ANALYSIS OF STUDENTS' ERRORS WITH NEWMAN'S ERROR ANALYSIS ON VIBRATION, WAVES AND SOUNDS CONCEPT

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Abstract

This study aims to find out what errors were made by Class VIII Junior High School students in story problem solving vibration, wave, and sound based on Newman's Error Analysis (NEA). And find out what factors are the cause of the error. This research is a qualitative research with a descriptive aroach. The data collection technique used is by using written tests, interviews, observations, and documentation. Then analyze the data using data reduction, data presentation, and verification. The results of this study indicated that Newman's Error Analysis can find out what mistakes were made by students and how these errors could occur. As for question number one, the percentage of reading errors is 0%, comprehension error is 14.28%, transformation error is 28.57%, process skills error is 19.04%, and encoding error is 0%. For question number two, the percentage of reading errors is 0%, comprehension error is 14.28%, transformation error is 19.04%, process skills error is 28.57%, and encoding error is 0%. Question number three type of reading error is 4.76%, comprehension error is 23.80%, transformation error is 9.52%, process skills error is 23.80%, and encoding error is 0%. Question number four reading error 0%, comprehension error 33.33% transformation error 19.04%, process skills error and encoding error is 0%. Question number five obtained 0% reading error, 33.33% comprehension error, 4.76% transformation and process skills, and 0% encoding error. This study concludes that many students experience errors because students don't understand the concept of the problem and are less thorough in working on the problem. From this it could be used as an evaluation for both students and teachers to be improving the learning process to make it more effective.

Keywords: *Analysis, Students Error, Newman's Error Analysis (NEA)*

INTRODUCTION

Natural Sciences is a science that is obtained due to scientific processes and scientific attitudes, in which the activity comes from human thought that produces a scientific product (Annisa & Ratna, 2013). Science learning in the 2013 Curriculum contains a lot of the importance of ability problem solving (Prastiwi, 2018). Quoted from Purwati (2015), Problem-solving is an activity to find solutions to problems faced with the knowledge possessed. With this, students who can aly their knowledge to achieve a new goal can be said to have been able to solve a problem. Problem solving is a form of process to find solutions or answers to the questions given. Teaching problem solving is the action of a teacher to encourage or shape students to be able to understand the problem, be interested in solving the problem, be able to use all their knowledge to formulate a strategy for solving the problem, implement the strategy, including the will and ability to evaluate the correctness of the solution. (Safitri & Hidayat, 2015). In science learning, students will find it difficult to solve science problems that prioritize problem solving if they are less able to understand mathematical concepts and skills (Reddy & Panacharoensawad, 2017). These difficulties cause students to make mistakes in solving science problems. Errors made by students are a form of deviation or error from the answers that have been written by students (Rahmania & Rahmawati, 2016). Errors made by students occur because the story problem does not only require one step in completion.

Efforts to be able to find out the extent of the abilities possessed by students when solving problems, it is necessary to identify errors experienced by students. The material for vibration waves and sound is one of the materials in science learning for class VIII semester 2 that must be mastered well by students to be able to proceed to the next stage of material. However, because there are still many students who are often unable to understand and solve problems well, it results in the occurrence of many mistakes made by students in solving these problems. The difficulties experienced by students are explained in research conducted by Yeo (2009) from the results of interviews, the difficulties experienced by students in understanding mathematical forms are a lack of understanding of the problems caused, and not understanding how to implement strategies in solving a problem, the inability to translate the problem into mathematical form, and the inability of students to operate mathematics (Sidnyaev, 2018)

Students who often do not understand the concept, cause errors in working on questions. By conducting a study of error analysis, it can be used as a way that can be used to find out various student errors. With the error analysis, it will be known what mistakes the students made, so that it can be used as a reference by the teacher to be able to provide the right type of assistance to students (Sahriah, 2011). By analyzing these various errors, the teacher is expected to be able to find out the types and causes of errors that are being experienced by students in working on the problem of wave and sound vibrations. This error

analysis can be done by giving questions in the form of story problems, the form of story problems will train students to improve their skills and understanding. As in the research that has been done by Putri (2008) which states that when solving story questions students often experience difficulties such as 1) not understanding simple concepts 2) not knowing the meaning stated in the question 3) unable to translate the question into mathematical sentences 4) unable to solve problems well 5) incompetent in counting 6) often find errors in writing numbers. With this, it is known that if students have successfully passed the test well when working on story questions, it can be said that students have been able to understand the concepts in the material well, story questions can be used as indicators in understanding concepts in students.

The story questions used must of course be questions that can measure problem solving abilities and good reasoning abilities. There are many forms of story questions, one of which is mathematical story questions (Ahmad, Tarmizi, & Nawawi, 2010) Solving mathematical story problems is not just getting results in the form of answers to the questions asked, but more importantly students must know the steps to get the answers (Ball, Hill, & Bass, 2005). The steps in solving story problems include reading and understanding, making model calculations, and performing calculations and drawing conclusions (Nurkaeti, 2018; Arafahanisa et al., 2020). If there is an error in one step, it will result in an error in the next step (Noutsara et al., 2021).

Characteristics of story questions with the PISA aroach can be used as a question instrument to measure the extent to which students understand the concepts and also what errors occur in students. PISA (Program for International Student Assessment) is an international study of achievement in reading literacy, mathematics, science, and finance for 15 year old school students (Aini, 2014). The focus of PISA is literacy which emphasizes the skills and competencies of students that are acquired from school and can be used in everyday life and various situations. The use of PISA questions is intended to measure mathematical literacy skills. Mathematical literacy is the ability to use mathematical content (concepts, facts, procedures, and tools) in real-life situations (Stacy & Turner, 2014). PISA questions which tend to be of the higher order thinking type and require good reasoning skills will be very helpful in training students to get used to dealing with problem solving problems.

Returning to the knowledge of student errors can later be used by the teacher as a reference / determinant of alternative learning and learning designs that can be taken to minimize the same mistakes. To find out and analyze student errors can be done with one of the procedures, namely error analysis according to the NEA procedure. According to Kapur & Ghose (2018), NEA or better known as Newman Error Analysis is a theoretical stage or procedure that is useful for analyzing errors made by students in solving description problems. The Newman error analysis method was first introduced in 1977 by Anne Newman, who worked as a mathematics teacher in Australia.

Newman suggests that there are five specific activities as something that is very crucial to help find the location of errors that occur in the work of students when solving a problem in the form of description questions, namely: Reading, Comprehension, Transformation, Process skill, and Endcoding. If students have carried out the five stages of NEA, it means that students have successfully completed description questions in the form of stories because at this stage of the NEA it is a reference for analyzing errors that occur in students in completing description questions (Jha, 2012).

The purpose of this study was to find out what mistakes were made by Class VIII Junior High School students in solving the problems of the story of wave and sound vibrations and also to find out what were the factors that caused the errors based on Newman's Error Analysis (NEA).

METHODS

In connection with the purpose, data, and usefulness of this research, it was chosen to use qualitative research methods. The use of qualitative research is intended to gain a broader and deeper understanding of the natural problems that exist in the field, namely that there are still many students who make mistakes in solving story problems. This study uses a descriptive aroach. Descriptive research does not provide treatment but describes a condition as it is.

The research subjects were taken from all students of class VIII D, totaling 21 students at SMP Nurusshibyan Paguyangan, Brebes. The method of data collection in this study uses the test method and interview method. The test method was carried out using five-story questions using the PISA aroach about vibration, waves, and sound. From the students' answers to the questions given, the types of errors and the causes of errors experienced by students will be revealed (Sumule et al. 2018). Then the interview method is carried out after the students have finished doing the written test, interviewing using an interview guide that has an error indicator according to Newman. Interviews were conducted to find out and dig deeper into the types of errors and the causes of student errors in solving problems (Pradini, 2019).

The data analysis used refers to the data analysis stated by Miles & Huberman in (Sugiyono, 2017). The stages of data analysis carried out in this study were data reduction, namely checking the results of written tests and student interviews.

Then presented the data in tabular form so that it was organized, and arranged so that it was easier to understand, then concluded/verified to find out any errors experienced by students in solving written test questions based on the Newman procedure.

To test the validity of the data in this study, triangulation techniques were used. Namely identifying student errors using a written test, then using interviews to ask about students' difficulties and the causes of errors, then comparing each written test and interview results with related documents.

RESULTS AND DISCUSSION

In the study of student error analysis using Newman's Error Analysis at SMP Nurusshibyan Paguyangan which was followed by

class VIII D with as many as 21 students, the written test showed that only a few students answered the questions correctly. For more details can be seen in table 1.

Table 1. Data on student work results

No	Description			
	ΣB	**ΣS**	**ΣTM**	**Total**
1	6	15	-	21
Percentage	28.57 %	71.42 %	-	100 %
2	4	13	4	21
Percentage	19.04 %	61.90 %	19.04 %	100 %
3	1	13	7	21
Percentage	4.77 %	61.90 %	33.33 %	100 %
4	-	11	10	21
Percentage	-	52.38 %	47.62 %	100 %
5	1	9	11	21
Percentage	4.77 %	42.85 %	52.38 %	100 %

Description :
ΣB   : Students who answered correctly
ΣS   : Students who answered incorrectly
ΣTM : Students who did not answer

Table 2. Data table for each type of error on written test questions

Types of Errors Based on NEA	Students Who Answered Incorrectly									
	No 1		No 2		No 3		No 4		No 5	
	ΣS	%	ΣS	%	ΣS	%	ΣS	%	ΣS	%
Reading	2	9.52%	0	0%	1	4.76%	0	0%	0	0%
Comprehension	3	14.28%	3	14.28%	5	23.80%	7	33.33%	7	33.33%
Transformation	6	28.57%	4	19.04%	2	9.52%	4	19.04%	1	4.76%
Process Skills	4	19.04%	6	28.57%	5	23.80%	0	0%	1	4.76%
Encoding	0	0%	0	0%	0	0%	0	0%	0	0%

After reducing the data by examining the results of student work, then conducting interviews to ask about the difficulties and causes of errors made by students, the results of the error analysis are presented in the following table 2.

1. Reading Error

In the type of reading error for question number 1 there are 2 subjects who make mistakes, namely with an error percentage of 9.52% of the total error of 76.20%. Subjects who made reading errors were subjects S14 and S16. At the time of conducting the interview, when the researcher asked about what was obtained after reading question number 1, S16 only answered about the vibration practicum and did not mention at all what was asked, namely the same spring period. The following is a sniet of the researcher's interview with S16 who had reading errors.

Researcher : Please read the question number 1 !
S16 : (S16 reads question number 1)
Researcher : From the questions that you have read, what is the question about?
S16 : About vibration practicum
Researcher : Anything else? what is being asked about this question?
S16 : None, ma'am

2. Comprehension Error

In question number 1, there are 3 subjects who have a comprehension type error with an error percentage of 14.28%. The three subjects are S15, S19, and S21. In the interview, when the researcher asked what was known in the questions, S19 was silent and finally answered hesitantly, he did not understand what was in the questions

and ended up answering simple questions. The following is a sniet of the researcher's interview with S19.
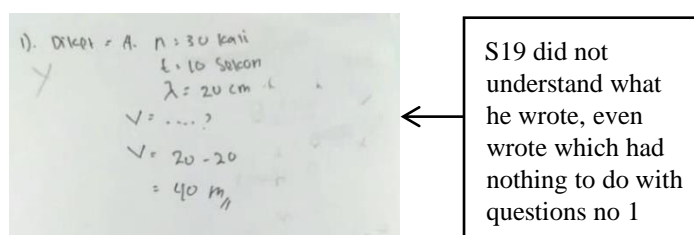
Researcher : What do you think is known in the problem?
S19 : ... (S19 was silent and did not answer)
Researcher : Please read it again, then what do you know in the question?
S19 : Period ma'am, don't know ma'am

In addition to the misunderstanding interview conducted by S19, it was strengthened by the results of the written test, the results showed that S19 did not understand what was in the question marked by S19 writing which actually had no relation to question number 1 (picture 1). Following are the results of S19's work for question number 1.

Picture 1. The result of s19's work which experienced an comprehension type error for question number 1

3. Transformation Error

For the test item number 1, there are 6 subjects who make transformation errors, namely with a percentage of 28.57% of the total error of 76.20%. Subjects who experienced transformation errors in question number 1 were S6, S7, S8, S9, S10, S18. When the researcher conducted an interview with S18 and asked what the question was about, what was known in the question, and what was asked in the question, S18 could

answer correctly. But when the researcher asked how to do question number 1, S18 answered that he didn't know and solved the problem as best he could. The following is a sniet of the researcher's interview with S18.

Researcher : Explain how you do this problem?
S18 : Don't know, Mrs.
Researcher : Then what formula did you use to solve the problem?

S18 : I only used the formula that I remembered, ma'am, who didn't actually know.
Researcher : Yes, thank you.
Apart from the results of the interview, the thing that shows that

S18 made a transformation error is by looking at the results of the written test that S18 did (picture 2). The following are the results of the written test work carried out by S18.

Picture 2. The result of S18's work which experienced a transformation type error for problem number 1

4. Process Skills Error

In question number 1 there are 4 subjects who experience process skill errors with an error percentage of 19.04%. The subjects who experienced this process skill error include S2, S3, S17, S20. Of the four subjects, when viewed from the results of their work in the written test, all of them made process skill errors due to their lack of accuracy in calculating so that the final results they obtained were less precise. The answer from S3 which shows that he experienced a process skill error is shown in picture 3.

Picture 3. The results of S3 work that experienced a transformation type error for question number 1

5. Encoding Error

From the results of the analysis that has been carried out on all the work of the subjects studied, all of them produce the same percentage of errors, namely 0% of questions number 1 - number 5 on the type of error. conclusion. These results did not occur because there were no subjects who answered incorrectly but occurred because previously the subject had experienced an error, in questions number 1,2,3 and 5 there were no longer subjects who answered correctly at the time of the process skill error stage so they could no longer continued for analysis of conclusion drawing errors. According to the results of research (Wahidah et al., 2017) the wrong calculation process causes errors in writing answers. Another reason why students don't write down answers is because students are used to writing the final

answer (conclusion) on their worksheets (Farida, 2015). While in question number 4, none of the subjects managed to pass the error in the type of transformation, so the error in the type of process skill and conclusion could not be analyzed anymore. The subject cannot be said to have made the next type of mistake if the subject has made a mistake in the previous type (Praktitipong & Nakamura, 2006). Therefore, for the error in drawing conclusions in questions number 1 – number 5, the percentage of error is 0%.

Looking at the results of written answers and interviews that have been conducted on the subject related to the answer, it was found that the most common errors started in the type of Comprehension errors. Errors in reading the questions are caused by the subject's ignorance of the topic concept. Generally, the subject can read well and correctly but cannot interpret the sentences in the question (Mulyadi et al., 2015). Then the error that occurs a lot starts with the type of error understanding the problem. This understanding error occurs in some students who cannot determine relevant information and not questions, so students do not use existing information to solve problems (Pomalato et al., 2020). This error is caused because many of the subjects themselves do not understand what is actually being asked in the question. In addition to errors in information entry, students also experienced errors in making mathematical models and the completion steps displayed (Jupri & Drijvers, 2016). The students' errors mentioned earlier can be caused by a lack of reading comprehension ability, so students have difficulty understanding the words in the story problems (Boonen et al., 2016). The next mistakes that are often made are transformation errors and process skills errors. This is not much different from the results of research conducted by (Abdullah, Abidin & Ali, 2015) which revealed that student errors in solving HOT questions were mostly caused by errors in understanding the intent of the questions given, then transformation errors and process skills, so that causing the writing of the final answer to be wrong. When the subject has understood what is being asked in the question, another problem that comes is that the subject does not understand which formula he has to solve the problem. One of the interviewed subjects stated that he could not get past the type of transformation error because he did not remember what formula to use when working, lacked focus and concentration in following class lessons, also lacked practice in doing practice questions so that the subject only use the formula that is remembered at the time and resulted in the error occurring. It is different with the subject who has successfully passed the transformation error type but failed to continue or experienced an error in the type of process skill, after seeing the test results and conducting interviews it can be found that the subject who experienced the type of process skill error was caused by the subject's lack of accuracy in calculating, the subject's lack of skill. In completing calculation operations, it is not uncommon for subjects to experience errors in this type of process skill because the time left to do is not enough so they do not write down and continue the calculation

process. In line with (Utami, 2016), errors in process skills are also caused by students having difficulty manipulating calculations.

This study also uses questions with a PISA aroach for the instrument, the PISA questions which tend to be of the high orther thinking type are expected to be able to grow students' ability to deal with problem solving problems, but because the PISA questions are still foreign to the subject, it makes them a little bit still groping and adapting to questions that have not yet been answered. According to research conducted (Johar & Lubis, 2018), which uses PISA story questions as an instrument, students make representational errors because students are not familiar with questions that require representation and questions in the form of math story questions. Accustomed to encountering it, this can also be one of the factors that causes many subjects to experience errors when working on questions.

From the results and discussion, it can be seen that Newman's analysis is able to help find out what mistakes are mostly made by students. This is the same as that found by (Praktitipong & Nakamura, 2006) who said that they had found the use of the Newman procedure to analyze and test the level of students' problem solving skills.

Factors Causing Students Errors in Concept of Vibration, Waves and Sound

Based on the exposure from the previous discussion, it is clear that the errors experienced by students are of various types. These errors occur because each student has different problem-solving abilities including the absorption of students in the material that has been given by the teacher while learning.

After doing the analysis by comparing the data on the results of the work on student test questions, interviews and direct observations in the field, it can be found that the factors that cause errors experienced by students.

First, students are not careful. The causes of students making mistakes are because students forget how to work on questions, errors in determining formulas and are not careful in doing calculations (Murtiyasa & Wulandari, 2020). Many student errors occur because when working on students' questions are less thorough and less focused. Students' focus is needed when working on questions. When researchers conducted interviews with students, students' answers were found which said that when working on questions they did not read the questions well, were in a hurry, and panicked. According to research results (Rohmah & Sutiarso, 2018) students who are not careful and not careful in the work process are the cause of calculation errors. This makes students experience errors when working on questions.

Students do not understand the concept. From the results of their students' work, they experienced many errors caused by not understanding the concept of the material of vibration, waves and sound. It can be seen that when working on the questions, many students have difficulty answering them, even many who do not even know what is actually being asked in the question. Lack of understanding of students when working on story forms

is a common problem (Ju, 2013). The reason is because there is still a lack of ability of students to analyze problems and understanding concepts that are still very lacking. Kristianto et al. (2019) added that students can read correctly but do not understand the problem as a whole or the terms in the problem. They wrote the wrong formula and also could not convert the question into the mathematical form or symbols requested in the problem. If they still can't change the question into mathematical form and symbols, it means that they don't understand what is asked in the problem, they don't understand how the concepts contained in the lesson are. If this is left unchecked, later it will hinder the learning process, students who are left unable to understand the concept from the start will find it difficult for them to follow the next lesson. This was also reinforced during interviews with students, many of whom answered they did not know, forgot, and made up when working on the questions. The problems that many students experience, in the future can be an evaluation tool for teachers, why this can haen, what makes students not understand the concept of wave and sound vibration material. Teachers can strive for more effective learning or can also change the learning model so that the material presented can be well received by students and students can not only work on questions but still really understand the concepts contained in the material.

Students Lack Practice. From the results of this study, one of the most common student errors found was in the type of process skill error, this haened because students did not practice enough to work on problem solving problems. It was also found that there were many student errors on questions that tended to be difficult and varied from usual. As in the research conducted (Wahyuni & Widayanti, 2020) which concluded that students were not used to working on problem solving problems, the questions given as exercises did not vary, almost questions were given in the same context. Students who do not practice solving problems and are only given questions of the same type make students' process skills not develop and end up with students who cannot solve problems. This is in accordance with research (Tambychik & Meerah, 2010), that students experience difficulties in the process of solving mathematical problems because of their inability to master mathematical skills.

CONCLUSION

Based on the results of this study, it can be concluded that there are many students of class VIII D SMP Nurusshibyan Paguyangan who make mistakes in solving the problem on Vibration of Waves and Sounds concept based on the NEA. The most commonmade were the mistakes first to comprehension error 14.28% in numbers one and two, 23.80% in number three and 33.33% in numbers four and five. The second most common errors experienced were transformation errors of 28.57% in number one, 19.04% for number two, 9.52% for number three, 19.04% for number four and 4.76% for number five. The third most common error was process skill errors, 19.04% occurred in number one, 28.57% in number two, 23.80% in number three, 0% for number four, and 4.76% on question

number five. The next error is a reading error of 0% on questions number one and two, 4.76% on question number three, and 0% on questions number four and five. Furthermore, the last 0% in each number in the encoding error, this occurs not because the student did not make an error in the encoding error, but because the student has made a type error before so that it can no longer be analyzed for an encoding error. The factors that cause errors are students who are not careful, students do not understand the concept and students lack practice.

After conducting an error analysis using Newman's Error Analysis, various kinds of errors were found in students, and knowing what the causal factors were, from this it could be used as an evaluation for both students and teachers to be more serious in learning and correcting deficiencies as well as improving the learning process to make it more effective.

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