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CORRELATION OF READING COMPREHENSION SKILL AND ABILITY TO SOLVE MATHEMATICAL STORY PROBLEMS OF STUDENTS IN INDONESIA: A META-ANALYSIS

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Abstrak

Kemampuan siswa dalam memahami teks bacaan berhubungan positif dengan peningkatan prestasi belajar mereka. Penelitian ini bertujuan untuk menilai dampak keterampilan membaca terhadap kemampuan siswa dalam menyelesaikan masalah matematika. Data yang digunakan berasal dari berbagai sumber penelitian yang dipublikasikan dalam jurnal dan tersedia dalam database online Google Scholar sejak 2012-2022 serta dibatasi pada studi-studi yang melibatkan sampel siswa SD, SMP, dan SMA, maupun sederajat. Delapan belas sampel publikasi penelitian diambil dari database online (google scholar) sesuai dengan kriteria kelayakan yang telah ditentukan. Analisis data menggunakan pendekatan meta analisis. Hasil penelitian menunjukkan bahwa terdapat pengaruh positif dan signifikan antara kemampuan membaca pemahaman dan kemampuan menyelesaikan soal cerita matematika, dengan nilai efek *summary effect size* yang berada dalam interval kepercayaan.
Kata kunci: Pemahaman Bacaan, Pertanyaan Cerita Matematika, Pembelajaran Matematika.

Abstract

Students' ability to comprehend reading texts is positively related to their improved learning achievement. This study aims to assess the impact of reading skills on students' ability to solve math problems. The data used came from various research sources published in journals and available in the Google Scholar online database from 2012-2022 and were limited to studies involving samples of elementary, junior high, and high school students, or equivalent. Eighteen samples of research publications were retrieved from the online database (google scholar) according to predetermined eligibility criteria. Data analysis used a meta-analysis approach. The results showed that there was a positive and significant influence between reading comprehension ability and the ability to solve math story problems, with a summary effect size value that was within the confidence interval.
Keywords: Reading Comprehension, Mathematics Story Question, Mathematics Learning.

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INTRODUCTION

Mathematics education holds a crucial role in the development of students within the school system. The primary objectives of mathematics instruction encompass grasping mathematical concepts and elucidating the relationships that exist between these concepts. It also involves problem-solving, which entails the ability to comprehend problems, formulate mathematical models, refine these models, and interpret the resulting solutions. Additionally, it seeks to foster an appreciation for the significance of mathematics in everyday life, nurturing curiosity, attentiveness, and an intrinsic motivation for learning mathematics (Öztürk et al., 2019).

Proficiency in reading, writing, and numeracy serves as the foundational steppingstones for students. A significant proportion of assessments found in mathematics textbooks requires strong reading skills. Research indicates a strong correlation between students' reading abilities and their overall academic performance. Insufficient reading skills can disrupt the learning process. Furthermore, students' reading abilities can serve as an indicator of higher-order cognitive skills such as problem-solving and comprehending mathematical problems (Werf, 2015). Proficiency in writing and reading significantly influences a student's capacity to understand questions. Enhanced reading skills contribute to improved comprehension of questions, and conversely, weaker reading skills can hinder this understanding (Beal et al., 2010).

In Indonesia, the competency levels of reading and literacy among students still exhibit a notably low standing. According to the outcomes of the 2015 PISA assessment, Indonesian students' performance in science, reading, and mathematics ranks relatively low, with rankings of 62nd, 61st, and 63rd out of a total of 69 participating countries. These rankings and average scores in Indonesia have

displayed minimal fluctuations when compared to previous PISA assessments and surveys conducted in 2012, which indicated a similarly low level of subject mastery among Indonesian students (Wuttke, 2007; Grek, 2009; OECD, 2013). The International Reading Literacy Study (PIRLS) targeting fourth-grade students also underscores Indonesia's very insufficient performance in reading and numeracy. Within this study, Indonesia holds the 45th position among the 49 countries included. Indonesia's score stands at 405, although it surpasses that of Qatar (353), Morocco (323), and South Africa (302) (Mullis et al., 2012).

Based on the available data, there exists a marginal divergence between students' reading and numeracy competencies. In the context of research within the purview of PISA and PIRLS, numeracy assessment instruments predominantly adopt a narrative text format. Consequently, both reading, and numeracy assessments employ textual stimuli. The comprehension of these textual stimuli require adept reading skills alongside high-order cognitive thinking capabilities (Bell, 1995; Aitchison and Lewis, 2004; Myles, 2010). It is essential to underscore that a person's capacity for analytical thinking is profoundly influenced by their language proficiency (Waters, 2006; Rezaei, Derakhshan, and Bagherkazemi, 2011; DePoy and Gitlin, 2016). Furthermore, the developmental trajectory of language competence serves as an indicator of cognitive development (Carruthers, 2002; Clark, 2006). Consequently, an individual's linguistic proficiency can mirror their aptitude for analytical thinking (Piaget, 1964; Albert, Albert, and Radsma, 2002). Language, therefore, emerges as an indispensable tool for communicating complex concepts to others (Bell, 1995).

Furthermore, mathematical problems can be presented in two distinct formats: employing mathematical symbols and utilizing verbal symbols. Proficiency in both symbol types facilitates effective problem-solving in mathematical contexts (Lin et al., 2013; Björn, Aunola, and Nurmi, 2016). Nevertheless, when numeracy questions are posed in the form of verbal symbols, it is often observed that students' performance tends to be comparatively lower than

when mathematical symbols are employed (Vilenius-Tuohimaa, Aunola, and Nurmi, 2008; Ozuru, Dempsey, and McNamara, 2009).

Previous research conducted by Anwar et al. (2022), Hashima (2020), Fitria et al. (2022), and Nimah (2014) showed that students' ability to read comprehension and ability to solve stories had a moderate relationship, but this contrasts with research carried out by Permana (2019), Serlan et al. (2022), and Kumalasari et al. The differences in the findings raise new questions concerning the certainty of the relationship between the readability variable and the student's ability to solve mathematical stories. Through the meta-analysis performed on the two variables, a clear relationship can be found between the variables because the meta-analysis can provide accurate information through the summary of the size effect. However, the source that can provide such information is still difficult to find; therefore, it is important to do a meta-analysis of the variable reading ability and the ability to resolve the mathematics story of the student to obtain precise information related to the magnitude of relationships, such as what exists between the two. The research aims to fill existing gaps and provide a comprehensive and up-to-date perspective on the relationship that exists between the ability to read comprehension and the ability to solve stories of students in particular in Indonesia.

METHOD

This study constitutes a systematic review and meta-analysis, following the methodology outlined by Hunter et al. (2006). It encompasses an examination of multiple studies that delve into the independent variables, specifically focusing on the association between reading comprehension skills and the aptitude for solving mathematical story problems. Consequently, the research employs a meta-correlation analysis design. The research outcomes are reflected in the correlation coefficient between the variables, the t-values derived from t-tests, or the f-values, subsequently converted into r-values. Additionally, the study considers sample size and education level in its analysis.

The research data were procured from diverse research publications available in journals and accessible through the online Google Scholar database. The selection of Google Scholar as the recommended web-based academic search engine was based on its widespread usage and comprehensive database, which encompasses a substantial number of records ranging from 2 to 100 million. A freely available web portal called Google Scholar compiles research findings from many internet sources (Haddway et al., 2015). In particular, in the context of this research conducted in Indonesia, its accessibility and cost-free nature make it easier for researchers to find papers relevant to variables of interest. Eighteen articles meeting predefined criteria were included in the study selection process. These criteria encompassed the following:

1. The articles were published in 2012-2022
2. The articles were published in national journals, proceedings, or others.
3. The articles can be fully downloaded for free
4. The articles discuss the effect of reading comprehension skills on students' ability to solve mathematical story problems
5. The articles provide the statistical information that is needed for meta-correlation analysis which is *r*-values, or *f*-values, or *t*-values, and the number of samples.

Coding is imperative for data analysis in this study, encompassing school level (JS_i), year of publication (T_i), and sample size (N_i). The data analysis process involves several stages: (1) Examination of Sample Characteristics, (2) Assessment of Heterogeneity, (3) Verification of Publication Bias, (4) Estimation of effect size weights and the overall combined effect size, (5) Creation of forest plots, and (6) Hypothesis testing (Grasman, 2017; Borenstein et al., 2009; Hunter et al., 2006). JASP 0.8.4 is employed to streamline the data analysis process. The categorization of effect sizes according to Cohen et al. (2007) is provided in Table 1 below:

Table 1. Effect Size Classification

Intervals	Classifications
0 – 0,20	Weak Effect
0,21 – 0,50	Simple Effect
0,51-1,00	Moderate Effect
>1,00	Strong Effect

RESULT AND DISCUSSION

The characteristics of each research publication are presented as follows:

Table 2. Variables Characteristics of Each Research Publication

Author	N	r	Classifications	Education Levels
Almadiliana et al, (2021)	35	0,790	Moderate Effect	Elementary School
Yudiani et al, (2014)	73	0,790	Moderate Effect	Elementary School
Andanik, (2018)	46	0,746	Moderate Effect	Elementary School
Anwar et al, (2022)	88	0,900	Moderate Effect	Elementary School
Herlina, (2020)	55	0,305	Simple Effect	Elementary School
Widyanto, (2017)	123	0,686	Moderate Effect	Elementary School
Nimah, (2014)	30	0,869	Moderate Effect	Elementary School
Calista et al, (2017)	145	0,721	Moderate Effect	Elementary School
Kumalasari et al, (2021)	150	0,098	Weak Effect	Elementary School
Hashima, (2020)	91	0,910	Moderate Effect	Elementary School
Rohmah, (2015)	85	0,632	Moderate Effect	Elementary School
Sarlan et al, (2022)	33	0,065	Weak Effect	Elementary School
Fitria et al, (2022)	24	0,984	Moderate Effect	Elementary School
Widyanti et al, (2020)	48	0,534	Moderate Effect	Elementary School
Wahyuddin, (2016)	1048	0,675	Moderate Effect	Junior High School
Gusniwati et al, (2021)	43	0,752	Moderate Effect	Junior High School
Wijarani, (2016)	238	0,590	Moderate Effect	Junior High School
Permana, (2019)	40	0,459	Simple Effect	Senior High School

Each research publication has a sample size and various r-values. Heterogeneity testing was carried out for research publications that were sampled in this meta-analysis. The purpose of this test is to determine the analysis used to

estimate the summary effect size and publication bias. The results of the sample of heterogeneity tests are presented in Table (3) below.

Table 3. Random Effect Model

	Q	df	p-value
Omnibus test of Model Coefficients	51.148	1	<.001
Test of Residual Heterogeneity	268.115	17	<.001

P-values are approximate, the model was estimated using the Restricted ML method

Heterogeneous residual test scores are shown in the Q value (268,115) with a p-value of 0.001 <0.05, meaning that publications used as samples meet the heterogeneity criteria (Hunter et al., 2006). These results are consistent with the results presented in Table (4) below.

Table 4. Residual Heterogeneity Estimates

Estimation	Value
τ^2	0.268
τ	0.518
I^2 (%)	96.617
H^2	29.563

The estimation of heterogeneous residual values is indicated by the values 0.268 and 0.518, which are greater than 0.05. Additionally, the I^2 value, at 96.617%, is approaching 100%, suggesting that the sample used adheres to the criteria for heterogeneity. Consequently, based on these two approaches, it can be inferred that the selected publications fulfill the heterogeneity assumption. Therefore, the subsequent analysis for estimating a summary effect size and publication can employ the random effects model. The forest plots below depict the outcomes of the effect size analysis.

These forest plots illustrate the effect size derived from each research publication. Out of the 12 publications, effect sizes are below 1 in 6 of them, while in the remaining 6 publications, effect sizes exceed 1. Each effect size falls within a specific range. Among the 18 research samples, the highest effect size is observed in the study published by Fitria et al. (2022), with an effect size of 2.41 within the interval of 1.98 to 2.84. Conversely, the smallest effect size is found in the research

by Sarlan et al. (2022), with an effect size of 0.06 within the interval of -0.29 to 0.42. The overall summary effect value (M) for all samples is 0.90, within the interval of 0.66 to 1.15. The distribution of effect sizes for each publication can also be visualized in the form of a funnel plot as shown below.

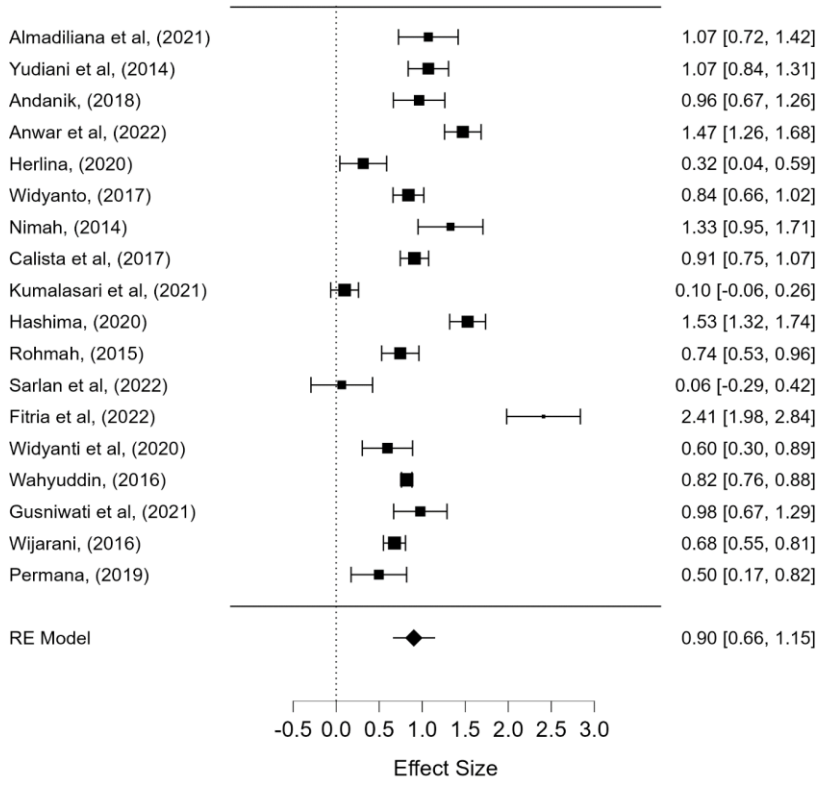

Figure 1. Forest Plot Random Effect Model

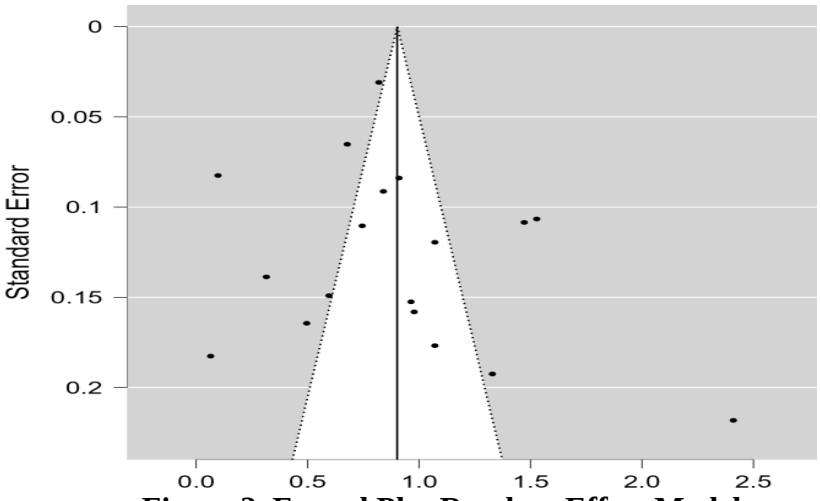

Figure 2. Funnel Plot Random Effect Model

The result of the funnel plot shows that from 18 publications that became samples in this research, most of the samples are medium sample size and large sample size. The result of Standard Error (SE) is about 0,18 and 0,06, which means that the error result from each publication is still small. The result of the standard error value influences a summary effect size of reading comprehension skills to solve mathematic story problems. The next stage of the analysis is the research hypothesis test.

Hypothesis statistic:
$H_0: M = 0$
$H_1: M \neq 0$

Furthermore, to find out whether the hypothesis is accepted or not, it can be seen from the coefficient of the p-value presented in the following table.

Table 5. Summary Effect Size Random Effect Model

Coefficients

					95% Confidence Interval	
	Estimate	**SE**	**z**	**p**	**Lower**	**Upper**
intercept	0.902	0.126	7.152	< .001	0.655	1.150

Note. Wald test.

According to the data presented in Table 5, the p-value is less than 0.01, indicating that p-value (<0.01) < 0.05, which leads to the rejection of the null hypothesis. Consequently, there is compelling evidence to suggest a strong and statistically significant association between students' reading comprehension skills and their ability to solve mathematical story problems. Furthermore, a crucial step in conducting a meta-analysis is the assessment of publication bias, for which the trim-fill analysis approach was employed. The results of the trim-fill analysis are depicted in both a forest plot and a funnel plot.

Upon examination of the forest plot (Figure 3), it is evident that there are no additional samples recommended for inclusion in the analysis. In other words, there

are no missing data points. The summary effect value (M) remains at 0.90, within the interval of 0.66 to 1.15, consistent with the value obtained in Figure 1. Thus, it can be inferred that there is no indication of publication bias. This conclusion is further supported by the presentation of the funnel plot, which lacks the appearance of blank circles (dots) typically associated with publication bias. Additionally, the funnel plot exhibits symmetry and corresponds to the funnel plot shown in Figure 2. Based on the results of the trim-fill analysis, it can be confidently concluded that there is no evidence of publication bias in the meta-analysis investigating the correlation between students' reading comprehension skills and their ability to solve mathematical story problems, thus substantiating the scientific validity of the study.

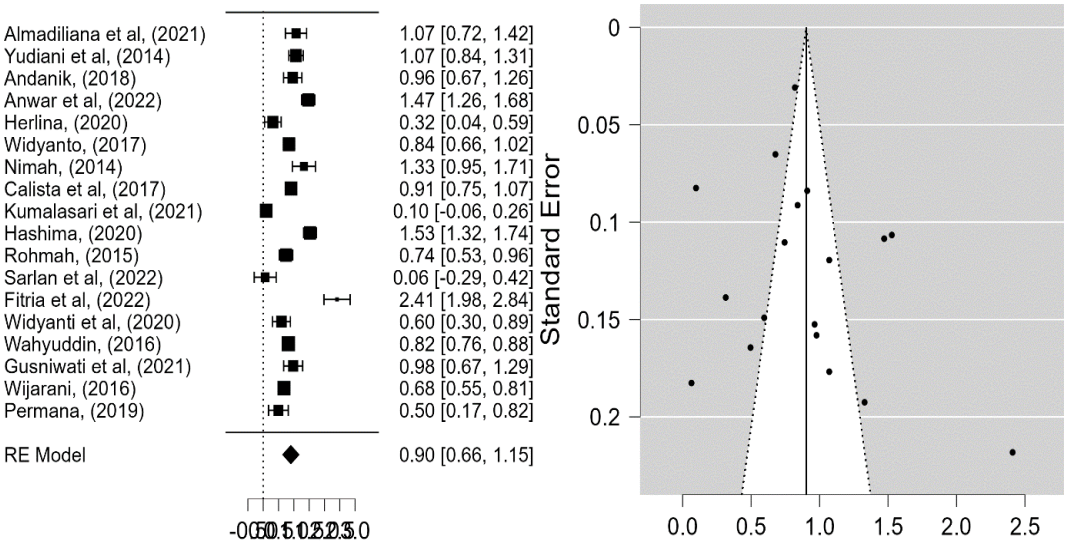

Figure 3. Trim Fill Analysis Using Random Effects

Based on the preceding analysis, it can be deduced that there is a favorable connection between students' reading proficiency and their capability in solving mathematical story problems, spanning from elementary to high school levels. This affirmative outcome implies that as students enhance their reading comprehension skills, their competence in addressing mathematical story problems increases correspondingly, while a decline in reading skills is linked to a decrease in their proficiency in solving such mathematical problems. These research outcomes are in line with the viewpoint expressed by Werf (2015), who postulates that students'

reading skills exhibit a correlation, where stronger reading abilities contribute to enhanced academic achievement. Low achievement of students in reading will interfere with their learning abilities. The students' reading skills can be used to measure the higher cognitive skills as students' reading skill can be used to measure higher cognitive skills such as problem-solving and mathematical questions comprehension. The research conducted by Beal et al. (2010) confirms that writing and reading skills for students have a large impact in understanding the questions, the more proficient students are in reading, the more the understanding of questions increases and vice versa.

The influence of reading skills in solving story questions is more effective when implemented in elementary school versus junior high school and senior high school levels. It is because there is a relationship between reading skills and the habits of elementary school students with the given story problems, so that they can complete them well, compared to students of junior high and senior high schools who are not used to working on mathematics questions in the form of story questions because they are used to variation of question forms in subjects other than mathematics. For example, the form of multiple choice questions and filled-in questions sa shown by research from Andanik & Fitrianawati (2019), which states that there is a relationship between reading skills and the cognitive development of students aged 10-11 years (range of grades IV-V of Elementary School) in which certain logical structures begin to form that support mental operations. Limited to realistic objects. This research did not look at student who develop improved reading skills later in their school career but excelled in mathematical non-story problems throughout their educational path.

CONCLUSION

Reading proficiency among students at different educational levels, ranging from elementary to secondary, can serve as an indicator of their cognitive abilities, particularly in problem-solving and comprehending mathematical story problems. The impact of students' reading skills on their aptitude for solving

mathematical story questions is quite significant. Among the three educational levels-Elementary School, Junior High School, and Senior High School-it is more effective to take advantage of the influence of reading skills at the elementary level. This is primarily due to the established connection between elementary school students' reading skills and their familiarity with story-based questions, enabling them to tackle such questions more skilfully. In contrast, students at the junior and senior high school levels may not be as accustomed to mathematical questions presented in the narrative format, as they are more accustomed to a variety of question formats in subjects other than mathematics.

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