Behaviour analysis of students in solving mathematics word problem

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Abstract. The purpose of this research was to identify the behaviour of students with auditory learning style in solving mathematics word problem on geometry material. The procedure was giving a test of mathematics word problem to students and interviews to representatives of students have an auditory learning style. The result of the research found that behaviours of students with auditory learning style demonstrated in solving mathematics word problems on geometry material showed the category of problem solving behaviour namely DTA-not proficient, DTA-Proficient and DTA-Limited of context. Thus, it can be said that the students with auditory learning style in solving mathematics word problem have behaviour solving problem still not optimal. Therefore, it is important for the teachers to consider auditory learning style of students in solving mathematics word problem to design and to plan better mathematics learning.

1. Introduction
Mathematics is one of the sciences which play the important role in supporting advancement and development in science and technology. Mathematics existence in this life is very significant because it is a universal science which can be conducted in another discipline. It is in line with the explanation that the study of mathematics is considered to be very important in each and every country of the world. Students are required to learn mathematics which is considered as a basic education since the skill of mathematics computation is essential in every walk of life [1]. In addition, mathematics is at the heart of many successful careers and successful lives for societal development, particularly in the extraordinary and accelerating change circumstances [2].

Indonesia is one of the countries recognized how the important mathematics in education. Thus, it has become one of the obligatory lessons in every education level. It must be mastered from basic level (elementary school) until high level (university). One of the signs whether mathematics learning process succeeds or not in a class showed from students’ achievement in applying concept and formula in solving a task. However, based on the report of Trends in International Mathematics and Science Study (TIMSS) 2011, Indonesia ranked 38 of 42 countries with the overall score mean is 386 [3]. The result of Programme for International Student Assessment (PISA) 2015 showed that Indonesia ranked 63 out of 70 countries regarding with mathematics problem solving ability [4]. Also, more than 60% Indonesian students were only able to complete the problem under level 2. It indicates the low of mathematics problem solving ability of Indonesian students.
The low students’ ability in solving mathematics problem also supported based on the result of observation we have conducted in SMP 3 Kebakkramat. It is a junior high school in Karanganyar, Central Java, Indonesia. The observation showed the low students’ ability in solving mathematics’ problem. Most of them acquired difficulty in mathematics learning in solving word problem include geometry lesson. Thus, they often get confused for comprehending what is the aim of the task and find difficulties to declare mathematics model from a word problem. It is in line with the explanation that one of the difficulties which are mostly obtained by them in mathematics problem is in solving mathematics word problem [5, 6]. The difficulties which have been obtained by them is not only in solving the problem requiring interpretation of the sentence but also the difficulties in mathematics model which have a meaning related to a problem.

The difficulties in solving mathematics word problem given are probably influenced by some factors, one of them is kind of students’ learning style in the classroom. Students’ learning style is a manner which is chosen by someone to receive information from the environment and to process them continually which each of students has their students’ learning style selves. Thus, it influences students to determine how to study mathematics effectively. Manners of study effectively help them to catch and understand this lesson. A research conducted by Makhlouf, Martinez and Dahawy found that kinesthetic learning style owned by male and female students made the learning result statistically different which male students have better achievement than female [7]. But, for visual learning style and auditory style, the results showed that students’ learning style give the different result for each student [7]. It is also supported by Halim [8], Zahro and Assyar [9] which shows that students’ learning style influenced significantly by the students’ behaviour in solving word problems.

In learning process at the SMP 3 Kebakkramat, the teacher often uses conventional learning model. The teacher gives a speech to the students who have an auditory learning style. Sometimes, the teacher also addresses problems to the students and they usually use three steps: writing the given information, writing the purpose, and writing the solution. Furthermore, they are given a mathematics word problem. The teacher explains what is given in the problem. Then, the teacher writes what the purpose is, and finally, the teacher writes its answer. Hereby, the students are given the explanation about it clearly. In order to memorize the steps, they are given mathematics word problem by the teacher with the same model with the example provided. Following these steps, most of the students in the classroom still could not solve the word problems.

In mathematics learning, especially problem solving, one of the very important things is the process which the students should have a custom and curiosity in solving the problems. In this condition, students’ behaviour in problem solving is very vital. Pape [10] observed and described the students’ behaviour when solving mathematics word problem from the perspectives of the reading comprehension process, including the kind of reading strategy. They read repeatedly, conclude, ask a question and interpret the structure of the text to improve reading comprehension. Moreover, Pape [10] classified kind of behaviours in solving mathematics word problem into two parts. They are direct translation approach and meaning-based approach. In the direct translation approach, it was divided into sub-categories. They are direct translation approach proficient, direct translation approach not proficient and direct translation approach limited context. On the other hand, the meaningful based approach was divided into two sub-categories. They are meaningful-based approach full context and meaning-based approach justification.

Based on the research conducted by Pape [10], direct translation approach category was categorized by the students which had the lack of interpreting information from the problem or using problem context include all the sources in every element and relation between problems element. Based on this consideration, the researcher can conclude that the characteristic of direct translation approach includes the students who could not relate the problem elements yet in solving problems process. Furthermore, based on research conducted by Pape [10], meaningful-based approach category was divided behaviours changed include read repeatedly in acquiring an information with problem context, and explain the correct answer to operate calculation system. Based on the consideration the researcher can conclude that the characteristic of meaningful based approach includes information recording, using problem context which has description and assessment in mathematics operation.
We are interested to identify and to classify the students’ behaviour in solving mathematics word problem in geometry lesson, especially the material of prism which is considered an auditory learning style. The purpose of the research is to identify and to classify kind of students’ behaviour in solving mathematics word problem in geometry lesson especially in prism material considered by auditory learning style.

2. Method
The design of this research is descriptive qualitative using with case study method. Qualitative research was a research aimed to understand phenomena regarding subject’s experience holistically through the description in the form of word and language [11]. Yin [12] defined case study as an empirical inquiry that investigates a contemporary phenomenon within its real-life context. Thus, our research tried to investigate and to identify deeply and holistically the contextual phenomena experienced by the subject. In this research, the contextual phenomena are the behaviour of students in solving mathematics word problem.

Before selecting the subject, we gave a learning style questionnaire to obtain students with auditory learning style. Then, we gave mathematics word problem and interviewed the research subjects. The research was conducted at SMP 3 Kebakkramat in 2017. The subjects in this research were three students from the 8th grade chosen by using purposive sampling taken from 32 students with auditory learning style considered to communicate their idea or their process in problem solving. Through this procedure, we obtained data of the answer sheet in solving the mathematics word problem and the result of interviewing the research subjects.

In this research, the data have been obtained through written tests and interviews on the subject of research. Furthermore, to verify the credibility of the data, we used triangulation method. We also used analysis steps by Miles and Huberman, including the data reduction, presentation, and verification [13].

3. Result and discussion
Based on the result acquired from the three research subjects with auditory learning style is followed by an interview to find out the subject’ behaviour in solving the word problems. The result of data analysis of written test is provided in Figure 1.

![Figure 1. The answer provided by Subject 1 indicated by DTA-Limited Context](image-url)

Based on the answer provided by Subject 1, Subject 1 could mention the given information in the problem context and declared what is the task question. Subject 1 was able to write the length of aquarium, the wide of aquarium and the height of aquarium in the answer sheet. Furthermore, Subject 1 was able to write what they inquire in the problem in writing how much volume of the water which
is able to be fulfilled into the aquarium. However, the calculation and description were limited that appeared in the lack of calculation process. In the calculation of Subject 1, there is no writing in length and wide before changing into a number. In the answer sheet, Subject 1 has provided the conclusion indicated in the last writing of the answer. The result of interview towards Subject 1 suggests that Subject 1 used limited problem context. There is a limitation in the mathematical calculation, and read repeatedly followed with a calculation which probably includes problem context, and writes the last sentence completion directly.

Further, we got an answer sheet from the Subject 2 as shown in Figure 2.

![Figure 2](image)

**Figure 2.** The answer provided by Subject 2 indicated by DTA-Proficient

Based on the answer provided by Subject 2, Subject 2 was able to declare what it was found in the problem. It appeared on the answer sheet that Subject 2 wrote the length, the width, and the height of the aquarium correctly. However, in this condition, Subject 2 did not use the problem context in calculation process correctly. Because, whether it is wrong way in interpretation formula in the aquarium with prism shape, the effect appeared inappropriate context with the problem.

Based on the interview towards Subject 2, Subject 2 did not read repeatedly the problem. In this condition, Subject 2 did not use the problem context in the process of the calculation. Furthermore, a description of mathematical calculation is not provided. Subject 2 provided the conclusion of the solution, but it was inappropriate with problem context.

The last answer sheet was obtained from Subject 3 as shown in Figure 3.
Figure 3. The answer provided by Subject 3 indicated by DTA-not Proficient

Based on the answer provided by Subject 3, Subject 3 has used problem context. However, Subject 3 provided an incorrect height of aquarium at prism size. Subject 3 did not use problem context in the process of the calculation and then provided the wrong result. Subject 3 incorrectly used the formula for the base area of the aquarium. As the result, the last answer is incorrect. The result of interview towards Subject 3 suggests that Subject 3 did not read repeatedly the problems. Subject 3 seems to use the problem context in the calculation process, but it is inappropriate with what it should be.

According to the data analysis in written test and interviews, we can acquire the classification and identification of students’ behaviour in solving mathematics word problem in prism material with auditory learning style as follows.

Subject 1’s behaviour in solving mathematics word problem described that the behaviour category is Direct Translation Approach (DTA) with sub-category Direct Translation Approach Limited Context, include: (1) using problem context in calculation was limited, (2) in this condition it describes about limitation in mathematical calculation, and (3) read repeatedly is directly followed by calculation which probably includes using problem context, (4) write the last answer completion. It is acquired from the reason of Subject 1 when solving the problem;

Subject 2’s behaviour in solving mathematics word problem described behaviour category for Direct Translation Approach (DTA) for sub-category Direct Translation Approach Proficient, include: (1) not read repeatedly the test, (2) not using problem context in the process even though in the calculation, (3) not describing mathematical calculation, (4) in this condition, the last answer was inappropriate with problem context.

Subject 3’s behaviour in solving mathematics word problem described behaviour category for Direct Translation Approach (DTA) for sub-category Direct Translation Approach Not Proficient, include: (1) not read repeatedly the test, (2) not use problem context in the process even though in the calculation, (3) not explain the mathematical calculation, (4) the difficulties in calculation on problem solving, (5) there is the last answer, but it was inappropriate with problem context.

Based on the result of the test and interview for the Subject 1, it is acquired that Subject 1 has behaviour characteristic in problem solving as follows: (1) used problem context in the calculation, but it was limited. It is able to be found from the capability of subject 1 to write an to mention what is detected, is questioned, and used problem context in the calculation; (2) Those are limited explanation in the mathematical calculation; it seemed a few descriptions for problem completion; (3) read repeatedly which is directly followed by the calculation which is probably including used problem context. It is acquired from the reason of Subject 1 when solving the problem; and (4) write the last answer completion which seemed from the capability of subject 1 in answering the last result with problem context.
Moreover, based on consideration of written test and interview towards Subject 2, it is acquired that Subject 2 has behaviour category in solving the problem, including: (1) not read repeatedly the test. It is acquired from the reason when Subject 2 was solving the problem, (2) not using problem context in the process even though in the calculation. Subject 2 is able to be detected by capability in explaining and answering the problem which is wrong in describing what is detected in the used of formula in problem solving, (3) not explaining for mathematical calculation which appeared from the answer of Subject 2 without giving any description in every step in problem solving; (4) in this condition, the last inappropriate answer with problem context appeared from the subject 3 capability is failed in writing the last answer. And then, based on the consideration of the written test and interview for Subject 3, it is acquired that Subject 3 has behaviour characteristics in problem solving, including: (1) not read repeatedly in the test acquired from the reason when it was solving the problem; (2) not using problem context in the process even though in calculation which is found from the capability in explaining and answering the fault which is still fault in describing what is detected and is used the formula in problem solving; (3) not describing mathematical calculation which appeared from the answer of Subject 3 without giving description in every step in problem solving; (4) the difficulties in calculation process in solving problem. And also, it has been found difficulties to operate multiplication and addition; (5) in this condition, the last inappropriate answer with problem context appeared from the Subject 3 capability is failed in writing the last answer.

Based on the consideration and description of discussion, it is acquired that the characteristic of Subject 1 is classified as Direct Translation Approach (DTA) for sub-category Direct Translation Approach Limited Context, Subject 2 is classified as Direct Translation Approach Proficient category, and Subject 3 is classified as Direct Translation Approach Not Proficient. In this condition, it is appropriate with the behaviour in problem solving which is divided the behaviour in solving mathematics word problem when they solve the word problem into two parts [10, 14]. They are direct translation approach and meaningful based approach. Direct translation approach is divided into three sub-categories. They are direct translation approach proficient, direct translation approach not proficient and direct translation approach limited context. Whereas, the meaningful based approach is divided into two parts. They are meaningful based approach full context and meaningful based approach justification. Based on consideration from the data analysis, this behaviour is being in the kind of problem solving by Pape. Based on the three consideration, it is appropriate with the result of several research which classified students’ behaviour in solving mathematics word problem, include: meaning-based approach full context, meaning-based approach limited context, direct translation approach limited context, direct translation approach proficient and direct translation approach not proficient [15-17]. Therefore, it can be said that the students’ behaviour in solving the mathematics word problem with auditory learning style is not optimal yet which appeared in kind of behaviours in direct translation approach (DTA).

4. Conclusion
Based on the result and discussion the research concludes that classification of students’ behaviour in solving mathematics word problem be considered from auditory learning style is Direct Translation Approach (DTA) for sub-category Direct Translation Approach Limited Context, Direct Translation Approach Proficient and Direct Translation Approach Not Proficient.

It shows that the students with auditory learning style in solving the mathematics word problem have behaviour solving problem still not optimal. Thus, the teacher should guide when the students read the task, they must write the information from the problem context which has been known. After that, they write a method used include the reason. And when they are writing the solving procedure, they must write the sequences process and the end of the result. Besides, the teachers must select of models, methods, strategies, and mathematics learning media to optimize the behaviour of students in solving the mathematics word problem. And it is really important for mathematics teachers to consider more attention toward students’ auditory learning style in designing better mathematics learning.
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