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The Trends of Newman's Error Analysis in Mathematics Subject for Elementary Schools in Indonesia: A Systematic Literature Review

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Abstract. This Systematic Literature Review (SLR) analyzes various research articles conducted in Indonesia and published in Google Scholar-indexed journals from 2020 to 2024. The main motivation of this research is to examine different aspects related to the error analysis of elementary school students in Indonesia when answering mathematics questions using Newman's Error Analysis (NEA). The findings of this study indicate that there has been a significant trend in analyzing student errors using NEA over the past five years. Moreover, it was revealed that there is a mixed-methods research design among qualitative research generally conducted by researchers with numerical material elements as popular subjects. In addition, grades 4 and 5 are the most popular classes to study for concentrating on error analysis in word problems, and most of the research locations are in Central Java. Based on the outcomes of this research, the recommendations that can be made are to intensify research in analyzing student errors using NEA for all grades in elementary schools, the need for further investigation into different materials in the mathematics subject in elementary schools, and it can be conducted in unlike regions so that the distribution of this NEA research can be more equitable and extensive to identify the location of student errors in answering mathematics questions.

Keywords: Newman's Error Analysis, Elementary School, Mathematics Subject, SLR

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INTRODUCTION

Mastery and understanding of mathematics are needed early, so mathematics learning is needed at the elementary school level (Hastuti et al., 2019). Mathematics learning is learning that emphasizes students' ability to think critically, logically, systematically, carefully, effectively, and efficiently (Jusniani, 2022; Trisnani et al., 2024) and solve mathematical problems creatively through various perspectives (Mursidik & Samsiyah, 2015) and can develop students' reasoning power (Rahmawati, 2022). Various strategies, approaches, and learning models have been implemented in mathematics learning to improve students' mathematical understanding. However, not all students have the same thought process and ability to understand mathematics (Purwanto et al., 2019). Whereas having mathematical understanding will provide students with knowledge that can be utilized flexibly and applied in everyday life (Davis, 2001).

As one of the main goals in mathematics education is to achieve mathematical understanding (National Council of Teachers of Mathematics, 2000), then to determine the level of understanding of students it is necessary to evaluate by analyzing their understanding through mathematical activities (Görgüt & Dede, 2023). One way to analyze students' mathematical understanding is through giving evaluations in the form of word problems. According to Schreiber and Ashkenazi (2024) solving word problems is one of the important aspects of students' mathematical knowledge. it is done to build mathematical connections between various representations and various mathematical concepts. But in reality, when working on word problems, there is always the possibility that students make careless mistakes and there are students who deliberately give the wrong answers because of the lack of motivation to answer word problems according to their ability level (White, A.L, 2010). According to Newman (1977), errors

in working on math word problems come from five errors, namely reading, comprehension, transformation, process skills, and coding.

Analyzing errors means identifying the difficulties faced by students and the causes of those errors in solving math word problems. (Gulvara et al., 2023). Student errors can be identified through the application of one of the analysis methods, namely Newman's Error Analysis (NEA) (Hadaming & Wahyudi, 2022; Hapsari et al., n.d.; Pramesti & Hasanudin, 2024; Roisah et al., 2024; Satria et al., 2022). According to Newman (1983), NEA is an initial step that can be used to determine the reasons why students cannot solve word problems. This analysis can then guide in-depth investigations and appropriate improvement strategies to address the challenges faced by students. As a result, various studies have been conducted to identify students' mistakes in solving word problems in mathematics.

A study conducted by Taulia Damayanti & Enjelina Zees (2023) provided an overview of research in NEA-related mathematics education by examining trends over five years from 2018-2022. The results of the study found 15 articles studied from 200 articles indexed in national journals and 2 articles indexed in international journals. This study only focused on linear program material at the secondary school level and found that the errors made caused the students to be less able to solve linear program math word problems. This happens because of several factors, namely, students are less careful and in a hurry, students lack practice solving word problems and are not confident, students do not understand how to transform word problems into mathematical language, students do not use time well and forget to write sample problems, weak understanding of mathematical concepts and students do not understand the methods used and forget to write the final answer.

However, this current study differs from the previous ones, especially in its focus on exploring Google Scholar data sources published in Indonesia from 2020 to the middle of this year (2024). The aim was to review several articles related to mathematics learning in all subjects taught at the elementary school level in Indonesia according to the curriculum. Moreover, content analysis was conducted based on several fundamental parameters.

This research aims to comprehensively examine the following questions: (1) How has the quantity of research on elementary school students' errors using NEA in mathematics word problems in Indonesia developed over time? (2) What types of research methodologies are used in studies on elementary school students' errors using NEA in math word problems in Indonesia? (3) What mathematical topics frequently appear in research related to elementary school students' errors in solving word problems? (4) What grade levels frequently appear in research related to elementary school students' errors in solving word problems? (5) Which geographical region is most prominent in research on the analysis of elementary school students' errors using NEA on math word problems in Indonesia?

METHODOLOGY

This section outlines the methodology used to review current research (covering the period 2020 to August 2024) on analyzing elementary school students' errors in mathematics learning using Newman's Error Analysis (NEA) in Indonesia. The selection of the Systematic Literature Review (SLR) methodology for this research follows the principles of content analysis and seeks to analyze the findings of various studies (Lame, 2019) and has been published in scientific journals indexed by Google Scholar.

The application of SLR is essential for an in-depth examination of the research that addresses NEA at the elementary school level. In addition, SLR provides an overview of research gaps and reveals current knowledge (Okoli & Schabram, 2010). SLR also facilitates trends and patterns in the existing literature, including research methodologies, frequently researched topics, and existing research locations (Ammirato et al., 2023). By conducting an SLR, researchers can gain valuable insights into the current research landscape and areas that require further investigation (Alifulloh et al., 2024). As is the case in this study, it is very necessary to overcome the complexity surrounding mathematics education for elementary schools in Indonesia in examining and contributing to the investigation of elementary school students' error analysis in answering word problems using the NEA method.

The literature review conducted in this study follows the guidelines outlined in the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) protocol to ensure the quality and accuracy in presenting the results of the literature review (Okoli and Schabram, 2010; Tricco et al., 2018).

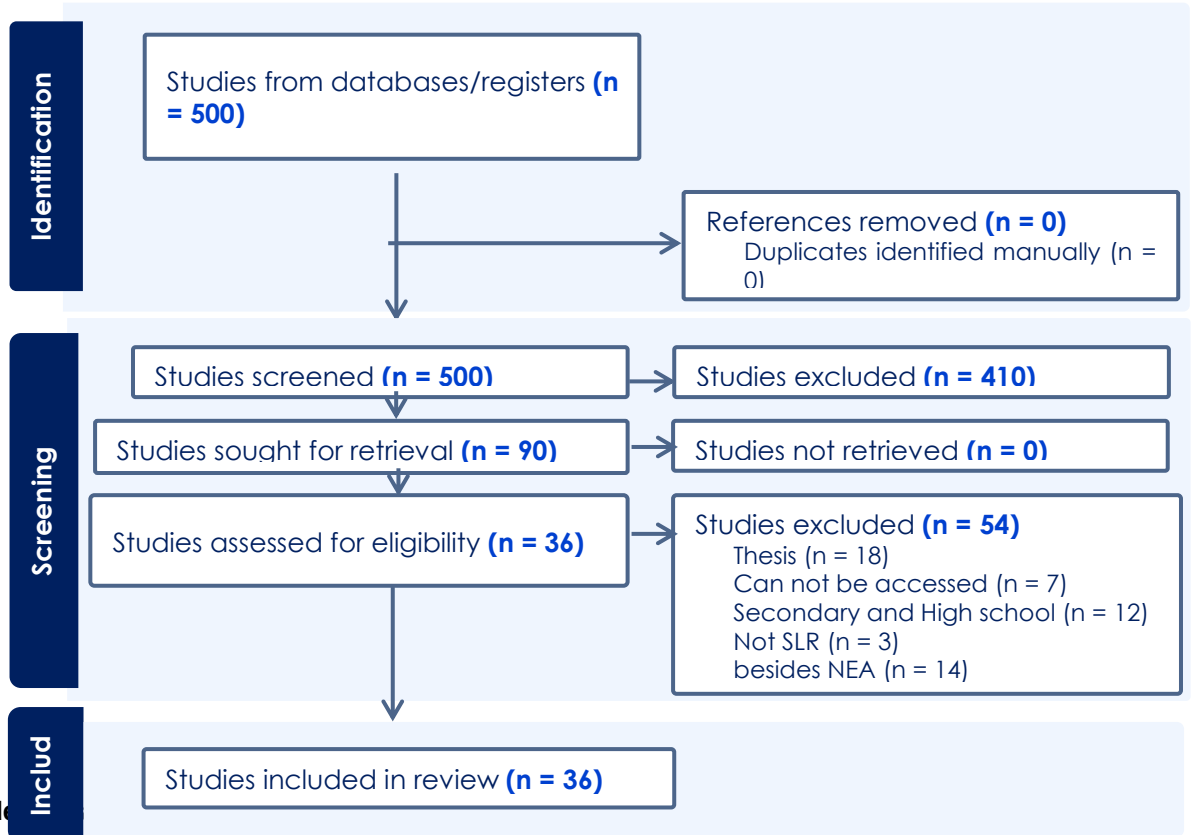

Figure 1. PRISMA Diagram

The strategy used was with the help of the Publish or Perish 8 application and Google Scholar to find a collection of relevant articles with the keywords “Newman's Error Analysis”, and “Newman's error

analysis in elementary school" or "NEA in mathematics subject in elementary school". By using these keywords, 500 journal articles can be found in this phase. Then the articles were processed using *covidence.app* for the next phase, specifically the screening and eligibility phase.

Screening

We screened by evaluating the titles and abstracts to identify relevant articles and screening the whole text based on predefined criteria. This screening process used predefined inclusion and exclusion criteria as shown in table 1 below.

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Articles published in the last 5 years since 2020	< 2020
Journal articles and proceedings	Besides journal articles, book reviews or book chapter
Research location in Indonesia	Outside Indonesia
Mathematics education in elementary school	Besides research on mathematics education in elementary schools
Newman's Error Analysis (NEA)	Not applying the NEA method

Table 1 shows the inclusion and exclusion criteria to screen articles based on publication time, field of study, school level, and student error analysis using Newman's Error Analysis (NEA). Only articles published between 2020 and the present (2024) were retrieved. The data taken are journal articles that have been indexed on Google Scholar and are not books or book chapters. Moreover, the focus of the research location is from Indonesia at the elementary school level. For the subjects taken, the articles were specifically researching mathematics learning, and other subjects were excluded. Lastly, we focused on one of the methods of analyzing student errors in answering math word problems, namely NEA, other than that it was not included. After the screening phase, 90 articles were identified for selection.

Eligibility

After the screening phase, articles screened through inclusion and exclusion criteria are then identified for eligibility through re-screening using eligibility criteria. Eligibility criteria are used to determine an appropriate decision according to the defined research task (Weng et al., 2010). The eligibility criteria we have set as shown in Table 2 below.

Table 2. Eligibility Criteria

No	Eligibility criteria
1	NEA's application in analyzing student errors
2	the research subjects were elementary school students
3	Journal articles are accessible and not literature reviews
4	Journal articles that contain keywords and are not a thesis

Table 2 is a guideline for selecting articles in this eligibility phase. The articles identified at this phase still contained many articles that used math error analysis other than NEA. Therefore, research articles other than NEA were excluded. In addition, the research respondents were also focused on elementary schools so articles that examined junior high school and high school levels were excluded. We filtered articles based on the title and abstract containing keywords according to the data to be studied and all of them are research articles that are not thesis and can be accessed. Following this, we focused on all research methodologies except SLR. As a result, 36 articles were identified in this phase and included the articles we wanted to study as our SLR research.

Data Analysis

The data collected was analyzed using data processing software, specifically Microsoft Excel. At that point, the findings were processed and presented visually through tables and line charts depicting trends in each category studied along with descriptive information. This approach ensures a holistic understanding of the literature that emphasizes the importance of categorization and visual representation for effective analysis of the trends observed in the articles studied (Alifulloh et al., 2024).

RESULTS AND DISCUSSION

Number of publication

The quantity of publications written or published by a group of researchers within a certain period of time is a simple method used to measure the quantity of keywords to be researched (Durieux & Gevenois, 2010). Based on this we have drawn a line diagram of the development of NEA research in elementary school mathematics from 2020 to the present (2024), as depicted in Figure 2 below.

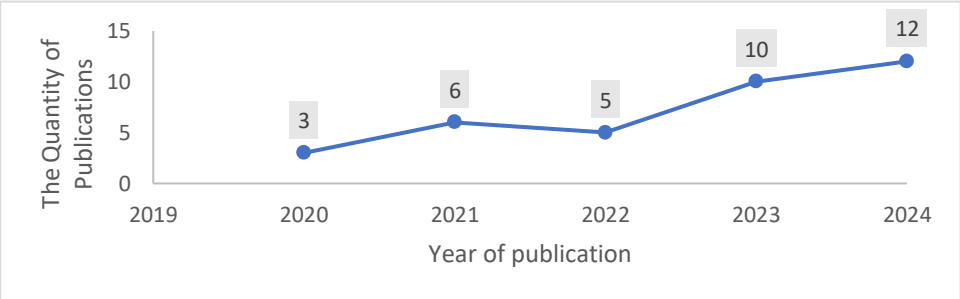

Figure 2 Number of researches from 2020 to 2024

It can be seen in Figure 2 that there is a fluctuation in research studies from year to year. Every year, there has been an increase in research related to NEA in elementary schools except in 2022. Then, in the following year, 2023, research related to NEA doubled. Therefore, based on that data, it can be concluded that the trend of research related to NEA in elementary school mathematics subjects has increased. Research related to NEA needs to be continuously conducted to understand the common mistakes made by elementary school students when solving math word problems.

Types of Research

According to Creswell (2003), there are three types of research methods: quantitative, qualitative, and mixed methods. Therefore, in this study, we found two types of research used to analyze students' errors in math word problems using NEA, i.e. qualitative and mixed methods. This is illustrated in the following line diagram.

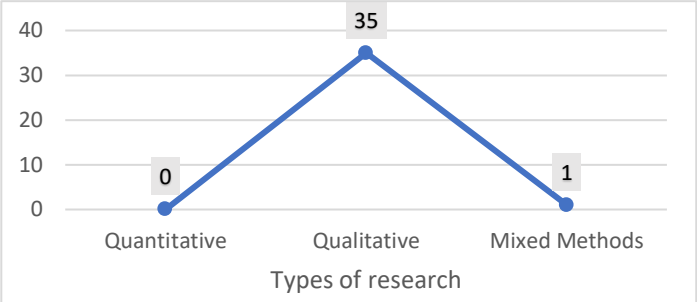

Figure 3. Types of research

It can be concluded that based on Figure 3, qualitative research is research that is often done in analyzing student errors in mathematics word problems using NEA at the elementary school level, while only one study used mixed methods. Therefore, qualitative analysis is used to find out student errors by digging deeper into the causes of these errors. However, it does not rule out the possibility that one day someone wants to research with quantitative research or add to the trend of mixed method research. Conducting a mix of methods will provide more in-depth and comprehensive research results related to the causes of student errors in answering math word problems in order to find interventions that can be applied to improve students' ability to solve math word problems.

Mathematical Topic

There are five materials contained in mathematics lessons, namely, 1) numbers and operations, 2) algebra, 3) geometry, 4) measurement, and 5) statistics and probability (Trafton et al., 2001). However, based on the analysis of the selected research articles, shows that most of them examined the topic of number and operations, namely 24 studies. While geometry, measurement, and data analysis and opportunities are only a small part, there is no research related to the topic of algebra related to the analysis of student errors on math word problems using NEA. The following is a visualization of the line diagram based on the research topics in the selected research articles.

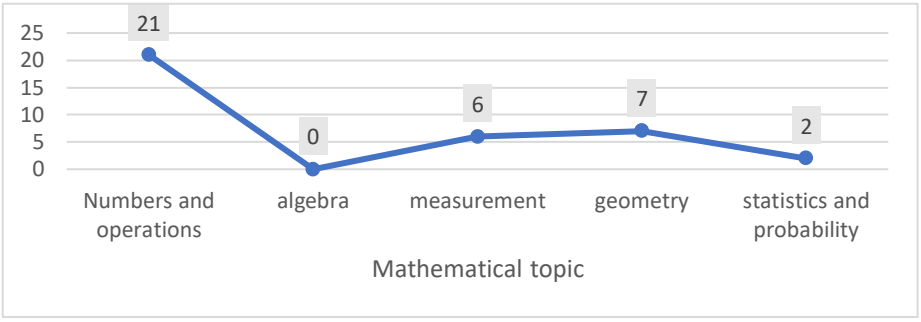

Figure 4. Mathematics education topic

The content analysis in these articles is also described in accordance with mathematics subject matter based on five mathematics topics. As shown in Table 3, the subject matter or fraction material is a common material studied related to the analysis of student errors in word problems using NEA. Other than that, no material related to algebra and probability was found in the studied articles.

Table 3. Mathematical topic details

Topic	Material	Frequency
Numbers	Integers	7
	Whole number	1
	fractions	13
Algebra	Ratio and proportion	0
Measurement	Geometry field measurement	6
Geometry	Plane figure	3
	Solid figure	4
Statistics and probability	statistics	2
Total		36

Fractions are the only research material in mathematics with the most studies compared to others. In other materials, such as algebra, no one has conducted research to find out comprehensively whether students make errors in answering math word problems related to the material. Therefore, a comprehensive study is needed on each mathematics material to provide a complete representation of student errors using NEA in answering math word problems.

Research Subject

According to Untari (2023) the research subject is something that intrinsically provides information related to the research to be carried out in collecting the data to be studied. Based on the results of the content analysis of the selected articles, they can be classified based on the research subjects they studied. The research subjects in question are elementary school students spread from grade 1 to grade 6. The results of the analysis are depicted in the following line diagram.

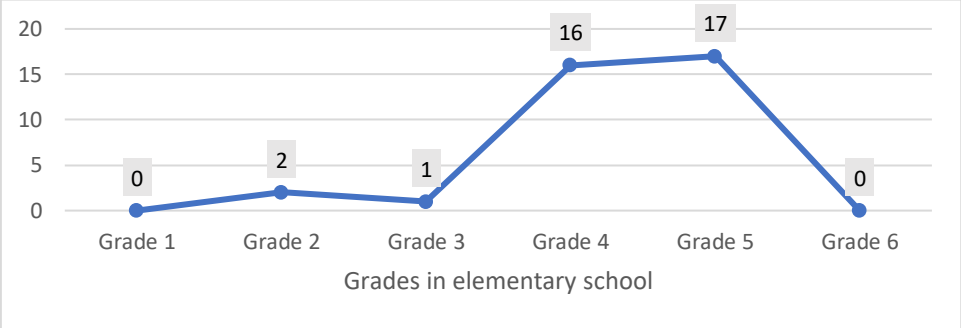

Figure 5. Research subject in elementary school

Based on Figure 5, in general, we conduct research related to NEA in grade 4 and grade 5. This indicates that the research trend in these classes is very high and many students who make mistakes in solving math word problems occur in these classes. However, it does not rule out the possibility that

in grade 1 and grade 6, there are also students who make mistakes in solving word problems but there has been no research that discusses NEA as a research variable in these classes. So this can be a motivation for other researchers to conduct research in grade 1 or grade 6 and can also enrich the research trend in grades 2 and 3 which are still very few examining student errors using math word problems using NEA in these classes.

Research Location

Determining the research location is essential to conducting effective research (Tuckman & Harper, 2012). Various considerations are needed in determining the research location to achieve the research objectives to be studied. Based on the results of the analysis of articles related to the use of NEA to determine student errors in answering math word problems, it is found that the most prominent location is in Central Java province with 11 studies, followed by West Java and East Java regions with 5 and 6 studies, while other regions are scattered with a relatively small number of studies. As visualized in the line Figure 6 below.

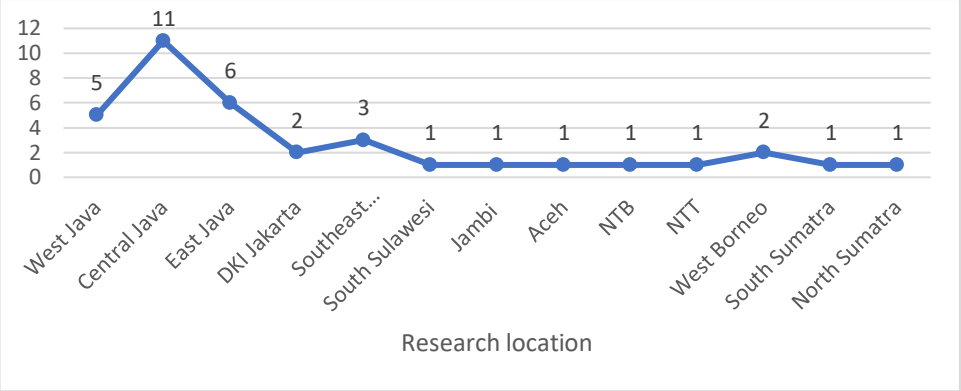

Figure 6 Distribution based on research locations

Based on Figure 6, it is found that Java Island plays an important role in improving the quality of education, especially at the elementary school level related to analyzing student errors in answering mathematics word problems using NEA. Compared to other provinces outside Java Island, there are still few studies related to the application of NEA in analyzing student errors. The application of NEA in analyzing student errors in various regions in Indonesia evenly is also very important to provide a comprehensive overview of student errors in answering mathematics word problems.

CONCLUSION

This study analyzes the trend of using NEA in analyzing student errors in answering mathematics word problems published on Google Scholar from 2020 to the present (2024). Interestingly, there is a significant increase in the trend of using NEA from year to year. This indicates that there are studies that want to know the causes of students making mistakes in answering math word problems. Especially in the material “numbers and operations” which is specifically the most frequently researched material and 4th and 5th grade students are the most popular class subjects in the NEA research trend. In addition,

the Java Island region was identified as the most prominent region in applying NEA in analyzing students' errors in answering mathematics word problems, especially in the provinces of Central Java, East Java, and West Java. Meanwhile, further research is needed to explore the use of NEA in more diverse materials, such as algebra and data analysis, as well as in the early grades and grade 6 elementary schools which are still less researched, and the least research methodology is mixed methods, even though using mixed methods can provide a deeper understanding of the research results related to the causes of student errors. However, it is also important to note that the distribution of NEA research is also important so that we can get a more holistic understanding of student errors throughout Indonesia to support more effective teaching and learning of mathematics at the elementary school level.

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