



# Cognitive Ability and Working Memory as Predictors of Reading Comprehension in Elementary School Students

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**Abstract:** This study examines the relationship between cognitive abilities, working memory, and reading comprehension in elementary school students. Using a cross-sectional analytical model, data were collected from 50 students in grades 3 to 6 using standardized instruments that had been adapted and validated to measure cognitive abilities, working memory, and reading comprehension. The results indicate that both cognitive skills and working memory have a positive relationship with reading comprehension, with working memory emerging as the strongest predictor. These results suggest that students' reading comprehension is closely related to their cognitive processing abilities. This study is limited by the relatively small sample size and the use of a cross-sectional design, which restricts causal conclusions. Nevertheless, these findings have important implications for special education and inclusive education practices, particularly in the context of early identification and intervention for students with diverse learning needs. Improvements in working memory and cognitive functioning can serve as a basis for the design of adaptive teaching strategies and support services in elementary school classrooms.

**Keywords:** *working memory, cognitive ability, reading comprehension, inclusive education, special education needs*

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## I. Introduction

Primary school is a crucial phase in a child's cognitive development, particularly in terms of developing logical reasoning skills, information processing, and understanding written language. At this stage, children begin to be able to organize information, understand cause-and-effect relationships, and conclude concrete experiences. The development of these cognitive abilities forms the main foundation for academic success, particularly reading comprehension, which plays an important role in achieving good results in different subjects (Santrock, 2021; Gellert & Elbro, 2020).

Reading comprehension is a cognitive process that involves integrating information, reasoning, and using prior knowledge. This process requires not only the ability to recognize words, but also involves higher-level cognitive functions, particularly working memory. Working memory is used to temporarily store and process information during reading, allowing students to retain important information, connect ideas between sentences, and construct the overall meaning of the text (Cain et al., 2020; Nation & Snowling, 2022; Peng et al., 2023). Several studies show that limitations in working memory contribute to reading comprehension difficulties, even among students who have already mastered basic reading skills (DeCat et al., 2021). In the context of special education (PLB) and inclusive education, understanding the role of cognitive abilities and working memory is crucial for recognizing the diverse learning needs of students and designing appropriate, learner-centered instructional support (NAEYC, 2020).

In the context of primary education in Indonesia, the literacy results of primary school students still require special attention. Data from the LPMP (Lembaga Pengembangan dan Pengawasan Pendidikan) in Central Java show that students' reading and writing skills are still at the minimum required level. This situation indicates that some students have not yet reached an optimal level of reading comprehension, which could be related to cognitive and working memory limitations. In line with national policy, the implementation of special education emphasizes the importance of early detection and learning services tailored to the diversity of students' abilities (Ministry of Education and Culture of the Republic of Indonesia, 2013). However, empirical studies conducted in Indonesia that specifically analyze the relationship between cognitive abilities, working memory, and reading comprehension in the context of primary education and inclusive education are still limited, including in publications in the Journal of Research and Development in Special Education, which place greater emphasis on service and intervention aspects than on studying the relationships between cognitive variables as a basis for identifying learning needs.

Although there is ample international evidence highlighting the role of cognitive abilities and working memory in reading comprehension, empirical studies simultaneously exploring this relationship in the context of primary and inclusive education in Indonesia remain limited, particularly in the field of special education research. Therefore, this study aims to analyze the relationship between cognitive abilities, working memory, and reading comprehension in elementary school students. The hypothesis is that both cognitive skills and working memory have a positive relationship with reading comprehension, with working memory playing a dominant predictive role.

## II. Method

### A. Research Design

This study employed a quantitative approach using an observational analytical design with a cross-sectional framework. Quantitative correlational designs are appropriate for examining the strength and direction of relationships among cognitive variables without manipulating the research setting (Hodge, 2020). A cross-sectional approach was selected to capture variability in cognitive ability, working memory, and reading comprehension at a single point in time, a design commonly used in educational and psychological research to examine associative and predictive relationships without establishing causal mechanisms (Creswell & Poth, 2016). Therefore, the use of the term predictor in this study refers to statistical contribution within a regression model rather than causal inference.

The selection of a cross-sectional analytical design was grounded in the practical and contextual realities of primary school settings particularly within inclusive education environments. The researcher considered cognitive ability and working memory as relatively stable constructs within short developmental periods at the elementary school level allowing meaningful interindividual variation to be captured without repeated measurement. The research focus emphasized the examination of naturally occurring differences in cognitive functioning rather than developmental change or experimental manipulation. This design supported the identification of statistical relationships between cognitive variables and reading comprehension in authentic classroom contexts relevant to early identification and instructional decision making in special and inclusive education.

### B. Participants

The study was conducted in the Selogiri District, Wonogiri Regency, Indonesia, from January to September 2025. Participants consisted of 50 elementary school students enrolled in grades three to six. These grade levels were selected because they represent a developmental stage in which reading comprehension increasingly relies on higher-order cognitive processes, including reasoning and working memory, rather than basic decoding skills (Brunfaut, 2021; Kim, 2020). These developmental characteristics provided a relevant basis for examining reading comprehension within heterogeneous classroom populations, where cognitive variability is naturally observed across students.

The students were recruited from public elementary schools implementing regular classroom instruction within an inclusive education context. Inclusion criteria included: (1) enrollment in grades three to six, (2) the ability to follow classroom instructions, and (3) the ability to complete reading tasks independently. Exclusion criteria included students with uncorrected sensory impairments or neurological conditions that could substantially interfere with assessment procedures. Total sampling was applied to include all students who met the criteria, which is appropriate for small, well-defined populations in educational research (Casteel & Bridier, 2021).

### C. Instruments

Data were collected using three instruments measuring cognitive ability, working memory, and reading comprehension. Cognitive ability was operationalized as students' capacity for reasoning, problem solving, and information processing, consistent with classical and contemporary conceptions of cognitive functioning in educational psychology (Wu & Molnár, 2022). Working memory was defined as the ability to temporarily store and manipulate information during ongoing cognitive activities, particularly language-related tasks such as reading (Baddeley, 2015). Reading comprehension was measured as students' ability to construct meaning from written text through literal understanding and inferential processing (Basaraba, 2013).

All instruments were adapted from established measurement frameworks and adjusted to the linguistic and educational context of Indonesian elementary school students. Content validity was established through expert judgment involving specialists in special education and educational psychology, a procedure widely recommended to ensure construct representation in adapted instruments (Pearl, 2018). Reliability analysis indicated acceptable internal consistency, with Cronbach's alpha coefficients exceeding 0.70, which meets commonly accepted standards for educational and psychological measurement (Hajjar, 2018).

#### D. Data Collection Procedure

Data collection was conducted during regular school hours in coordination with classroom teachers. Individual administration was used to reduce distraction and to accommodate individual differences in cognitive processing, which is particularly important in inclusive education settings (Ashman & Conway, 2017). Standardized instructions were provided to all participants prior to assessment to minimize procedural bias and ensure consistency across administrations (Reynolds, Altmann, & Allen, 2021). Each assessment session lasted approximately 30–40 minutes, which aligns with recommended practices for maintaining students' attention and minimizing fatigue effects during cognitive testing (Woolfolk, 2016).

#### E. Data Analysis

Data analysis was performed using statistical software. Descriptive statistics were used to summarize students' scores on cognitive ability, working memory, and reading comprehension measures. Bivariate relationships were examined using Spearman's rho correlation, which is appropriate when data do not meet normality assumptions or when variables are ordinal or non-normally distributed (Okoye & Hosseini, 2024). This preliminary analysis provided an initial understanding of the direction and strength of associations among variables and informed the subsequent selection of a multivariate analytical model.

Multiple linear regression analysis was conducted to examine the predictive contribution of cognitive ability and working memory to reading comprehension while controlling for age, gender, and grade level. Regression analysis is widely used in educational research to estimate the relative contribution of multiple predictors to an outcome variable (Mizumoto, 2023). Prior to interpretation, regression assumptions, including multicollinearity and residual distribution, were examined to ensure model validity.

### III. Results and Discussion

#### A. Results

##### 1. Descriptive Analysis

The results of the descriptive analysis show variation in scores for cognitive abilities, working memory, and reading comprehension among students in grades three through six. This variation reflects the diversity of learning abilities among students in regular classrooms, which is a common feature in the context of inclusive education and special education services (NAEYC, 2020).

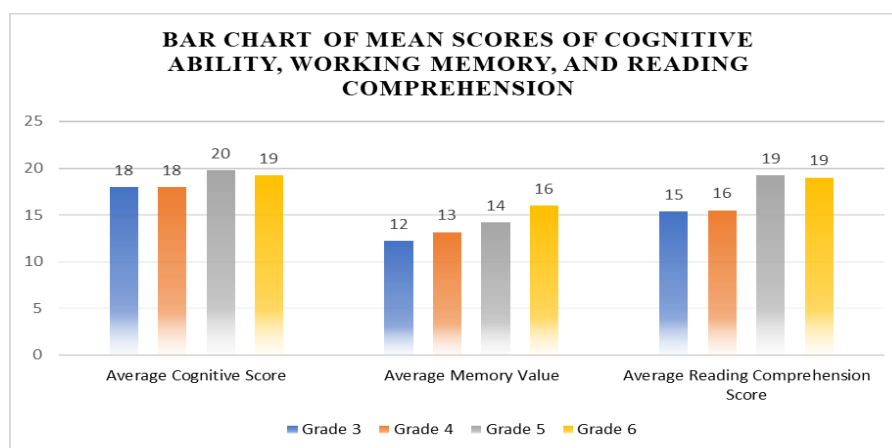


Figure 1. Diagram of average scores for cognitive abilities, working memory, and reading comprehension

2. Bivariate Analysis

Spearman's correlation test shows a positive relationship between cognitive abilities and reading comprehension ( $\rho = 0.358$ ;  $p = 0.041$ ) as well as a strong positive relationship between working memory and reading comprehension ( $\rho = 0.608$ ;  $p = 0.000$ ). The relationship between cognitive abilities and working memory is not statistically significant ( $\rho = 0.234$ ;  $p = 0.190$ ).

Table 1. Conclusions from Spearman's rho Test Results between Main Variables

Relationship	Correlation Value ( $\rho$ )	Sig.	Interpretation
Cognitive Ability ↔ Memory	0.234	0.190	Weak positive, not significant
Cognitive Ability ↔ Reading Comprehension	0.358	0.041	Moderate positive, significant ( $p < 0.05$ )
Memory ↔ Reading Comprehension	0.608	0.000	Strong positive, significant ( $p < 0.01$ )

According to the classification of effects, the relationship between cognitive abilities and reading comprehension is a moderate effect, while the relationship between working memory and reading comprehension is a strong effect, highlighting the important role of working memory in supporting reading comprehension (Cohen, 1988; Peng et al., 2023).

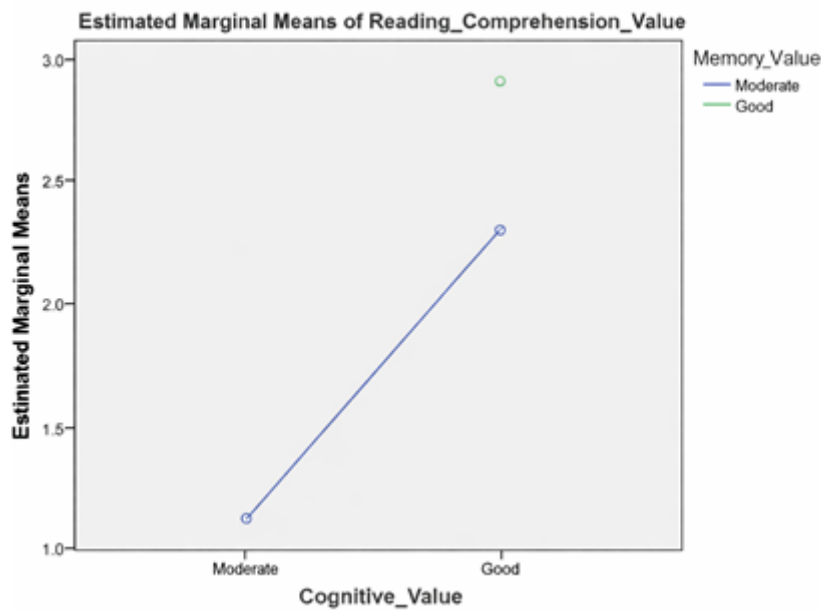


Figure 2. Scatter plot illustrating the relationship between working memory and reading comprehension

3. Multivariate Analysis

The results of the multiple linear regression analysis indicate an  $R^2$  value of 0.561, which means that 56.1% of the variation in reading comprehension abilities can be explained simultaneously by cognitive abilities, working memory, age, gender, and grade level.

Table 2. Model Summary Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.749 <sup>a</sup>	.561	.479	.435	2.552

- a. Predictors: (Constant), Memory\_Value, Gender, Cognitive\_Value, Age, Grade
- b. Dependent Variable: Reading\_Comprehension\_Value

The  $R^2$  value indicates that the model has moderate to strong explanatory power, which is consistent with the results of the meta-analysis showing that cognitive variables are the main predictors of reading comprehension in school-age children (Peng et al., 2023).

Table 3. Anova Results

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	6.522	5	1.304	6.887	.000 <sup>b</sup>
Residual	5.114	27	.189		
Total	11.636	32			

- a. Dependent Variable: Reading\_Comprehension\_Value  
b. Predictors: (Constant), Memory\_Value, Gender, Cognitive\_Value, Age, Grade

The results of the ANOVA test show that the regression model is statistically significant ( $F = 6.887$ ;  $p = 0.000$ ), indicating that the independent variables jointly contribute to the variation in reading comprehension abilities.

Table 3. Regression Coefficient

Model	Unstandardized Coefficients		Standardized Coefficients	1	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	-1.699	1.606		-1.058	.299		
Age	-.148	.133	-.288	-1.112	.276	.242	4.125
Gender	.025	.163	.021	.154	.879	.900	1.112
Grade	.272	.143	.517	1.901	.068	.220	4.549
Cognitive_Value	1.095	.472	.316	2.318	.028	.875	1.142
Memory_Value	.500	.177	.405	2.828	.009	.794	1.259

- a. Dependent Variable: Reading\_Comprehension\_Value

Partially, cognitive abilities ( $B = 1.095$ ;  $p = 0.028$ ) and working memory ( $B = 0.500$ ;  $p = 0.009$ ) have a significant influence on reading comprehension. In contrast, age, grade level, and gender do not show a significant partial influence ( $p > 0.05$ )

## B. Discussion

### 1. The Role of Cognitive Abilities and Working Memory

The results of this study show that working memory is the most important predictor of reading comprehension, followed by cognitive abilities. These results are consistent with international studies confirming that working memory plays an essential role in retaining textual information, integrating ideas, and constructing a coherent representation of meaning during the reading process (Cain et al., 2020; Nation & Snowling, 2022; Peng et al., 2023). A recent meta-analysis also shows that working memory capacity has a consistent and significant relationship with reading comprehension abilities in school-aged children, including those with learning difficulties (Peng et al., 2023).

In classroom practice, limitations in working memory can cause students to have difficulty following along while reading, even if their ability to recognize words is sufficient. This situation is common among students with mild learning disabilities and special educational needs. Recent research in the context of inclusive education shows that students with special educational needs, such as specific learning difficulties and mild intellectual disabilities, tend to have working memory limitations that directly impact reading comprehension and learning autonomy (DeCat et al., 2021; Alloway & Alloway, 2022). Therefore, strengthening learning strategies that promote working memory is an important aspect of special education practice, particularly in the design of reading accommodations and interventions tailored to students' individual needs.

## 2. Control Variables and Insignificant Results

The insignificant influence of age and grade level shows that improvements in reading comprehension are not solely determined by chronological factors, but rather influenced by the quality of cognitive functions that develop through learning experiences and the educational support received by students (Santrock, 2021; Peng et al., 2023). These findings are consistent with studies conducted in the context of inclusive education, which assert that students with special educational needs may exhibit variable reading outcomes regardless of their age or grade level, as their academic development is strongly influenced by their individual cognitive characteristics and the quality of the interventions implemented (Alloway & Alloway, 2022).

Gender also has no significant influence on reading comprehension, which is consistent with recent research findings that differences in reading skills among elementary school children are influenced more by cognitive factors and the learning environment than by biological factors (Gellert & Elbro, 2020; Lonigan et al., 2021). In the context of special education, these findings reinforce the idea that the design of educational services and interventions should not be based solely on demographic characteristics, but rather on an assessment of each student's learning needs and cognitive profile. It is important to discuss these non-significant findings in order to avoid overgeneralization and to support inclusive educational practices focused on students' needs and potential.

## 3. The Indonesian Context and Inclusive Education

In the Indonesian context, the results of this study are relevant in terms of the literacy skills of primary school students, which are still at the minimum proficiency level, as reported by LPMP Jawa Tengah (2023). This situation indicates that some students have not yet reached an optimal level of reading comprehension. These poor results can be interpreted as reflecting cognitive limitations and working memory that have not yet been systematically addressed in regular or inclusive classroom learning practices. Several national studies confirm that the implementation of inclusive learning in primary schools still faces difficulties in identifying learning needs and providing support based on students' cognitive functions (Directorate of Special Education and Special Services, 2021).

The results of this study also align with those of a national study published in the journal *Jurnal Penelitian dan Pengembangan Pendidikan Luar Biasa*, which highlights that the academic difficulties experienced by students in inclusive classrooms are often linked to limitations in basic cognitive functions, particularly attention and working memory, which are not yet optimally addressed in mainstream education (Sari & Mulyadi, 2021). Unlike some international studies that emphasize specific program-based interventions, this study provides local empirical evidence that highlights the importance of a cognitive function-based approach as the foundation for the development of special education services in primary schools. This approach is in line with national policy, which emphasizes adaptive, equitable educational services focused on the individual needs of students, including those with special educational needs (Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia, 2022).

#### 4. Implications for Classroom Practice and Special Education

The results of this study have practical implications for classroom learning, including the need to implement strategies that promote working memory, such as the use of concept maps, dividing texts into small units, and guided discussions. These strategies have been shown to be effective in helping students retain important information and gradually develop their reading comprehension, especially for those with cognitive limitations. Recent research in the field of special education shows that instructional interventions explicitly designed to support working memory can improve school engagement and academic comprehension in students with learning difficulties (Alloway & Alloway, 2022). For students with special needs, particularly those with learning disabilities or cognitive processing disorders, these findings underscore the importance of early detection of working memory limitations as a basis for implementing appropriate and sustainable educational accommodations (NAEYC, 2020; European Agency for Special Needs and Inclusive Education, 2022).

At the national level, the implementation of special education and extraordinary education services emphasizes the need to provide services tailored to the diverse needs of students, including early screening, functional assessment, and adaptation of learning to individual strengths and needs (Ministry of Education and Culture of the Republic of Indonesia, 2013). Technical guidelines for the implementation of special schools (SLB) also emphasize the importance of designing programs, assessments, and learning strategies that take into account the cognitive aspects and special educational needs of students (Ministry of Education and Culture of the Republic of Indonesia, 2017). In line with international recommendations on inclusive education, schools should implement a multi-tiered support system that enables collaboration between teachers, specialized teachers, and other support staff in designing interventions based on cognitive assessment (UNESCO, 2020). Therefore, findings on the role of working memory and cognitive abilities in reading comprehension have direct implications for the implementation of special education services in elementary schools, particularly in strengthening procedures for identifying, referring, and designing structured and contextual accommodations and interventions for reading instruction

#### IV. Conclusion and Suggestion

This study shows that cognitive abilities and working memory play an important role in reading comprehension among elementary school students, with working memory making a relatively stronger contribution. These results confirm that reading ability is not only related to technical aspects but also to the cognitive processes underlying text comprehension. In the context of inclusive education, the results of this study highlight the importance of a pedagogical approach that takes into account the diversity of students' cognitive functions, including those with special educational needs.

However, this study has certain limitations, including a small sample size, limited school coverage, and a cross-sectional design that does not allow for causal conclusions. It is therefore recommended that schools incorporate learning strategies that promote working memory and cognitive functions, such as visual organization of information and step-by-step instruction. At the policy level, there is a need to support literacy programs that incorporate the assessment of basic cognitive functions as part of strengthening inclusive education. Future research should test working memory-based interventions through longitudinal designs or experiments involving more diverse populations, particularly students with special needs.

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