

Mathematics Errors in Elementary School: A Meta-Synthesis Study

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Abstract— Understanding mathematical errors is important for improving learning. In order to map the pattern of studies related to the mathematical errors, this study used qualitative approach with systematic meta-synthesis method. Data collection conducted in this research using documentation techniques by reviewing and summarizing the results of similar research. The studies included in this research were generated from 5 theses of bachelor and master degree of elementary school major in Universitas Negeri Malang. The results showed that there are eight types of errors: (1) conceptual; (2) procedural; (3) problem solving; (4) understanding of problems; (5) converting problem sentences into the mathematical sentences; (6) computational; (7) planning; and (8) implementing the settlement plan. In addition, other findings such as student problem solving solutions will be discussed in this paper.

Keywords—meta-synthesis, error analysis, elementary school mathematics

I. INTRODUCTION

The basic view of mathematical concepts becomes a mindset that embodies existing concepts and applications, especially in mathematics. Furthermore, the need to use and understand mathematical thinking as part of life becomes very urgent [1], [2]. According to that paradigm, the basis of mathematics in learning process is about the understanding of mathematical concept itself [3]. That is why, it is important for all of students to have a deep comprehension towards mathematical concepts they learn from school.

The fundamental problem related to this is about the variety of student's understanding and student's attainments [4]. Understanding mathematical concepts, facts, or procedural, can be indicated from not making a mistake. Error in mathematics can be identified as a misunderstanding which is generated from gap. This gap is becoming apparent when students make mistakes in some of the concepts [5].

With regards to this issue, making mathematics errors can be classified into several categories, namely factual, conceptual, or procedural errors [6]. Moreover, there are several components used in analyzing mathematics errors in students learning: (1) collecting students' sample works, (2) asking how students solve the problems whether they are using think aloud method or not, (3) recording all student responses, (4) analyzing the responses and looking the patterns, (5) looking for "exceptions" examples, (6) describing the patterns observed in simple words, and (7) asking students directly for confirmation [6].

Several studies have been conducted to analyze mathematical errors. One of them, digital media assistance (CBA) is a way for teachers in having a better understanding about mathematical errors faced by their students[7] or from another computation analysis [8]. Apart from that, the understanding related the teacher's perspective on the didactic and epistemological approaches related to students' mathematical errors becomes important to understand the gaps occurred [9].

Apart from the teacher's point of view, it is important to understand the type of errors made by students in mathematics learning. Result of the research showed that in general, third grade students made errors in calculation procedure, such as addition [8]. Additionally, there were also errors made by students in common problems, especially in addition and subtraction calculation [10].

Having a brief comprehension towards errors analysis in mathematics, research toward this issue become crucial to state the solution or action for giving interventions when students have those difficulties and make errors. For this reason, this research is based on the emerge of error analysis on elementary school mathematics learning on thesis of students majoring in elementary school teacher education. The purpose of this study is to map the patterns and causes of mathematics errors of students in elementary school. However, it is unfortunate that most of these studies only stopped at the analysis process without any alternative problem solving or even follow-up plan to overcome the errors made by students. Moreover, reports are only based on theses in university library. The urgency of this research is to provide empirical findings for efforts to improve the quality of elementary school mathematics learning.

II. METHOD

This research is basically designed by using a qualitative approach with a systematic meta-synthesis method. Meta-synthesis is conducted by summarizing the results of thesis research on the analysis of student error in mathematics of bachelor and master degree of elementary school major in Universitas Negeri Malang period 2013-2017. Data collection techniques used in this study are documentation techniques. The researcher conducted a review of the results of the thesis research of elementary school teacher education students on the analysis of the mistakes of elementary school students on the content of mathematics in the last five years. The data were analyzed by focusing on the content of the thesis, namely (1) conducting literature

search; (2) conducting appropriate screening and selection of research results; (3) synthesizing qualitative findings; and (4) compiling a final report.

III. RESULT AND DISCUSSION

The results and discussion in this study are as follows. Based on the analysis that had been done in the research thesis, the study mapped the type of student error and also grasped the problem-solving solution. The data obtained from the analysis showed that there are 8 types of errors from the studies observed and the type of error is presented in the following table 1.1.

TABLE 1. DATA TYPES OF STUDENT ERRORS TABLE TYPE STYLES

No.	Author	Thesis Title	Types of errors
1	Bayu Gustama Kurniawan (2014)	<i>Profil Penyelesaian Soal Cerita Materi Operasi Hitung Campuran Siswa Kelas III Sd Se-gugus 1 Kecamatan Pesantren Kota Kediri</i>	1. Conceptual Error 2. Procedural/Skill Errors 3. problem solving/conclusion
2	Ratih Rahayu Agustina (2015)	<i>Studi Kasus Tentang Kesulitan Belajar Siswa Dalam Menyelesaikan Soal FPB dan KPK Di Kelas IV Sdn Tugu Kecamatan Purwasari Kabupaten Kediri</i>	4. Understanding the problem 5. Changing sentences into mathematical sentences
3	Dhita Wuryaningtyas (2017)	<i>Profil Kesalahan Siswa Dalam Mengerjakan Soal Cerita Pecahan Pada Tema Indahnya Keragaman Di Negeriku Kelas Iv Sd Se-Gugus 4 Blimbing</i>	6. Computing 7. Error in planning 8. Errors in implementing the settlement plan
4	Ainul Ferianto (2017)	<i>Profil Kesalahan Siswa Dalam Menyelesaikan Soal Matematika Materi Operasi Hitung Campuran Kelas Iii Di Sdn Se-Gugus 03 Kecamatan Taman Kabupaten Sidoarjo</i>	
5	Anggun Dewi Novita (2017)	<i>Analisis Kesalahan Siswa Dalam Mengerjakan Perkalian Kelas Ii Pada Tema 8 Subtema 2 Di Sd Se-Gugus 5 Kecamatan Sukun Kota Malang</i>	

Based on the Table 1.1, it can be seen that there are 8 types of errors made by students from 5 studies regarding to the analysis of students' mathematical errors in working on the questions. Explanation of student errors presented in table are discussed below.

A. Conceptual Error

Conceptual errors occurred in 3 thesis studies analyzed namely [11], [12], and [13]. Based on these three types of the thesis, conceptual errors occur because students do not understand well the use of basic counting operations such as multiplication, division, addition, and subtraction, resulting in misconceptions. Student's misconceptions occur because students still do not have the understanding about the classification of each level of operation (addition, subtraction, multiplication, and division) [14].

B. Procedural Errors / Skills

The conceptual found in the thesis research analysis occurs in the description written by [11], [12] and [13]. This procedural error occurs because of the lack of accuracy of students in working on the problem. The factors that cause student errors in working on the story of some of them are hasty and less thorough [15]. Besides that, another cause of procedural errors is the lack of training carried out by students in working on the questions. The students made procedural mistakes are due to students' lack of mastering materials and practicing doing the problem [16].

C. Inference Errors

Errors in the case of inferences occur in all the theses analyzed. After further analysis, it can be seen that the errors of the conclusion were largely due to errors in the process before the conclusion such as concept and procedural errors. Another reason resulted in conclusion error was students were not used to working on the problem by including a conclusion in the answer. The lack of knowledge of these students caused them to become less skilled and did not know that some errors occurred. Furthermore, the cause of errors in conclusions stage because of several things that two of the students were not accustomed to writing conclusions at the end of the answer and according to students, teachers were not strict about this rule [15].

D. Misunderstanding Questions

Errors in understanding this problem occurred only in 2 studies conducted by [17] and [18]. The cause of the errors made by the students was due to students who lacked on training of the questions and lack of understanding the way the writing of the statements was known and asked. Some of the causes of errors in understanding the problems found because students did not understand the meaning asked in the problem well enough, lacked rigor, and lack of practice working on questions with different variations [19].

E. Errors in Alteration of Sentences Problem into Mathematical Sentences

The cause of this error is based on the results of the analysis that because of the lack of students' understanding of the questions and practices to understand the story questions. Based on the results of interviews conducted, also further suggested the cause of this error was due to students who did not understand the matter well and lack of accuracy in determining information about what was known and asked about the question [20].

F. Computing Errors

Based on the results of the analysis, computational errors occurred during mathematics learning due to lack of training by students in performing basic counting operations [17]. Moreover, the reason for this computational error was the students were too hasty in the process, were unskilled at counting and reading the problem because they were not familiar and lack of accuracy [21].

G. Planning Errors

Planning errors found in the results of this thesis research analysis because of the confusion that occurred when students determined the counting operation that would be used [18]. Students still did not know what operations

should be used because they had no conceptual understanding in reading the problems and planning how to solve that.

H. Errors in Implementing the Settlement Plan

This error occurred because students did not properly understand fractional counting operations and they forgot how to count subtraction of fractions with different denominators by directly adding up and subtracting which resulted in an incorrect answer [18]. Calculation errors in the fraction occurred because students thought that the way to solve the fraction sum was by adding the denominator to the denominator without equating it first, so did they do in other operation [22].

Based on an explanation of the types of errors found in the results of the analysis, then several solutions were given. Alternative solutions to this problem could be used as an effort to correct similar errors found in mathematics learning as explained below.

A. Conceptual Error

There is an alternative solution to the problem of conceptual errors in students by offering a learning model to reduce conceptual errors [23]. The model offered is problem solving. Based on the implementation of the Problem Solving learning model, the average value of understanding the subject's mathematical concepts in pre-cycle, the cycle I, to the cycle II has increased. This is an indication that problem-solving models can be used to minimize conceptual errors that often occur in students in mathematics.

B. Procedural / Skill Errors

To overcome procedural errors made by students, there is needed problem-solving approaches. Problem solving can be done using appropriate learning methods. Students' procedural knowledge in working on questions related to the forms of questions that require procedures is getting better with the use of error-based assignment methods [24]. The results showed an increase from 'Try out' 1 to 'Try out' 3 in the procedural knowledge of students.

C. Inference errors

Based on the analysis carried out, it is necessary to have a problem-solving solution to overcome or minimize this inference error. One solution that can be offered is the use of the right learning media that can improve students' skills in working on questions. The application of work card media in learning would increase the percentage of students' inferred skills in working on questions from cycle I to cycle II. Besides that, it is an alternative solution to other problems regarding this type of inference error, namely by using the right learning method. Using the drill method can improve mathematical problem solving skills in this case students' mathematical problem-solving skills and raise students' active and creative attitudes, especially in trying to solve the given questions [25].

D. Understanding Problem

In order to overcome the problem in understanding, implementing the steps to resolve the Polya story is become one of the solutions. There are 4 steps of Polya in solving story problems, namely understanding the problem in the problem, making a plan, carrying out planning and

concluding and checking the results of the work. Additionally, the implementation of Polya steps could ease students in solving story problems, especially in understanding the problem, and minimizing errors [26].

E. Changing Sentences Problem into Mathematical Sentences

Errors in changing the sentence of the story into mathematical sentences are errors that are often found in research on story problems. This error can be solved by a method using the modeling method with algebraic form [27]. In addition to the method of work on the question, based on the cause it is known that students lack in practice training questions so that there is an error in transferring the sentence about the story into mathematical sentences.

F. Computing Errors

This computational error can be given an alternative problem solving using the right approach. Learning using the Realistic Mathematics Education approach or commonly referred to as RME is effective learning because it provides opportunities for children to engage in various activities so that acquired numeracy or computational abilities are increased in each cycle [28].

G. Planning Mistakes

This planning error can be overcome or given a problem solving using the proper settlement method. One method of settlement is by using four steps Polya statements, namely understanding the problem or problem, making a plan, implementing planning, and concluding and checking the results of the work. In terms of planning, the completion step of Polya and the drill method, students will be skilled in completing the problem with Polya's steps, especially in this case at the planning step which will ultimately minimize the errors that will occur [25], [26].

H. Errors in Implementing the Settlement Plan

Errors in carrying out this settlement plan could be overcome by using the proper settlement method such as using the Polya settlement method. Problem-solving will be more effective if done with frequent intensity, so students will be more skilled at using Polya completion steps in solving story problems [26]. Not only using the drill method, mathematical problem-solving skills could increase students' understanding of this type of error [25]. Based on the two opinions from the results of the study, the use of Polya steps can help students overcome story problems and the drill method can improve problem-solving skills. In that case, the use of the pattern steps in solving the problem-solving stories, especially in terms of this implements the completion plan combined with an intensive drill method would bring up an effective problem-solving alternative to the problem of errors in carrying out a solution to the problem-solving story by this student.

IV. CONCLUSION AND SUGGESTION

A. Conclusion

Based on the analysis of five studies in elementary education of State University of Malang, there were eight mathematics errors identified, namely, conceptual errors, procedural errors, inference errors, misunderstanding

questions, errors in changing the sentence into mathematical sentences, computational errors, planning errors, errors in carrying out the completion plan. The causes of these errors identified are misconceptions and lack of understanding of students' concepts regarding basic counting operations, lack of students' understanding of the questions, the confusion of students in determining the calculation operation to be used. Furthermore, confusion occurs because of the lack of explanation and training given to students.

According to the discovery of the types of errors made by students and their causes, alternative solutions to problems were given in order to overcome or minimize similar errors. The solutions offered were using appropriate learning methods, appropriate learning media, settlement method, drill methods, Realistic Mathematic Education (RME), the Polya settlement method. There are still many other alternatives that can be given to overcome these problems such as a brief description of alternative solutions to these problems supported by the results of previous studies that have similarities.

B. Suggestion

Based on the results of the research obtained and the findings found by the researchers during the study, several suggestions can be given to improve students learning in mathematics. For further researchers, it is better to check the error analysis as well as to offer an action plan to overcome the errors found after doing the analysis.

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