

Foreign Language Aptitude Predicts Multimedia-Assisted Reading Comprehension among Indonesian Senior High School EFL students

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Abstract: Reading comprehension remains one of the most challenging skills for Indonesian senior high school EFL students, and prior research suggests that instructional media alone cannot fully explain the substantial variation in students' achievement. This study investigated whether Foreign Language Aptitude (FLA) predicts students' Multimedia-Assisted Reading Comprehension, while also comparing achievement between multimedia-assisted and conventional paper-based instruction. A quasi-experimental pretest-posttest control group design was employed involving 69 Grade XI students (34 experimental, 35 control) selected through cluster random sampling. Data were collected using the Researcher-Developed Foreign Language Aptitude Test (R-FLAT) and a 30-item reading comprehension test based on argumentative texts, and analyzed using independent and paired-samples t-tests and simple linear regression. Results showed that both groups improved after treatment, but the experimental group achieved a substantially larger gain (+15.07) than the control group (+6.47). Foreign Language Aptitude was also found to significantly predict multimedia-assisted reading comprehension achievement ($B = 2.52$, $p < .001$, $R^2 = .884$), indicating that students with higher aptitude benefited more from multimedia instruction. These findings suggest that multimedia-assisted instruction is more effective than conventional instruction, but its effectiveness depends on learners' cognitive aptitude rather than technology alone. The study recommends that English teachers complement multimedia-assisted reading instruction with differentiated, aptitude-responsive support to promote more equitable learning outcomes.



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INTRODUCTION

Reading comprehension constitutes one of the most fundamental competencies in learning English as a Foreign Language (EFL), as it enables learners not only to recognize written symbols but also to interpret, evaluate, and integrate information into meaningful understanding. Successful comprehension extends beyond decoding vocabulary or grammatical forms; it requires readers to coordinate multiple cognitive processes, including activating prior knowledge, identifying explicit information, drawing inferences, and constructing coherent mental representations from the text. Consequently, reading is increasingly viewed as an active meaning-making process rather than a passive act of recognizing written language. Consistent with this perspective, (Jeon & Yamashita, 2014). demonstrated through a meta-analysis that second-language reading comprehension is

influenced by the interaction of linguistic knowledge, cognitive abilities, and strategic reading processes rather than by language proficiency alone.

Within the Indonesian senior high school context, reading occupies a prominent position in the English curriculum because it serves as the primary medium through which learners acquire academic information and develop higher-order thinking skills. Nevertheless, many EFL learners continue to encounter persistent difficulties when engaging with English texts. Limited vocabulary knowledge, insufficient grammatical awareness, unfamiliar text structures, and challenges in making inferences frequently restrict students' ability to comprehend written discourse effectively. These recurring obstacles suggest that learners' reading performance cannot be explained solely by deficiencies in language knowledge. Instead, comprehension appears to emerge from the complex interaction between linguistic competence and the cognitive mechanisms that support information processing during reading.

The rapid integration of digital technology into language education has encouraged teachers to adopt multimedia-assisted instruction as an alternative to conventional text-based learning. Rather than relying exclusively on printed materials, multimedia environments combine written texts with complementary resources such as images, audio narration, animation, video, and interactive vocabulary support. Such integration is expected to provide learners with multiple pathways for processing information while simultaneously increasing engagement with learning materials. As digital learning environments become increasingly accessible in Indonesian schools, multimedia-assisted instruction has attracted growing attention as a practical approach to supporting students' reading development.

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The theoretical rationale for multimedia-assisted learning is largely explained by Mayer's Cognitive Theory of Multimedia Learning (CTML). According to Mayer (2021), meaningful learning occurs when learners actively select relevant information, organize verbal and visual representations, and integrate them with their existing knowledge through two interconnected cognitive channels. Because verbal and pictorial information are processed simultaneously but through partially independent systems, appropriately designed multimedia materials can reduce unnecessary cognitive load and facilitate deeper understanding. Earlier work by (Mayer, 2020). similarly emphasizes that instructional materials should be designed to optimize learners' limited cognitive capacity, enabling them to construct coherent mental models instead of merely receiving information.

Empirical evidence has consistently supported the educational value of multimedia-assisted instruction across diverse EFL contexts. Previous studies have reported that multimedia resources facilitate vocabulary acquisition, increase learner engagement, and improve reading comprehension by providing contextual cues that assist learners in interpreting unfamiliar linguistic input (Akbulut, 2017; Chen et al., 2024). Likewise, a systematic review conducted by Mohamad Subaidi bin Abdul Samat (2020)

concluded that multimedia-supported instruction generally produces better learning outcomes than conventional text-based approaches. Visual representations, synchronized audio, and interactive learning features appear to reduce processing demands while encouraging learners to construct richer and more integrated representations of textual information.

Despite these encouraging findings, the effectiveness of multimedia-assisted instruction should not be interpreted as universal. Classroom experience and previous empirical studies indicate that students exposed to identical multimedia materials frequently achieve substantially different learning outcomes. While some learners demonstrate remarkable improvement in reading comprehension, others exhibit only modest gains despite receiving the same instructional support. This inconsistency suggests that instructional technology alone cannot fully account for differences in reading achievement. Instead, learners' individual cognitive characteristics may influence how effectively multimedia resources are processed and transformed into meaningful comprehension. Such observations are consistent with contemporary research in Second Language Acquisition (SLA), which increasingly recognizes individual differences as one of the principal explanations for variation in language learning outcomes (S. Li & Zhao, 2021).

Among the various learner-related factors that have been investigated in Second Language Acquisition (SLA), Foreign Language Aptitude (FLA) has regained considerable attention as an important predictor of language learning success. Although advances in instructional technology have transformed classroom practices, learners continue to display substantial variation in achievement even when they receive comparable instruction. Such variation has encouraged researchers to reconsider the contribution of relatively stable cognitive abilities that enable some learners to process, retain, and apply new linguistic information more efficiently than others. Rather than viewing language learning outcomes as the product of instructional quality alone, contemporary SLA research increasingly recognizes the interaction between pedagogical approaches and learner characteristics.

The concept of Foreign Language Aptitude was originally proposed by Carroll (1981), who described aptitude as a constellation of cognitive abilities that facilitate the acquisition of an additional language independently of general intelligence. These abilities include phonetic coding ability, grammatical sensitivity, inductive language learning ability, and associative memory. Together, they enable learners to perceive linguistic patterns, identify grammatical relationships, infer language rules from limited input, and establish durable associations between new forms and meanings. Although Carroll's framework was developed several decades ago, subsequent empirical research continues to confirm its theoretical relevance and predictive power across a wide range of language-learning contexts (S. Li, 2016).

Recent investigations have further expanded the understanding of language aptitude by demonstrating that its influence is not uniform across instructional settings. Instead, aptitude appears to interact with particular teaching methods and learning environments, resulting in different learning outcomes for learners with different cognitive profiles. S. Li (2016) argues that language aptitude remains one of the strongest predictors of second-language achievement despite significant developments in language pedagogy. Similarly, (Kamilla, 2024) emphasizes that instructional effectiveness should not be viewed independently of learners' individual characteristics because students possessing different aptitude profiles often respond differently to identical learning experiences. These

findings suggest that instructional innovation alone cannot eliminate individual differences in language achievement.

Another cognitive factor that complements the role of language aptitude is working memory. During reading, learners are required to retain lexical information, interpret syntactic relationships, integrate textual ideas, and connect new information with existing knowledge within a limited period of time. These simultaneous cognitive operations depend heavily on working memory capacity. Learners with greater working memory resources generally demonstrate stronger reading performance because they are better able to coordinate multiple processes while maintaining comprehension of the overall text (Sagarra, 2017). Consequently, working memory and language aptitude should not be regarded as competing explanations but as closely related cognitive resources that jointly contribute to successful language learning.

Despite the growing body of evidence supporting multimedia-assisted instruction and the well-established importance of language aptitude in SLA, these two lines of inquiry have largely developed independently. Research on multimedia learning has predominantly examined whether technology-enhanced instruction improves learning outcomes compared with conventional teaching approaches. In contrast, studies on Foreign Language Aptitude have focused primarily on language domains such as grammar acquisition, vocabulary learning, pronunciation, and listening comprehension. Comparatively little attention has been devoted to examining whether learners' aptitude influences the extent to which they benefit from multimedia-supported reading instruction. This omission is particularly evident in Indonesian senior high school EFL classrooms, where multimedia resources have become increasingly available but considerable differences in students' reading achievement continue to be observed.

The absence of research integrating these perspectives represents both a theoretical and practical gap. From a theoretical standpoint, existing multimedia studies provide limited explanation for why learners respond differently to the same instructional materials, while aptitude research has seldom incorporated multimedia learning environments into its analytical framework. From a practical perspective, English teachers require evidence not only regarding whether multimedia instruction is effective but also regarding which learners are most likely to benefit from it. Addressing this gap offers an opportunity to enrich current understanding of individual differences in SLA while providing a stronger empirical basis for designing reading instruction that is responsive to learners' cognitive characteristics rather than relying solely on technological innovation.

Against this background, the present study addresses an underexplored issue in the field of Second Language Acquisition by examining whether Foreign Language Aptitude (FLA) predicts learners' achievement in multimedia-assisted reading comprehension. Although previous studies have demonstrated the effectiveness of multimedia-supported instruction and confirmed the importance of language aptitude in second language learning, these two strands of research have rarely been integrated within a single empirical investigation. Most multimedia studies have focused primarily on evaluating instructional effectiveness, whereas research on language aptitude has concentrated on language domains such as grammar, vocabulary, listening, and pronunciation. Consequently, relatively little empirical evidence is available regarding the extent to which learners' cognitive aptitude influences the effectiveness of multimedia-assisted reading instruction, particularly in Indonesian senior high school EFL classrooms.

Investigating this relationship is expected to contribute to both theory and practice. Theoretically, the study integrates perspectives from Second Language Acquisition, the Cognitive Theory of Multimedia Learning by (Mayer, 2020), and Foreign Language

Aptitude Theory (Carroll, 1981), to provide a more comprehensive explanation of multimedia-assisted reading comprehension. Rather than viewing instructional effectiveness solely as a consequence of technological innovation, the present study recognizes that learning outcomes emerge from the interaction between instructional conditions and learners' cognitive characteristics, consistent with recent developments in SLA research outcomes (S. Li & Zhao, 2021). Practically, the findings are expected to assist English teachers in designing multimedia-supported reading instruction that is more responsive to learners' cognitive diversity, thereby promoting more effective and equitable learning experiences.

Accordingly, this study pursues three research objectives. First, it examines the level of Foreign Language Aptitude among Indonesian senior high school EFL students. Second, it compares students' reading comprehension achievement between multimedia-assisted instruction and conventional paper-based instruction. Third, it investigates whether Foreign Language Aptitude significantly predicts students' achievement in multimedia-assisted reading comprehension. Through these objectives, the study seeks to extend current understanding of the relationship between individual cognitive differences and multimedia-assisted language learning while providing empirical evidence to support the development of more adaptive reading instruction in Indonesian EFL classrooms.

THEORETICAL SUPPORT

The present study is situated within the broader framework of Second Language Acquisition (SLA), which views reading comprehension as a complex cognitive activity involving the dynamic interaction of linguistic knowledge, cognitive resources, and strategic processing. Reading in a second or foreign language extends well beyond the recognition of vocabulary and grammatical structures. Learners are required to activate prior knowledge, interpret textual information, establish relationships among ideas, generate inferences, and continuously monitor their understanding while reading. Consequently, successful reading comprehension depends on the coordinated operation of multiple cognitive processes rather than on language knowledge alone. Supporting this perspective (Jeon & Yamashita, 2014) identified vocabulary knowledge, grammatical competence, first-language reading ability, metacognitive strategies, and working memory as the principal predictors of second-language reading comprehension. Their meta-analysis reinforces the view that reading achievement is shaped by the interaction of linguistic competence and cognitive functioning.

Building upon this understanding, the instructional dimension of the present study is informed by Mayer's Cognitive Theory of Multimedia Learning (CTML). The theory proposes that meaningful learning occurs when learners actively process information instead of passively receiving it. According to (Mayer, 2020), learners construct knowledge by selecting relevant verbal and visual information, organizing each form of information into coherent mental representations, and integrating these representations with existing knowledge stored in long-term memory. Because verbal and pictorial information are processed through two interconnected but partially independent cognitive channels, appropriately designed multimedia instruction enables learners to optimize limited cognitive capacity while minimizing unnecessary processing demands to (Mayer, 2020). further argues that multimedia learning is most effective when instructional materials support essential cognitive processing without overloading learners' working memory, thereby facilitating deeper conceptual understanding rather than superficial information retention.

Within English as a Foreign Language (EFL) classroom, these theoretical principles have received considerable empirical support. A growing body of research demonstrates that multimedia-based learning environments enrich language instruction by combining written texts with visual illustrations, audio narration, videos, animations, and interactive vocabulary support. Such multimodal resources provide contextual information that assists learners in interpreting unfamiliar linguistic input while maintaining engagement throughout the reading process. Previous studies have reported that multimedia annotations and visual support facilitate vocabulary acquisition and improve learners' comprehension of written texts (Akbulut, 2017; Mohamad Subaidi bin Abdul Samat, 2020; Wang et al., 2021). Likewise, systematic evidence indicates that multimedia-assisted instruction generally produces superior learning outcomes compared with conventional text-based approaches because learners are able to construct more coherent mental representations from multiple complementary sources of information (Akbulut, 2017; Mohamad Subaidi bin Abdul Samat, 2020; Wang et al., 2021). These findings collectively suggest that multimedia contributes not merely by increasing learners' interest but by supporting the cognitive processes required for effective reading comprehension.

While multimedia instruction explains one important dimension of learning, differences in instructional outcomes cannot be understood without considering learner-related cognitive characteristics. The cognitive perspective adopted in this study is therefore grounded in Carroll's (1981) Foreign Language Aptitude (FLA) Theory. Carroll conceptualized language aptitude as a relatively stable constellation of cognitive abilities that enables individuals to acquire additional languages efficiently regardless of general intelligence. The framework comprises four interrelated components: phonetic coding ability, grammatical sensitivity, inductive language learning ability, and associative memory. Phonetic coding ability facilitates the identification and retention of unfamiliar sounds; grammatical sensitivity enables learners to recognize functional relationships among linguistic elements; inductive language learning ability supports the discovery of underlying language rules from limited input; and associative memory assists learners in forming durable connections between linguistic forms and their meanings. Together, these abilities explain why learners exposed to similar instructional conditions frequently achieve markedly different language learning outcomes.

Subsequent investigations have consistently confirmed the continued relevance of Carroll's theoretical framework within contemporary SLA research. Rather than diminishing in importance, language aptitude has remained a robust predictor of achievement across diverse instructional contexts and language skills (S. Li, 2018; S. Li & Zhao, 2021). Meta-analytic evidence further indicates that aptitude interacts with instructional conditions, implying that learners possessing different cognitive profiles may benefit differently from identical pedagogical approaches (S. Li, 2018). In a similar vein, Kamilla (2024) argues that instructional effectiveness should be interpreted through the interaction between pedagogical design and learner characteristics rather than through teaching methods alone. Accordingly, aptitude represents an essential explanatory variable for understanding why learners exhibit varying levels of success even when instructional quality is held relatively constant.

Working memory constitutes another cognitive construct closely associated with language aptitude and plays a particularly important role during reading comprehension. Reading requires learners to retain lexical information while simultaneously analysing grammatical structures, integrating textual propositions, and generating inferences across successive sentences. Because these cognitive activities occur concurrently, efficient reading depends heavily upon the capacity of working memory to coordinate multiple

processing demands. Learners possessing greater working memory capacity are generally better able to allocate attentional resources, maintain relevant information during comprehension, and integrate new knowledge with existing cognitive structures, leading to superior reading performance (Sagarra, 2017). More recent SLA research further suggests that working memory and language aptitude complement one another in explaining individual variation in language learning performance, particularly under cognitively demanding instructional conditions such as multimedia-assisted (H. Li et al., 2023).

Taken together, these theoretical perspectives provide a coherent conceptual foundation for the present study. SLA theory explains reading comprehension as the outcome of coordinated linguistic and cognitive processes; the Cognitive Theory of Multimedia Learning clarifies how verbal and visual information can be integrated to facilitate meaningful learning; Foreign Language Aptitude Theory accounts for stable individual differences in language learning capacity; and working memory research explains learners' ability to process and integrate linguistic information during reading. Rather than operating independently, these complementary perspectives suggest that successful multimedia-assisted reading comprehension emerges from the interaction between instructional design and learners' cognitive characteristics. This integrated framework therefore provides the theoretical basis for examining whether Foreign Language Aptitude predicts students' achievement in multimedia-assisted reading comprehension among Indonesian senior high school EFL learners, while also responding to recent calls within Second Language Acquisition research for greater integration of instructional and individual-difference variables (S. Li & Zhao, 2021).

METHOD

Research Design

This study adopted a quantitative approach using a quasi-experimental pretest–posttest control group design. The design was selected because it enables researchers to examine the effectiveness of an instructional intervention by comparing students' learning achievement before and after treatment while controlling, to the greatest extent possible, for their initial level of performance (John W. Creswell, 2023). Since the study was conducted in an authentic school setting, intact classes rather than individual students were assigned to the experimental and control groups through cluster random sampling.

The experimental group received multimedia-assisted reading instruction, whereas the control group was taught using conventional paper-based reading instruction. Both groups completed the same pretest and posttest to measure changes in reading comprehension after the instructional intervention. In addition to comparing the effectiveness of the two instructional approaches, the study examined whether students' Foreign Language Aptitude (FLA) significantly predicted their achievement in multimedia-assisted reading comprehension. Accordingly, the research design integrates principles from Second Language Acquisition, Foreign Language Aptitude (Carroll, 1981; Mayer, 2020).

Participants

The participants were 69 Grade XI students enrolled in an Indonesian senior high school. Cluster random sampling was employed to select two intact classes, resulting in 35 students in the experimental group and 34 students in the control group. All participants had studied English for approximately six years under the same national curriculum and were taught by the same English teacher. This relatively homogeneous educational

background reduced the possibility that differences in instructional experience would influence the findings. Prior to the intervention, both groups completed a reading comprehension pretest to determine their initial level of proficiency. The pretest results indicated that the two groups possessed relatively comparable reading ability before the treatment was implemented.

Instruments

Two principal instruments were employed to collect the research data. The first instrument was the Researcher-Developed Foreign Language Aptitude Test (R-FLAT), which was designed according to Carroll's (1981) theoretical framework of Foreign Language Aptitude. The instrument assessed four dimensions of language aptitude: phonetic coding ability, grammatical sensitivity, inductive language learning ability, and associative memory. Collectively, these components provided an overall measure of each student's language learning aptitude.

The second instrument was a 30-item multiple-choice reading comprehension test based on argumentative texts included in the Indonesian senior high school English curriculum. The test measured students' ability to identify main ideas, recognize supporting details, infer implicit meanings, interpret vocabulary in context, identify references, and determine the writer's purpose and argument. The same test specifications were used for both the pretest and posttest to ensure comparability between the two administrations.

To support the instructional treatment, multimedia-assisted reading materials were developed based on Mayer's (2021) Cognitive Theory of Multimedia Learning. These instructional materials integrated written texts with visual illustrations, audio narration, short videos, highlighted keywords, and interactive vocabulary glosses. The multimedia components were intentionally designed to facilitate meaningful learning by supporting learners' cognitive processing of verbal and visual information.

Research Procedures

The study was conducted in four sequential stages. First, all participants completed the Researcher-Developed Foreign Language Aptitude Test (R-FLAT) before the instructional treatment began. The aptitude scores were collected to examine whether students' language aptitude predicted their subsequent reading comprehension performance. Second, both groups completed an identical paper-based reading comprehension pretest. The pretest established students' baseline reading proficiency and enabled comparisons of learning gains after the intervention. Third, the instructional treatment was implemented over six classroom meetings. Students in the control group received conventional reading instruction using printed texts accompanied by teacher explanation and classroom discussion. In contrast, students in the experimental group studied the same reading materials through multimedia-assisted instruction developed according to Mayer's (2021) multimedia learning principles. Although both groups learned identical content and pursued the same instructional objectives, the experimental group was supported by multimedia resources that combined verbal and visual information to facilitate reading comprehension. Finally, after the treatment period had been completed, both groups took the same reading comprehension posttest. The posttest scores were subsequently analyzed to determine improvements in students' reading achievement and to compare the effectiveness of the two instructional approaches.

Data Analysis

Data were analyzed using IBM SPSS Statistics Version 26. Descriptive statistics, including the mean, standard deviation, minimum score, and maximum score, were first calculated to describe students' Foreign Language Aptitude and reading comprehension performance.

Before hypothesis testing, the assumptions of normality and homogeneity of variance were examined using the Shapiro–Wilk test and Levene's test, respectively. After these assumptions had been satisfied, an independent-samples *t*-test was conducted to compare posttest reading comprehension scores between the experimental and control groups. A paired-samples *t*-test was also performed to examine whether each group demonstrated significant improvement from pretest to posttest.

To address the third research objective, simple linear regression analysis was employed to determine whether Foreign Language Aptitude significantly predicted students' multimedia-assisted reading comprehension achievement. In this analysis, Foreign Language Aptitude served as the independent variable, whereas posttest reading comprehension scores of the experimental group served as the dependent variable. Statistical significance was determined using an alpha level of .05.

Validity and Reliability

The reading comprehension test was evaluated by two experts in English Language Education to establish its content validity. Prior to the main study, the instrument was piloted with students possessing characteristics similar to those of the research participants. The pilot data were analyzed to evaluate item difficulty, item discrimination, and overall instrument quality.

Instrument reliability was examined using Cronbach's Alpha, with a coefficient of .70 or above considered acceptable for educational research (Taber, 2018). The Researcher-Developed Foreign Language Aptitude Test (R-FLAT) was constructed based on Carroll's (1981) theoretical model, while its development was informed by the LLAMA Language Aptitude Test, which has demonstrated satisfactory validity and reliability in previous Second Language Acquisition studies (Bokander & Bylund, 2020).

RESULT AND DISCUSSION

Result

Reading Comprehension Performance Following Multimedia-Assisted Instruction.

The first objective of this study was to examine whether students' reading comprehension improved after participating in multimedia-assisted instruction and to compare their achievement with that of students receiving conventional paper-based instruction. Before the intervention, both groups demonstrated relatively comparable levels of reading comprehension, indicating that the participants began the study with similar academic readiness. Following six instructional meetings, improvements were observed in both groups; however, the magnitude of the improvement differed considerably.

As presented in Table 1, the experimental group increased its mean score from 60.64 on the pre-test to 75.71 on the post-test, representing an average gain of 15.07 points. By contrast, the control group improved from 62.21 to 68.68, with a mean gain of 6.47 points. Although both instructional approaches contributed positively to students' reading achievement, the larger gain observed in the multimedia-assisted class indicates that students benefited more substantially from instruction supported by multimodal learning resources.

Table 1. Descriptive Statistics of Reading Comprehension Scores

Group	Pre-test	Post-test	Gain
Control (n = 35)	62.21	68.68	+6.47
Experimental (n = 34)	60.64	75.71	+15.07

The descriptive findings alone, however, are insufficient to determine whether the observed improvements reflect meaningful instructional effects. Consequently, paired-samples *t*-tests were performed to compare students' reading comprehension before and after the instructional intervention within each group.

The analysis revealed statistically significant improvement in both classes. Students who learned through conventional instruction demonstrated significant progress ($t = 5.05$, $p < .001$), while students exposed to multimedia-assisted instruction achieved an even stronger level of improvement ($t = 10.83$, $p < .001$). These findings indicate that reading comprehension developed under both instructional conditions, although the degree of improvement was considerably greater among learners receiving multimedia-supported instruction.

Table 2. Paired-Samples *t*-test Results

Group	<i>t</i>	<i>p</i>
Control	5.05	< .001
Experimental	10.83	< .001

Taken together, the descriptive statistics and inferential analyses consistently demonstrate that multimedia-assisted instruction was associated with greater gains in students' reading comprehension than conventional paper-based learning. The larger improvement observed in the experimental group suggests that integrating multiple forms of instructional representation—including written texts, visual materials, audio narration, and vocabulary support—provided a learning environment that more effectively facilitated students' understanding of argumentative texts.

Foreign Language Aptitude as a Predictor of Multimedia-Assisted Reading Comprehension.

The second objective of the study was to investigate whether Foreign Language Aptitude significantly predicted students' reading comprehension achievement after participating in multimedia-assisted instruction. To address this objective, a simple linear regression analysis was conducted using Foreign Language Aptitude as the predictor variable and post-test reading comprehension scores as the dependent variable.

The regression analysis revealed a statistically significant predictive relationship between the two variables. As shown in Table 3, Foreign Language Aptitude significantly predicted students' multimedia-assisted reading comprehension achievement ($B = 2.52$, $t = 15.85$, $p < .001$). Furthermore, the regression model explained a substantial proportion of the variance in students' reading comprehension scores ($R^2 = .884$; $F(1,33) = 251.30$, $p < .001$).

Table 3 Simple Linear Regression Analysis

Predictor	<i>B</i>	<i>t</i>	<i>p</i>
Foreign Language Aptitude	2.52	15.85	< .001

Model Summary Value	
R ²	.884
F(1,33)	251.30
p	< .001

The regression results indicate that students possessing higher levels of Foreign Language Aptitude consistently achieved higher reading comprehension scores after participating in multimedia-assisted instruction. The positive regression coefficient demonstrates that increases in aptitude scores were associated with corresponding increases in students' reading achievement, suggesting that learners' cognitive characteristics contributed meaningfully to differences in instructional outcomes.

Overall, the statistical findings indicate that multimedia-assisted instruction contributed to substantial improvements in reading comprehension while Foreign Language Aptitude emerged as a significant predictor of students' achievement within the multimedia learning environment. These results provide empirical evidence supporting the inclusion of both instructional and learner-related variables in explaining variation in English reading performance.

Discussion

Multimedia-Assisted Instruction Facilitates Reading Comprehension through Multimodal Cognitive Processing.

The findings of the present study demonstrate that students who participated in multimedia-assisted reading instruction achieved considerably greater improvement than those who learned through conventional paper-based instruction. Although both groups showed statistically significant progress, the experimental class exhibited a gain score that was more than twice that of the control group. This pattern suggests that the instructional benefits observed in the multimedia class cannot be explained merely by repeated exposure to reading activities. Rather, the integration of multimodal learning resources appears to have created learning conditions that supported more effective meaning construction during reading.

An important point emerging from these findings is that multimedia-assisted instruction should not be understood simply as the use of digital technology in the classroom. The instructional advantage observed in this study is more plausibly explained by the way multimedia resources organized information into complementary verbal and visual representations. During the learning process, students were exposed not only to written texts but also to visual illustrations, highlighted vocabulary, audio explanations, and interactive learning materials. These complementary representations likely reduced the cognitive effort required to process unfamiliar language while simultaneously strengthening learners' ability to connect textual information with existing knowledge structures. Consequently, students were able to devote greater cognitive resources to higher-order comprehension processes, including identifying implicit meanings, evaluating arguments, and integrating information across different parts of the text.

This interpretation is consistent with the Cognitive Theory of Multimedia Learning (CTML), which proposes that meaningful learning occurs when learners actively select relevant information, organize it into coherent mental models, and integrate newly acquired knowledge with prior understanding (Mayer, 2021). Rather than assuming that technology automatically improves learning outcomes, CTML emphasizes that instructional effectiveness depends on how multimedia materials correspond to the

architecture of human cognition. The present findings provide empirical support for this perspective. The superior performance demonstrated by the experimental group suggests that multimedia-assisted instruction became effective because it facilitated cognitive processing rather than because it merely introduced technological novelty.

Another noteworthy aspect of the findings concerns the role of learner engagement. Reading comprehension frequently presents difficulties for Indonesian EFL students because argumentative texts require sustained attention, inferential reasoning, and continuous monitoring of meaning. Conventional reading instruction often depends heavily on printed texts and teacher explanation, placing substantial cognitive demands on learners who must construct meaning using limited contextual support. By contrast, multimedia-assisted instruction offers multiple pathways through which students can access information. Visual cues, audio narration, and contextual vocabulary support may increase learners' confidence in interpreting unfamiliar language while maintaining attention throughout the reading process. These conditions are likely to encourage deeper engagement with textual content and reduce the likelihood that students disengage when encountering linguistic difficulties.

The findings also correspond with previous investigations reporting positive effects of multimedia-assisted learning on English language achievement. Earlier studies have demonstrated improvements in vocabulary acquisition, learner motivation, and reading comprehension when instructional materials integrate verbal and visual information within coherent instructional designs. The present study extends this body of evidence by demonstrating that such instructional benefits remain observable among Indonesian senior high school students learning argumentative texts within regular classroom settings. Rather than being limited to controlled laboratory environments, multimedia-assisted instruction appears capable of supporting authentic classroom learning when instructional resources are systematically designed.

Nevertheless, the findings should not be interpreted as evidence that multimedia instruction is universally effective regardless of context. The observed instructional advantage emerged within a learning environment where multimedia resources were intentionally aligned with learning objectives and accompanied by teacher guidance. Consequently, the results reinforce an important pedagogical principle: technology should function as a means of supporting learning rather than as an instructional objective in itself. Poorly designed multimedia materials that overload learners with excessive visual or auditory information may not produce similar outcomes. The effectiveness observed in the present study therefore highlights the importance of instructional design quality rather than the mere presence of digital technology.

From a practical perspective, these findings suggest that English teachers should consider multimedia-assisted instruction as part of a broader pedagogical strategy aimed at facilitating comprehension rather than replacing conventional teaching practices entirely. Combining carefully selected multimedia resources with explicit reading instruction, guided questioning, vocabulary scaffolding, and classroom discussion may provide learners with richer opportunities to construct meaning from increasingly complex English texts. Such an approach is particularly relevant within Indonesian secondary education, where improving students' higher-order reading skills has become an important objective of English language instruction.

Foreign Language Aptitude as a Cognitive Foundation for Multimedia-Assisted Reading Achievement.

Beyond demonstrating the instructional advantages of multimedia-assisted learning, the present study provides evidence that learners' cognitive characteristics substantially contribute to reading comprehension outcomes. The regression analysis showed that Foreign Language Aptitude (FLA) significantly predicted students' post-test reading comprehension scores after multimedia-assisted instruction. This finding indicates that instructional effectiveness cannot be attributed exclusively to the learning environment or the instructional media employed. Instead, learners' internal cognitive capacities appear to influence the extent to which they benefit from multimedia-supported reading activities.

This finding is theoretically consistent with Carroll's (1981) conceptualization of Foreign Language Aptitude as a constellation of relatively stable cognitive abilities that facilitate language learning independently of general intelligence. Carroll argued that learners possessing stronger phonetic coding ability, grammatical sensitivity, inductive language learning ability, and associative memory are generally able to recognize linguistic regularities more efficiently and acquire new language forms with less cognitive effort. The present findings suggest that these cognitive resources continue to play a meaningful role even when instruction incorporates sophisticated multimedia learning environments. Rather than replacing learner differences, multimedia instruction appears to amplify the advantages enjoyed by students possessing stronger cognitive readiness.

An important implication emerging from the present findings is that multimedia technology should not be regarded as an equalizer capable of eliminating individual variation in language learning. Digital learning environments undoubtedly provide richer instructional support than conventional printed materials; however, learners remain responsible for processing, integrating, and interpreting the information presented. Students possessing stronger language aptitude are likely to organize verbal and visual information more efficiently, identify linguistic relationships more rapidly, and retain newly acquired vocabulary more successfully than learners with lower aptitude. Consequently, they derive greater benefit from instructional environments that require simultaneous processing of multiple information sources.

This interpretation is compatible with recent perspectives in Second Language Acquisition, which increasingly conceptualize language learning as the product of interactions among instructional conditions, learner characteristics, and cognitive processing mechanisms. Rather than functioning as isolated predictors, instructional variables and learner variables operate together to influence learning outcomes. From this interactionist perspective, multimedia-assisted instruction provides opportunities for learning, whereas language aptitude influences learners' capacity to capitalize on those opportunities. The present study therefore contributes to a more integrated understanding of language learning by demonstrating that instructional innovation and cognitive individual differences should be examined simultaneously rather than independently.

Another noteworthy aspect of the present findings concerns The relationship between Foreign Language Aptitude and cognitive load management. Multimedia-assisted reading requires learners to coordinate information originating from written texts, visual representations, vocabulary support, and audio explanations within a relatively limited period of time. Such instructional environments inevitably increase the complexity of cognitive processing. Learners possessing stronger aptitude may manage these cognitive demands more effectively because they can allocate attention more efficiently, recognize relevant linguistic cues more rapidly, and integrate information across representational

modes without overloading working memory. Consequently, the effectiveness of multimedia instruction may depend not only on the quality of instructional design but also on learners' capacity to regulate complex cognitive processing during reading.

The remarkably strong predictive relationship observed in the present study should nevertheless be interpreted with appropriate caution. Although the regression analysis indicates that Foreign Language Aptitude explained a substantial proportion of variance in reading comprehension achievement, this statistical relationship should not be understood as evidence that aptitude alone determines students' reading success. Reading comprehension is widely recognized as a multidimensional construct influenced by numerous interacting variables, including motivation, vocabulary knowledge, prior reading experience, metacognitive strategy use, classroom engagement, instructional quality, and digital literacy. Consequently, the present findings should be interpreted as demonstrating that Foreign Language Aptitude constitutes a particularly important predictor within the instructional context examined in this study rather than as the sole determinant of reading achievement.

From a theoretical perspective, the present investigation extends existing aptitude research in two important ways. Previous studies have primarily examined the influence of aptitude on grammar learning, vocabulary acquisition, listening comprehension, or overall language achievement. Comparatively few investigations have explored its role within multimedia-assisted reading environments, particularly in Indonesian secondary education. By integrating Foreign Language Aptitude Theory with the Cognitive Theory of Multimedia Learning, the present study demonstrates that learners' cognitive characteristics remain influential even within technologically enriched instructional contexts. This integration contributes to the growing body of SLA research emphasizing that technology and learner cognition should be considered complementary rather than competing explanations for language learning outcomes.

Collectively, these findings suggest that future investigations should move beyond asking whether multimedia instruction improves language learning toward examining for whom, under what conditions, and through which cognitive mechanisms multimedia learning becomes most effective. Such an orientation would provide a more nuanced understanding of instructional effectiveness and contribute to the development of adaptive pedagogical models capable of accommodating learner diversity.

Pedagogical Implications for English Language Teaching.

The findings of the present study offer several implications for English language teaching, particularly within Indonesian secondary schools where multimedia resources are becoming increasingly accessible. The results indicate that successful technology integration depends not merely on providing digital instructional materials but on designing learning environments that align multimedia resources with students' cognitive needs. Consequently, instructional planning should move beyond questions concerning the availability of technology toward considerations of how multimedia materials facilitate meaningful cognitive engagement during reading.

One practical implication concerns the design of multimedia reading instruction itself. Rather than presenting learners with multiple digital resources simultaneously, teachers should organize instructional materials in ways that reduce unnecessary cognitive load while emphasizing information directly relevant to the learning objectives. Visual illustrations, vocabulary annotations, short explanatory videos, and audio narration should function as complementary supports rather than as competing sources of information. Such

instructional organization enables students to construct coherent mental representations instead of dividing attention among unrelated multimedia elements.

The findings further suggest that English teachers should recognize learner diversity when implementing multimedia instruction. Students enter the classroom with different cognitive strengths, language backgrounds, and learning strategies. Consequently, identical multimedia materials may produce substantially different learning outcomes across individuals. Teachers should therefore complement multimedia resources with differentiated instructional support, including guided reading questions, vocabulary pre-teaching, collaborative discussion, and graduated scaffolding that responds to learners' varying levels of readiness. Such differentiation is particularly important for students who may require additional support in processing complex multimodal information.

Assessment practices may also benefit from the present findings. Conventional reading assessments frequently evaluate only the final product of comprehension without considering the cognitive processes through which learners construct meaning. Multimedia-assisted instruction creates opportunities for incorporating formative assessment strategies that monitor learners' interaction with instructional materials throughout the learning process. Observation protocols, reflective journals, digital learning logs, and process-oriented classroom discussions may provide teachers with richer information concerning students' comprehension strategies than traditional paper-based tests alone.

The present findings likewise have implications for teacher professional development. Effective multimedia instruction requires competencies extending beyond technological proficiency. Teachers need to understand how learners process multimodal information, how multimedia influences cognitive load, and how individual learner characteristics affect instructional outcomes. Professional development programmes should therefore integrate pedagogical knowledge with technological knowledge, enabling teachers to make evidence-informed decisions regarding the selection, adaptation, and implementation of multimedia resources in English language classrooms.

Curriculum developers may also draw valuable insights from this investigation. As digital learning becomes increasingly embedded within national educational policy, curriculum frameworks should encourage instructional flexibility that accommodates learner diversity rather than prescribing uniform technological practices. Multimedia resources should be viewed as pedagogical tools supporting meaningful language learning rather than as indicators of technological modernization. Such an approach would ensure that instructional innovation remains grounded in educational objectives rather than technological enthusiasm.

Finally, the present study underscores the importance of adopting a learner-centred perspective in technology-enhanced language education. Multimedia instruction is unlikely to achieve its full educational potential unless it is accompanied by instructional practices that recognize differences in learners' cognitive profiles, language aptitude, and learning needs. The findings therefore encourage English teachers to design adaptive learning environments in which multimedia resources, classroom interaction, and differentiated scaffolding operate together to promote equitable opportunities for reading development. By integrating instructional technology with an understanding of learner cognition, English language education can move toward more inclusive and effective approaches capable of supporting students with diverse backgrounds and learning capacities.

Theoretical Contribution.

The present study contributes to the growing body of research on multimedia-assisted language learning by integrating instructional design and learner cognitive characteristics within a single explanatory framework. Previous investigations have frequently examined multimedia-assisted instruction and Foreign Language Aptitude (FLA) as independent variables. Research on multimedia learning has primarily emphasized the effectiveness of digital instructional media in improving language achievement, whereas aptitude research has traditionally focused on learners' cognitive readiness for language acquisition. By examining these two perspectives simultaneously, the present study offers a more comprehensive explanation of reading comprehension development among Indonesian EFL learners.

One theoretical contribution of this study lies in demonstrating that the effectiveness of multimedia-assisted instruction cannot be understood solely through technological or pedagogical perspectives. The findings indicate that instructional media create opportunities for learning, but learners' cognitive capacities influence how effectively those opportunities are utilized. In other words, technology provides the learning environment, whereas Foreign Language Aptitude shapes learners' ability to process, organize, and integrate multimodal information into meaningful comprehension. This interpretation extends the Cognitive Theory of Multimedia Learning by highlighting that individual learner characteristics should be considered alongside instructional design when explaining learning outcomes.

A second contribution concerns the role of learner differences within technology-enhanced language education. Educational technology is sometimes viewed as a means of providing equivalent learning opportunities for all students. However, the present findings suggest that learner diversity remains an important consideration even in multimedia-rich classrooms. Students who possess stronger language aptitude appear better positioned to benefit from multimodal instructional resources because they can process linguistic and visual information more efficiently. Consequently, technology should be viewed as a cognitive support system rather than a substitute for learners' underlying language-learning capacities.

The study also contributes to Second Language Acquisition (SLA) research by reinforcing interactionist perspectives that explain language learning as the product of relationships among instructional input, learner cognition, and learning processes. Rather than attributing reading improvement exclusively to instructional innovation or to learner aptitude, the present findings suggest that successful language learning emerges through the interaction of these factors. This integrated perspective provides a more balanced explanation than models that privilege either instructional variables or learner variables in isolation.

Within the Indonesian educational context, the study offers additional theoretical value by providing empirical evidence from senior high school EFL classrooms, a context that remains underrepresented in multimedia-assisted aptitude research. Most previous studies have been conducted in higher education or in laboratory-based settings. The present investigation therefore broadens the contextual applicability of multimedia learning theory while contributing evidence from authentic classroom instruction in Indonesian secondary education.

Taken together, these theoretical contributions suggest that future research should adopt multidimensional models capable of explaining how instructional design, learner cognition, motivational factors, and classroom context interact to influence language

learning outcomes. Such models are likely to provide richer explanations than approaches focusing on single variables alone.

CONCLUSION

The present study investigated the effectiveness of multimedia-assisted instruction in improving English reading comprehension and examined the predictive role of Foreign Language Aptitude among Indonesian senior high school EFL learners. The findings demonstrated that students who participated in multimedia-assisted instruction achieved significantly greater improvements in reading comprehension than those who received conventional paper-based instruction. These results indicate that integrating multimodal instructional resources into reading lessons can provide meaningful support for students' comprehension development.

The study further demonstrated that Foreign Language Aptitude significantly predicted students' reading comprehension achievement within the multimedia-assisted learning environment. This finding suggests that instructional innovation alone does not fully explain learning success. Instead, learners' cognitive characteristics remain important determinants of how effectively they benefit from multimedia-supported instruction.

More broadly, the findings highlight the importance of viewing technology and learner cognition as complementary rather than competing explanations for language learning outcomes. Multimedia resources create instructional opportunities by presenting information through multiple representational modes, whereas Foreign Language Aptitude influences learners' capacity to process, organize, and integrate those representations into meaningful understanding. Consequently, effective English language instruction should combine well-designed multimedia materials with pedagogical practices that acknowledge learner diversity and provide appropriate instructional scaffolding.

From a theoretical perspective, the study contributes to the integration of the Cognitive Theory of Multimedia Learning, Foreign Language Aptitude Theory, and contemporary Second Language Acquisition perspectives by demonstrating that instructional effectiveness emerges from the interaction between learning environments and learner cognition. From a practical perspective, the findings encourage English teachers to implement multimedia-assisted instruction in ways that prioritize pedagogical quality, cognitive support, and differentiated learning opportunities rather than focusing solely on technological innovation.

In conclusion, the present study provides empirical evidence that multimedia-assisted instruction, when implemented through pedagogically sound instructional design, can substantially enhance EFL reading comprehension. At the same time, the findings reaffirm that learners' cognitive differences remain central to understanding instructional effectiveness. Future research should continue to investigate how instructional design, learner aptitude, motivation, and other cognitive and contextual variables interact to support successful English language learning in increasingly technology-rich educational environments.

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