Analysis of Student Errors in Solving Mathematical Story Problems Based on Newman's Theory in View of Student Learning Styles

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Abstract

This study aims to describe the types of errors experienced by students in solving mathematical word problems based on Newman's theory in terms of the learning styles of junior high school students. This type of research is a qualitative descriptive research. The subjects of this study were class VIII students at SMP Negeri 3 Pasuruan, Pasuruan Regency, for the 2022/2023 academic year. The subjects of this study were 2 students with visual learning styles, 2 students with auditory learning styles, and 2 students with kinesthetic learning styles. Data collection techniques in this study were observation, giving learning style questionnaires, social arithmetic story questions, interviews and documentation. The data obtained was tested for its validity by technical triangulation. The results of this study are 1) Students with a visual learning style tend to make all mistakes except reading and understanding problems, 2) Students with an auditory learning style tend to make all mistakes except reading mistakes and, 3) Students with a kinesthetic learning style also tend to make all errors except read errors.

Keyword : Error Analysis, Newman Error Procedure, Social Arithmetic, Mathematical Story Problems, Learning Styles

Abstrak

Penelitian ini bertujuan untuk mendeskripsikan jenis kesalahan yang dialami oleh siswa dalam menyelesaikan soal cerita matematis berdasarkan teori newman yang ditinjau dari gaya belajar siswa SMP. Jenis penelitian ini adalah penelitian deskriptif kualitatif. Subjek penelitian ini adalah siswa kelas VIII di SMP Negeri 3 Pasrepan kabupaten pasuruan Tahun Pelajaran 2022/2023. Subyek penelitian ini adalah 2 siswa gaya belajar visual, 2 siswa gaya belajar auditorial, dan 2 siswa gaya belajar kinestetik. Teknik pengumpulan data dalam penelitian ini adalah observasi, pemberian angket gaya belajar, tes soal cerita aritmatika sosial, wawancara dan dokumentasi Data yang diperoleh diuji keabsahannya dengan triangulasi teknik. Hasil dari penelitian ini adalah 1) Siswa dengan gaya belajar visual cenderung melakukan semua kesalahan kecuali kesalahan membaca dan memahami masalah, 2) Siswa dengan gaya belajar auditorial cenderung melakukan semua kesalahan kecuali kesalahan membaca dan, 3) Siswa dengan gaya belajar kinestetik juga cenderung melakukan semua kesalahan kecuali kesalahan membaca.

Kata kunci: Analisis Kesalahan, Prosedur Kesalahan Newman, Aritmatika Sosial, Soal Cerita Matematis, Gaya Belajar

Introduction

Mathematics at school is not just learning to count using a certain theory that uses numbers and abstract formulas (Kurniawan & Hartono, 2020). Mathematics in school learning can educate students to think more mathematically, responsively, carefully and efficiently in finding solutions to any existing mathematical problems (Hartono, 2018). The realization of a good learning objective can be seen from how deeply students understand mathematics and how students can apply the understanding they gain to solving mathematical problems and other sciences that are still related to mathematics. Therefore an evaluation activity, test or examination is needed to be able to find out the level of student knowledge and be able to find out what kinds of mistakes students make. If the form of the error is known by the teacher, it is necessary to make efforts to overcome the error because it will result in the development of further learning because students will accumulate errors and will always use the theory they think is correct.

Based on the report on the results of the 2018 PISA survey, Indonesia is ranked 74th or sixth from the bottom with a math ability of 379 which is in position 73 (Dian, 2022). From these data it can be concluded that the ability of Indonesian students in mathematics is still very minimal and still requires a lot of effort to improve it. The mistakes experienced by students also need a lot of attention from the teacher. Meanwhile Newman (1997), argued that the majority of students failed to learn mathematics because students could not read or did not understand the words in the tasks they were supposed to complete. According to Drrownell, one of the analytical methods that can be used to analyze errors in solving math word problems is the Newman analysis method (Drownell, 2018). Newman distinguishes five types of errors, namely reading errors, comprehension errors, transformation errors, process skill errors and encoding errors. error). This method can be used to improve the process of teaching and learning so that the same mistakes will not be repeated.

On the other hand, the teacher's task is not only to examine and understand in more detail regarding student errors in solving mathematical problems, but the teacher must also know other factors that must be considered in learning mathematics, including willingness, ability, and certain intelligence, readiness of the teacher himself, the readiness of the students, the curriculum, and the method of presentation. A factor that is no less important is the learning style. Differences in learning styles also affect errors in solving math problems. In every tendency of the same learning style, students also have activities or behaviors that are not necessarily the same. Therefore, in solving mathematical problems, each student has a different learning behavior. Each individual has a different way of learning to make it easier to understand the material being studied. There are three types of learning styles according to DePorter and Hernacki. namely visual, auditory, and kinesthetic learning styles (Deporter & Hernacki, 2008). Every student has their own way of learning which is definitely different from the others. Therefore, each student has their own way of understanding the material being studied. Likewise when studying mathematics.

According to Wiradi (2002), analysis is an activity in which sorting, parsing and differentiating things to be grouped or classified according to certain characteristics or criteria which are then searched for meaning and relation. Another opinion according to Bogdan (1982), data analysis is the process of systematically searching for and compiling data obtained from interviews, field notes and other materials, so that it can be easily understood and the results of the findings can be informed to others. Meanwhile, according to Wijaya and Masriyah, error is a form of deviation or deviation from something that has been considered or agreed to be true (Wijaya & Masriyah, 2013).

Error analysis itself is an amalgamation of the definitions described above, namely a process or activity of searching for and compiling data regarding deviations from working on questions that have been carried out by students with predetermined data collection techniques by grouping student error data based on the type of error which is then searched for its meaning. According to Jha (2012), there are several types of errors, namely: reading errors, errors in understanding the problem, error in transforming the problem, error in processing ability, and error in writing the final answer.

The following is an indicator of Newman's error when working on math problems in the form of word problems.

Table 1 Indicators of Newman's Error

Error Type	Indicator
Reading Error	• Students cannot read the words, symbols and units contained in the questions correctly.
Comprehension Error	• Students do not write down what is known in the questions.
	• Students write down what they know about the questions but are not quite right.
	• Students do not write down what is asked in the questions.

	• Students have written down what was asked but it is not quite right or wrong.
Transformation Error	• Students cannot/incorrectly change word problems into mathematical form correctly. • Students write wrong methods for problem solving. • Students make mistakes in determining the correct formula.
Process Skill	• Students cannot continue the completion procedure (jammed) • Students make mistakes in doing calculations, because they use the wrong concepts and rules of mathematics. • Students do not write and do not explain the stages of calculation correctly.
Encoding Error	• Students do not write conclusions. • Students write conclusions but do not match the final calculations obtained or write according to the wrong final calculations.

According to Susilo (2006), learning style is defined as a process of behavior, appreciation, and tendency, a student learns and gains knowledge in his own way. Nasution (2009) also revealed that the way in which a student captures stimulus or information, how to remember, think, and solve problems (Nasution, 2005) apart from conditions and situations, each student also has a different way of learning, there are students who are faster absorbing information by reading, some by listening and some understanding by direct practice. According to Gunawan, learning style is a way that is most preferred by students in carrying out an activity of thinking, processing and understanding information (Gunawan, 2006).

Based on several definitions according to some experts above, the notion of learning style in this study is a process or way of students receiving and capturing information in conditions that students like. According to Depoter & Hernacki (2008) based on how to receive information, learning styles themselves are divided into 3 types of learning styles including visual learning styles, kinesthetic learning styles and auditory learning styles (Kurniawan & Hartono, 2020). According to Hasanah (2021) visual learning style is a way of learning that utilizes the sense of sight. Thus it means that vision can be realized by seeing or imagining activities as a conceptual depiction in information processing. Auditory learning style is a learning style that focuses on learning by hearing or through the sense of hearing (Yusuf & Amin, 2016). Kinesthetic learning style is a learning style in which students or learners learn by using physical activity.

From the above opinion, of course, it will affect the difference in the achievement of student error indicators with visual, auditory, and kinesthetic learning styles. Therefore, this study aims to describe the errors experienced by students in solving mathematical word problems based on Newman's theory in terms of student learning styles..

Method

This research is descriptive qualitative. The research subjects were grade VIII students of SMP Negeri 3 Pasrepan in the 2022 academic year which had been classified based on learning styles, namely students with visual, auditory, and kinesthetic learning styles. The tools used in this study were a learning style questionnaire, a story problem test on the subject of social arithmetic, and an interview guide referring to research indicators which have been validated by 3 validators consisting of 2 mathematics education lecturers and 1 mathematics teacher at SMP Negeri 3 Pasrepan.

Before collecting research data, the stage of selecting research subjects who meet predetermined criteria is carried out. In determining the subject of the study, a learning style questionnaire was carried

out which was given to 24 students of class VIII SMP Negeri 3 Pasrepan from 27 students who entered which contained study habits. Furthermore, the results of the student learning style test are corrected which are then differentiated based on each learning style. The learning style questionnaire data can be seen in Table 2. After being categorized according to the learning style category, the researcher chose each learning style represented by 2 students which were selected based on the opinion of the mathematics teacher at the school and student report cards. The selected research subjects were students with codes GV5 and GV9 for visual learning styles, students with codes GA4 and GA8 for auditory learning styles and students with codes GK3 and GK5 for kinesthetic learning styles.

Table 2 Number of Student Learning Styles

No	Learning Styles			The number of students
	Visual	Auditory	Kinesthetic	
1	9	9	6	24

Next, the researcher conducted a written test on the subject of social arithmetic to 6 research subjects and then conducted interviews according to the interview guidelines. After data collection is done and the data collected is carried out the next stage is data reduction, data presentation, and drawing conclusions. The validity of the data in this study used technical triangulation, namely by comparing the results of the written test of story questions with the results of the interviews. then the data that has been obtained is analyzed by researchers to produce a conclusion.

Results and Discussion

Based on the results of the research that has been done, out of 27 grade VIII students, they are distinguished based on the VAK learning style by using a learning style questionnaire which of the 27 students have different learning styles. A complete comparison of learning styles can be seen in the following figure:
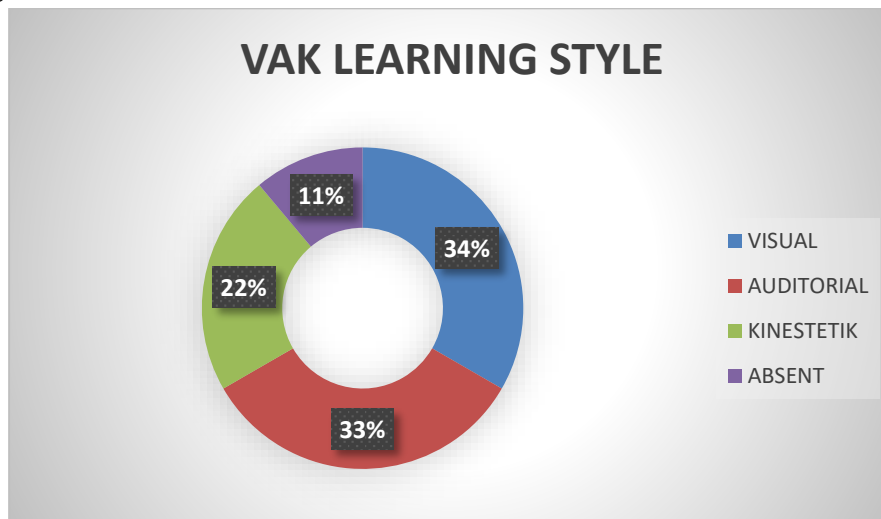
Figure 1 Comparison of learning styles

After the learning style data was obtained, 2 students were taken for each learning style representative with the selection of student criteria described in the previous discussion, which then carried out a story question on the subject of social arithmetic and interviews with the 6 students. Then the results of the story questions and interviews were analyzed and the causal factors of the mistakes made by students with each of the different learning styles were sought which had been explained in the previous discussion. The following is a discussion regarding the mistakes made by students in

solving story problems on the subject of social arithmetic.

Student Types of Visual Learning Styles

Based on the data that has been obtained and has been analyzed in the previous discussion, the results of the work on social arithmetic questions by subjects with a visual learning style in questions number 1 to number 3. In questions number 1, 2, and 3 all visual learning style subjects are GV5 and The GV9 did no error in reading the problem. GV5 had an misunderstanding of the problem in questions number 2 and 3, while in GV9 he also had an misunderstanding of the problem only in question number 3, for questions 1 and 2 he did not make a mistake in understanding the problem. Furthermore, GV1 and GV9 both made mistakes in transforming problems, process skills, and writing final answers to questions number 1, 2, and 3. So it can be concluded that in this study students with visual learning styles tended to or on average experienced errors in understanding problems, problem transformation, process skills and writing the final answer. The summary results of the analysis of the types of student errors in solving Social Arithmetic questions with a visual learning style can be seen in the following table:

Table 3 Errors of visual learning style students

Subject	Reading Error			Comrehension Error			Transformation Error			Process Skill Error			Encoding Error		
Question number	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
GV5				√	√	√	√	√	√	√	√	√	√	√	√
GV9					√	√	√	√	√	√	√	√	√	√	√

Students Types of Auditorial Learning Style

Based on the data that has been obtained and has been analyzed in the previous discussion, the results of the work on social arithmetic questions by subjects with an auditory learning style on questions number 1 to number 3. On questions number 1, 2, and 3 the subject of the auditory learning style, namely GA4, does not experience errors in reading problems while students with code GA8 in questions number 1 and 3 did not experience errors in reading problems, but in question number 2 GA8 experienced errors in reading problems. Furthermore, in questions number 1, 2, and 3, students with code GA4 experienced errors in understanding the problem, problem transformation, processing skills, and writing the final answer, which was different from GA8. it is having error transformation problem. In the error of understanding the problem, processing skills and writing the final answer students with code GA8 experienced errors in all questions. So it can be concluded that in this study students with an auditory learning style tend or on average experience all errors except errors in reading problems. The summary results of the analysis of types of student errors in solving Social Arithmetic questions with auditory learning styles can be seen in the following table:

Table 4 Errors of students' auditory learning styles

Subject	Reading Error			Comrehension Error			Transformation Error			Process Skill Error			Encoding Error		
Question number	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
GA4				√	√	√	√	√	√	√	√	√	√	√	√
GA8		√		√	√	√		√	√	√	√	√	√	√	√

Students Types of Kinestetik Learning Style

Based on the data that has been obtained and has been analyzed in the previous discussion, the results of work on social arithmetic questions by subjects with kinesthetic learning styles in questions number 1 to number 3. In questions number 1, 2, and 3 all subjects with kinesthetic learning styles, namely GK3 and the GK5 doesn't made a mistake in reading the problem.. Meanwhile, in questions 1, 2, and 3 students with kinesthetic learning styles, namely Gk3 and GK5, made mistakes in understanding the problem, transforming the problem, processing skills and writing the final answer. So it can be concluded that in this study students with a kinesthetic learning style experienced all errors except errors in reading problems. The summary results of the analysis of types of student errors in solving Social Arithmetic questions with kinesthetic learning styles can be seen in the following table:

Table 1 Errors of students' kinestetik learning styles

Subject	Reading Error			Comrehension Error			Transformation Error			Process Skill Error			Encoding Error		
Question Number	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
GK3				√	√	√	√	√	√	√	√	√	√	√	√
GK5				√	√	√	√	√	√	√	√	√	√	√	√

Based on the results of the analysis of the types of errors in the social arithmetic story questions and interview tests based on the Newman error procedure in terms of the VAK learning style, the student error data obtained in this study are presented in the following table:

Table 6 Student Errors Based on Newman's Error Theory in terms of Student Learning Styles

Subject	Reading Error			Comrehension Error			Transformation Error			Process Skill Error			Encoding Error		
Question Number	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
GV5				√	√	√	√	√	√	√	√	√	√	√	√
GV9					√	√	√	√	√	√	√	√	√	√	√
GA4				√	√	√	√	√	√	√	√	√	√	√	√
GA8		√		√	√	√		√	√	√	√	√	√	√	√

GK3		√	√	√	√	√	√	√	√	√	√	√	√
GK5		√	√	√	√	√	√	√	√	√	√	√

From the analysis carried out there were new findings of student errors in solving mathematical story problems on the subject of social arithmetic which were viewed from the student learning styles of class VIII students at SMPN 3 Pasrepan that students with a visual learning style tended to make errors in problem transformation, process skills, and writing final answers. Students with an auditory learning style tend to make mistakes in understanding problems, problem transformation, process skills, and writing final answers. Students with a kinesthetic learning style tend to make mistakes in understanding problems, problem transformation, process skills, and writing final answers. This is in line with Ulfa and Fuad (2019) research that students with auditory learning styles tend to make mistakes in understanding and transformation steps and students with kinesthetic learning styles make mistakes in the steps of understanding, transformation, and process skills.

Conclusion

Based on the results of the analysis and discussion of the data obtained in this study, mainly students with a visual learning style tend to make mistakes in transforming problems, processing skills, and writing final answers, students with an auditory learning style tend to make mistakes in understanding problems, transforming problems, processing skills, and writing final answers and students with a kinesthetic learning style tend to make mistakes in understanding problems, transforming problems, processing skills, and writing final answers.

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