Students' error on mathematical literacy problems

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Abstract. This research aims to analyze of students error on mathematics literacy problems related to trigonometry in secondary school. The error in solving this literacy problem was analyzed based on the types of error by Nolting. This research used descriptive research method and the data in this research were collected through mathematical literacy test and interview. Subjects were selected based on types of error on mathematical literacy test. The results of this research indicate that the types of error made by the student in solving the literacy problems were careless errors, concept errors, and application errors.

1. Introduction
The mathematical capabilities of the OECD framework are communication, mathematising, representation, reasoning and argument, devising strategies for solving problems, using symbolic, formal and technical language and operations, and using mathematical tools [1]. In the survey report, OECD describes that mathematical literacy involves or encompasses these seven mathematical capabilities. Mathematical literacy includes processes of problem-solving, judging, communication, critical and creative thinking, and is believed to be at least as important as literacy by contemporary societies [2]. Mathematical literacy is an individual’s capacity to formulate, employ, interpret mathematics in a variety of contexts, It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena and mathematical literacy assists individuals to recognise the role that mathematics plays in the world and to make the well-founded judgements and decisions needed by constructive, engaged and reflective citizens [1].

Mathematical literacy refers to students' knowledge and ability to take and apply the mathematical knowledge and skills gained from classes to their real-life experience and understand the situations involving mathematics and it includes the ability to consider ‘when’ and ‘how’ to apply such mathematical knowledge [3]. As numerous countries give importance to mathematical literacy and are concerned about their place in various types of literacy, OECD initiated the implementation of tests measuring mathematical and science literacy every three years to 15-year-old students who have completed their compulsory education. This is an indication of the degree of importance attributed to literacy at the international level [4].

Indonesia is one of the participating countries in the tests conducted by the OECD. The results of this test show that in 2012 with mathematics as the main domain, the score of Indonesia is 375. In this test, the problems given are problems of mathematical literacy. Then in 2015 the score of Indonesia only reached 386, the score of Indonesia in 2015 is still far from the average standard set by the OECD is 390. Thus, Indonesia is in the bottom ten of the overall surveyed countries. The low score obtained by
Indonesia is due to the many errors made by Indonesian students in solving the given problem. Mistake or error is defined as wrong idea or wrong deed [5]. Furthermore, the error analysis is the process of reviewing student work and then looking for patterns of misunderstanding [6].

Analyses of errors provide important findings not only for students and teachers in schools but also for authors of textbooks, syllabuses, and tests [7]. There are several types of error: (1) Misread direction errors - these errors occur when you skip directions or misunderstand directions but answer the question or do the problem anyway, to avoid this type of error, read all the directions; (2) Careless errors - mistakes made which can be caught automatically upon reviewing the test, to avoid this type of error, watch for simple mistakes carefully as you review the test; (3) Concept errors - mistakes made when you do not understand the properties or principles required to work the problem, to avoid this type of error in the future, you must go back to your textbook or notes and learn why you missed the problems; (4) Application errors - mistakes that you make when you know this concept but cannot apply it to the problem, to reduce this type of error, you must, learn to predict the type of application problems that will be on the test; (5) Test Procedure errors - mistakes that you make because of the specific way you take tests; (6) Study errors - mistakes that occur when you study the wrong type of material or do not spend enough time studying pertinent material, to avoid these errors in the future, take some time to track down -why the errors occurred so that you can study more effectively the next time [8, 9, 10].

And then, in other relevant studies, the researcher classifies errors as well as the number of errors made by students [11]. Furthermore, there are other researcher classified the error that made by students and explains how important for the teacher to analyze it [12].

2. Method
This research used descriptive research method and the data in this research were collected through mathematical literacy test in essay and interview. Mathematical literacy test in this research covers only space and shape content. The topic of the essay test was trigonometry. This research aims to analyze of students error on mathematics literacy problems. Furthermore, The error that has students made was analyzed based on the types of error by Nolting. This research was conducted at a secondary school in the city of Bandung. Three subjects (SY, MR dan RH) were selected based on the type of error that student made. Then, the subjects were interviewed to find out the cause of the error.

3. Result and discussion
The discussion in this research will be focus on one of the problems of mathematical literacy tests conducted by the subject of research. This problem includes space and shape content, with the personal context and the literacy indicator is formulate a mathematical situation. There are several types of error made by students. The results of this research indicate the percentage of types of error that made by students: (1) make two mistakes at once (careless errors and concept errors) are 58%, (2) concept errors are 33%, and (3) application errors are 9%. Students’ answers are analyzed as follows: ‘Fathan played a kite on the flat ground. The kite control thread is placed at a point such that between the yarn and the flat ground make an angle of 60°. If the length of the yarn from the stake on the kite is 50 m, what is the height of the kite? (Draw the approximate position of the kite with the pile according to the description of the problem)’. Student answers in solving the problem are shown in the following figure:

Figure 1. Answer the subject SY.
Figure 1 shows the SY’s answer of a mathematical literacy problem. SY answer appears that the subject SY is correct in drawing the illustration of the position of the kite with the pile in according to the description of the problem. It’s just SY made a careless error in drawing the illustration. The carelessness errors are mistakes made which can be caught automatically upon reviewing the test [8]. This carelessness is seen in the picture, that SY is wrong in writing the unit length on the length of the kite thread. The unit of length known in the problem is the unit of length in meters (m), but the subject writes a unit of length in degrees (°).

At the stage of formulating into the form of a proportion of trigonometry, SY made a concept error. Concept errors are mistakes made when you do not understand the properties or principles required to work the problem [8]. The error in calculating the height of the kite should be to use the concept of cosine but SY uses the sine concept. From the results of interviews known that to calculate the height of the kite, the concept of trigonometry that needs to be used is the concept of sine. SY also says that the sinus value is obtained from the length of the side in front of the angle (de) formed between the yarn and the flat ground divided by the length of the hypotenuse side (mi) which is the length of the kite’s thread. The uses of symbol ‘de’ in the subject's answer are to symbolize the vertical triangle side and ‘mi’ to symbolize for the hypotenuse side. From the interviews, it is seen that there is a confusion on the subject (SY) in understanding the concept of trigonometry. Furthermore, it is known that the error made by SY are careless errors and concept errors.

Figure 2. Answer the subject MR.

Figure 2 shows the MR’s answer of a mathematical literacy problem. MR cannot draw an illustration of the position of the kite with the pile according to the description of the problem. The MR answer process is wrong from the first step to the last step. In the first step, it has been seen that MR is wrong in choosing the concept to be used to find the height of the kite. In the answer process, MR uses the sinus concept but in formulating the trigonometry proportion, MR writes a proportion for the tangent. From this answer, it can be seen that MR does not understand well the concept of trigonometry. Then, from the results of interviews with MR, it is known that MR does not mastered the concept of trigonometry well so that it becomes the wrong trigger in using the concept and formulate the proportion of trigonometry. Thus, it is known that the error made by MR is concept error.

The MR’s answer process shows the thing to note is that although MR does not understand the concept of trigonometric proportion well, MR is correct in writing that sine 60 is \( \frac{1}{2} \sqrt{3} \). Thus, it is known that MR already understands the value trigonometry for certain angles. This was also clarified by MR during the interview. Understanding trigonometric angle values for certain angles can be a prerequisite for helping to learn the concept of trigonometric proportion.
Figure 3. Answer the subject RH.

Figure 3 shows the RH’s answer of a mathematical literacy problem. In RH's answer, it appears that the subject RH is correct in drawing the illustration of the position of the kite with the pile according to the description of the problem. In the RH answer process, starting from the first step RH has made an error. The answer process shows that RH uses the tangent concept, but for proportion, RH uses a cosine proportion. From the interviews, it is known that the subject of RH understands the steps to be taken to calculate the height of the kite, but the difficulty in applying it. In the first answer, RH had written cosine but was removed and changed to tangent. From the process of written answers and interviews, identified that the error made by RH is application error. The application errors are mistakes that you make when you know this concept but cannot apply it to the problem [8]. In this case, RH understands the concept that must be used, but RH cannot apply it.

Analyzing the answers of students in solving the literacy problem by describing the mistakes made is a way to know what the types of errors made by students. It is a process of reviewing a student’s work and then looking for patterns of misunderstanding [13]. Then, from the types of error made by these students, it is expected that educational practitioners, especially teachers, can take action so that the same mistake does not happen again. Furthermore, an error analysis can help a teacher too (1) identify which steps the student is able to perform correctly (as opposed to simply marking answers either correct or incorrect, something that might mask what it is that the student is doing right); (2) determine what type(s) of errors a student is making; (3) determine whether an error is a one-time miscalculation or a persistent issue that indicates an important misunderstanding of a math concept or procedure; (4) select an effective instructional approach to address the student’s misconceptions and to teach the correct concept, strategy, or procedure [14].

4. Conclusion
From the description of the kind the types of error that made by students, can be concluded that the types of error that made by the student are careless errors, concept errors, application errors. The errors that most students made are concept errors and application errors at once. From the explanation of these forms of error is expected that the teachers and all parties involved in learning can make an effort so that the same errors do not happen again.

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