tarim K, Ozsezer M, Canbazoglu HB (2017). Sinif ogretmeni adaylarinin matematik ve matematik ogretimine iliskin algilari. J. Kirsehir Educ. Faculty 18(3):1032-1052.

Yıldırım A, Simsek H (2008). Sosyal Bilimlerde Nitel Arastırma Yontemleri. Ankara: Seckin Press.

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