Error analysis and its causal factors in solving mathematical literacy problems in terms of habits of mind

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Abstract. Errors and factors causing mistakes in solving mathematical problems are important to be analyzed. This study aims to investigate the abilities, mistakes and factors that cause students to do mistake in solving mathematical literacy problems in terms of habits of mind. The study was conducted in junior high schools in Indonesia using a descriptive exploratory method. The participants are 3 students who have habits of mind limited, developing, and professional. Data were collected using mathematical literacy test and habits of mind questionnaire. All instruments used were tested for eligibility by two mathematics education experts. The conclusion shows that students who have habits of mind limited wrong in process skills that are wrong in interpreting and using different representations and expressing reasons, as well as communicating the results of interpretation and reason. While students who have habits of mind developing and proficient wrong in understanding that is wrong in combining different representations, symbols, connecting them to real situations, using a variety of limited skills and expressing various reasons, giving explanations and communicating with arguments. The factors causing errors are hesitation, inaccuracy, not doing calculations, unable to understand the information in the problem correctly, in a hurry in interpreting the problem without interpreting.

1. Introduction

Mathematical literacy is very important to help students solve mathematical problems and problems in everyday life. So that students are expected to have a good mathematical literacy that is able to formulate and interpret mathematics in various contexts. Why is mathematical literacy important? This is because mathematical literacy is the ability of a person to formulate, apply and interpret mathematics in various contexts. In addition, it is the ability to do mathematical reasoning and use concepts, procedures, and facts to describe, explain or predict phenomena or events. Literacy movements are developed in Indonesian schools that is aimed to develop potential in intellectual, emotional, linguistic, aesthetic, social, spiritual intelligence, with their adaptability to the development of technology and information flows of the students. Mathematical literacy according to PISA is defined as the ability of a person to formulate, apply, and interpret mathematics in various contexts, including the ability to do mathematical reasoning and use concepts, procedures, and facts to describe, explain or predict phenomena / events, which are related to the uses or functions of mathematics that has been learned by a student in school.

Various studies have been conducted, [1] mathematical literacy of prospective teachers in Tasikmalaya, the result shows that prospective teachers do not achieve mathematical literacy levels 5
and 6. In addition, [2] concerning mathematical literacy conducted in Mataram that students still have difficulty in solving mathematical literacy skills level 3 and 4. Study of mathematical literacy has been conducted [3] Bandung, Medan, Yogyakarta, Palembang, Samarinda, Kendari, and Kupang on high school level students, the results of the study show that mathematical literacy achievements of students are still low, even though the questions have been adapted to the Indonesian context. The Organization for Economic Cooperation and Development [4] organizes the Program for International Student Assessment (PISA) to determine the ability of students from various countries to solve literacy questions in reading, mathematics and science. Indonesia has been a participant of PISA since 2000, but the results of the mathematical literacy abilities of Indonesian students can still be classified as low because they always keep the bottom order positions of the various participating countries.

To improve the variety of mathematical thinking skills according to [5,6] included problem solving, creative thinking, critical thinking, including mathematical literacy needs to be analyzed for errors. Students still find it difficult to solve problems that require complex levels of thinking [7], difficulties result in errors in solving problems. Thus, errors in mathematical literacy need to be analyzed so that they can correct them. The mistakes made by students varied, according to Newman errors included reading errors, comprehension errors, transformation errors, process skill errors and encoding errors. There are aspects that affect students in answering questions other than cognitive aspects, namely affective aspects. This is in accordance with [8] that in addition to cognitive aspects, affective aspects also need to be improved as demands in the 2013 curriculum students are expected to improve 3 aspects namely cognitive, affective and psychomotor. Research on mathematical literacy was conducted by [9] on reflecting mathematics. Besides, the study of mathematical literacy [10] compares between adults and students in PISA. Furthermore [11] study of mathematical literacy, an example of a cross-curricular project. Similar to the study conducted by [12] on mathematical literacy and curricular numeration and the construction of mathematically literate.

One of the affective abilities that must be possessed and enhanced by every student is habits of mind. This is because, good Habits of mind is needed for students, because habits of mind form the tendency of students to behave using intellectuals or think intelligently when solving problems. The characteristics of habits of mind [13] are persisting, managing impulsivity, listening to others with understanding and empathy, thinking flexibly, thinking about thinking; striving for accuracy and precision; questioning and posing problem; applying past knowledge to new situation; thinking and communicating with clarity and precision; gathering data through all senses, creating, imagining and innovating; responding with wonderment and awe; taking responsible risk, finding humor, thinking interdependently; remaining open to continues learning. Furthermore, [13] categorized habits of mind into five stages, namely no concept, limited, developing, professional, and distinguished.

Noting the various studies that have been carried out about mathematical literacy, no one has examined the mathematical literacy in terms of habits of mind, and then analyzed Newman errors and their causal factors. The purpose of this study is to explore mistakes of students in solving mathematical literacy problems in terms of habits of mind.

2. Method

This study was conducted at one of the junior high schools in Indonesia using survey methods and think aloud techniques [14]. This research is a qualitative study carried out in one of the junior high schools in Indonesia, involving three respondents. Stages of this study include: making instruments, feasibility tests, carrying out mathematical literacy tests, filling out the habits of mind questionnaire. Level 1, 2, 3, 4, 5, and 6 mathematical literacy instruments were adopted from PISA. Habits of mind questionnaire, the results of the feasibility test from 2 validators were declared feasible. Beginning with taking habits of mind data by distributing questionnaires to students, then the data obtained are grouped into habits of mind limited, developing, and professional. No habits of mind are found and no concepts are found. Furthermore, in each group the habits of mind are carried out mathematical literacy tests to obtain saturated or sufficient data. Obtained respondents namely SL, SD, and SP, respectively from habits of
mind limited, developing, and professional. Next, Newman errors and causes of errors from SL, SD and SP are analyzed.

3. Results and Discussion
The findings of the data analysis results, SL in solving level 1 mathematical literacy problems, do not make mistakes. Can solve the problem correctly, answer according to level 1 indicator that is answering questions with known contexts, and all relevant information is available with clear questions, identify information, and perform general procedures based on clear instructions; and shows an action in accordance with the stimulation provided. Furthermore SL solved the level 2 mathematical literacy problem, but SL made a mistake while working on a basic algorithm and could not do a simple procedure. SL made a mistake making a basic algorithm and could not carry out simple procedures, and SL could not give a proper reason about the results of its completion. FFS can interpret and recognize situations in contexts that require direct conclusions, and can select relevant information from a single source and use a single presentation method. Figure 1 is SL answer to problem level 2.

![Figure 1. SL error in Mathematical Literacy Level 2](image)

Figure 1 shows that SL actually has a good understanding of level 2 literacy problems and can determine what information should be used as well as the arithmetic operations performed. SL makes mistakes in multilevel division, so it does not meet the indicator can use basic algorithms and simple procedures so that it causes errors in process skills in the level 2 literacy problem. SL also looks doubtful when answering questions from researchers and hesitant when writing the answers.

Respondent SD towards level 1 literacy problems can solve problems correctly. Answers according to level 1 indicators, namely answering questions with known contexts and all relevant information are available with clear questions; identify information, and carry out general procedures based on clear instructions; and shows an action in accordance with the stimulation provided. In the level 2 literacy problem elementary schools can solve problems correctly and not make mistakes. SD can solve problems according to level 2 indicators, namely interpreting and recognizing situations with contexts that require direct conclusions; choose relevant information from a single source, and use a single presentation method; work on basic algorithms, use formulas, carry out simple procedures; and give exact reasons for the results. Furthermore, at level 3 problems, the SD is able to carry out procedures clearly, including procedures that require sequential decisions. In addition, elementary schools can solve problems and implement simple strategies, but are wrong in interpreting and using representations based on different sources of information and cannot communicate reason. So, SD does not meet indicators at level 3. SD errors can be seen in Figure 2.
Figure 2 shows that the error made by SL on level 2 literacy problems is that he cannot interpret and use representations based on different sources of information and state the reasons directly; and communicating the results of interpretations and reasons. SD can carry out procedures clearly, including procedures that require decisions in sequence and can solve problems, as well as implementing simple strategies. SD cannot interpret and use representations based on different sources of information and express their reasons directly and communicate the results of their interpretations and reasons. So that it can be stated that the SD does not meet the indicators of level 3 mathematical literacy problems. The mistake made by the elementary school is an error of understanding, because he cannot understand what the question is being asked about.

In the level 1 mathematical literacy problem, SP can solve the problem correctly and not make mistakes. Can answer the problem in accordance with level 1 indicators, namely answering questions with known contexts and all relevant information available with clear questions; identify information, and carry out general procedures based on clear instructions; and shows an action in accordance with the stimulation provided. In the level 2 mathematical literacy problem, SP can answer the problem correctly and not make mistakes. SP can be able to solve problems according to level 2 indicators, namely interpreting and recognizing situations with contexts that require direct conclusions; sort out relevant information from a single source, and use a single presentation method; work on basic algorithms, use formulas, carry out simple procedures; and give exact reasons for the results. SP on level 3 mathematical literacy problems can solve problems correctly and not make mistakes. Can answer according to level 3 indicators, namely: implement procedures clearly, including procedures that require decisions in sequence; can solve problems, and apply simple strategy; interpret and use representations based on different sources of information and state the reasons directly; and communicating the results of their interpretations and reasons. For the level 4 mathematical literacy problem, SP cannot fulfill the indicator of choosing and combining different representations, including symbols, connecting them to real situations; use a limited range of skills and express reasons with some clear contextual views; provide explanations and communicate them with arguments based on interpretation and action. Thus SP is unable to arrive at level 4 mathematical literacy problems, the error can be seen in Figure 3.
Figure 3 shows that SP made a mistake that is not able to meet the indicators of choosing and combining different representations, including symbols, connecting them to real situations; use a limited range of skills and express reasons with several views in a clear context; provide explanations and communicate them with arguments based on their interpretations and actions. In addition, experiencing errors also in understanding the problem so that it causes errors from the beginning. It can be stated that SP does not meet 3 indicators from level 4, namely choosing and combining different representations, including symbols, connecting them to real situations; use a limited range of skills and make excuses with some clear contextual views; and provide explanations and communicate them with arguments based on their interpretations and actions. So, SP made a mistake in the level 4 mathematical literacy problem.

4. Conclusion

The conclusion of this study is that respondents with habits of limited initials SL were able to solve the level 1 mathematical literacy problem, but were unable to solve the level 2 mathematical literacy problem due to incorrect answers. At level 2 mathematical problems make a process skill error. Respondents with the habits of mind developing initials SD, were able to solve the problems of level 1 and 2 mathematical literacy, but made mistakes on the level 3 mathematical literacy problems. On the level 3 mathematical literacy problems made mistakes in understanding. Respondents with the habit of mind proficient initials SP, are able to solve mathematical literacy problems level 1, 2, and 3, but make mistakes on level 4 mathematical literacy problems because they cannot combine different representations, including symbols, connecting them to real situations; use a limited range of skills and make excuses with some clear context views; provide explanations and communicate accompanied by argumentation. In this level 4 problem the subject made a misunderstanding. The factors causing errors made by SL, SD, and SP are all relatively the same, namely inaccurate, lack of process skills, not understanding the problem, and in a hurry to answer.

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