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Augmented Reality-Assisted Multiliteracy Learning and Reading Comprehension among Students

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Abstract

Reading lessons now include more than printed words. Students often need to connect text with visual and digital information. We examined reading comprehension in a Grade 7th class that used a multiliteracy model supported by augmented reality (AR). We used a quasi-experimental nonequivalent control group pretest-posttest design. Sixty students from one of public school in Jakarta took part. Thirty students learned with the AR-assisted multiliteracy model, and 30 students received regular text-based instruction. We used a reading comprehension test and analyzed the scores with descriptive statistics, paired-samples t-tests, direct group comparisons, and Hedges' g. Both groups improved from pretest to posttest ($p < .001$). The control group gained 11.97 points, while the experimental group gained 17.20 points. The experimental group also had a higher posttest mean, $t(58) = 4.10$, $p < .001$. The standardized posttest difference was large (Hedges' $g = 1.04$). The results show that AR can support reading when teachers use it as part of a clear multiliteracy lesson. AR supported meaning making by presenting visual and contextual information alongside the text. It complemented reading activities without replacing them.

Keywords: multiliteracy, augmented reality, reading comprehension, multimodal reading

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INTRODUCTION

Reading comprehension requires more than finding words on a page. Students need to follow ideas, connect details, draw inferences, and evaluate what they read. Digital reading adds to these demands, as text may appear alongside images, links, and other visual information (Niklas et al., 2026). Reading activities therefore need careful design. In Indonesia, PISA 2022 results show that reading remains a challenge. Indonesian students scored an average of 359 in reading, compared with the OECD average of 476 (OECD, 2023).

We cannot depend on technology alone to solve this reading comprehension problem. Some studies have found that readers understand texts slightly better on paper than on screens (Clinton, 2019; Delgado et al., 2018). Singer Trakhman et al. (2023) reported a similar finding when students read multimodal texts in print and digital formats. The digital format did not always make the text easier to understand. For teachers, these findings point to the need to consider what each digital element adds to a reading task.

Multiliteracies offers a useful starting point for planning these tasks. The New London Group (1996) explained that people make meaning through written language as well as visual, spatial, audio, and other modes. Cope and Kalantzis (2009) developed this idea further in teaching and learning. In a multiliteracy lesson, students compare information across modes and explore how the different parts connect. They use those connections to build meaning. Research with secondary students also supports the value of multimodal input for digital reading comprehension (de-la-Peña et al., 2024).

AR fits this approach by placing digital information alongside printed texts or physical objects. How we use that information matters. A picture, a short animation, or a contextual cue can help explain what students are reading. When the connection to the text is unclear, however, it can distract them. Studies of AR in learning have repeatedly highlighted the importance of design and pedagogy (Akçayır & Akçayır, 2017; Garzón et al., 2020). For example, Lai et al. (2019) used AR to link verbal and visual information in science reading and reported better reading performance.

Other reading studies have reported positive results. Bursalı and Yılmaz (2019) found that students who took part in AR-supported reading activities showed stronger reading comprehension. Danaei et al. (2020) reported better overall comprehension with an AR storybook, particularly for questions that required readers to understand information that was not directly stated. Studies of EFL reading (Ebadi & Ashrafabadi, 2022) and AR storybooks (Şimşek & Direkçi, 2023) reported similar findings. Looking more broadly at language learning, Cai et al. (2022) found a positive overall effect of AR in their meta-analysis. Yet the benefits can vary. The duration and design of AR use can affect both comprehension and cognitive load (Şimşek et al., 2025).

Recent studies in also suggest that digital support works best when it serves a clear reading activity. Chang et al. (2024) included dialog-reading prompts in AR picture books and reported higher learning effectiveness than conventional parent-child reading. Mills et al. (2025) found that early adolescents drew on prior knowledge and managed their attention while reading multimodal AR and VR texts. Parandhama (2025) described how Grade 8 emergent readers used multimodal texts to build comprehension, with many preferring audio-visual input. Oakley et al. (2025) showed how a teacher used extended reality within a structured 5E science lesson to support disciplinary literacy. Together, these studies support connecting AR to a clear literacy task rather than treating it as a separate digital feature.

Most of these studies focus on AR as the main technology. In our study, we use AR within a multiliteracy model to help students build meaning across written and visual information. We compare reading comprehension between students who learned through this model and those who received regular text-based instruction. We focus on Indonesian language learning in Grade 7, a context that has received less attention in research on AR and reading.

METHOD

We conducted the study with Grade 7 students at a public school in Jakarta during the 2025/2026 academic year. We used a quantitative quasi-experimental design with a nonequivalent control group and pretest-posttest assessments. Sampling took place at the class level. We first listed the Grade 7 classes that followed the same Indonesian language curriculum, then selected two through a simple draw. One served as the experimental group and the other as the control group. Each class had 30 students, giving us a total sample of 60.

Before the lessons began, both groups completed the same reading comprehension pretest. The teaching took place over four meetings, each lasting about 80 minutes. One Indonesian language teacher taught both classes, using similar reading topics, learning objectives, and assessment schedules. The main difference between the groups was how students worked with the reading material.

In the experimental class, each lesson began with the teacher introducing the topic and explaining the reading goal. Students first read the main text. At selected points, they scanned AR markers in or beside the material using a mobile device. These markers opened visual or contextual information linked to the passage. Students then compared this information with the written text, discussed the main idea, drew inferences, and answered comprehension questions. The teacher also asked them to explain how the visuals helped them understand what they had read. In the control class, the teacher covered the same reading topics through regular text-based explanations, discussions, and comprehension questions, without AR. Both classes took the posttest after the final meeting.

The main instrument was a reading comprehension test covering four areas: identifying main ideas, interpreting information, drawing inferences, and evaluating textual content. Two experts reviewed its content and language. The first validator awarded 70 out of 80 possible points (87.50%), while the second awarded 52 out of 60 points (86.67%). The average of the two validation percentages was 87.08%.

To describe classroom conditions before the intervention, we used an observation sheet focused on teacher and student activities. We also prepared an interview guide as supporting material. The main comparison reported in this article, however, uses the reading comprehension scores.

We summarized the scores using the mean, standard deviation, minimum, and maximum. Paired-samples t-tests were used to examine changes within each group, and we compared the two groups at both pretest and posttest. We also calculated Hedges' g for the posttest difference using

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the available group sizes, means, and standard deviations. The significance level was .05. Where the statistical software displayed a p value of .000, we report it as $p < .001$.

The school granted permission for the study. Before collecting data, we explained the study's purpose to the students and told them how their data would be used. We kept their identities confidential throughout the analysis and reporting.

RESULTS AND DISCUSSION

Initial Classroom Condition and Instrument Check

The first observation showed limited classroom activity. The teacher activity score was 18 out of 40, or 45%. The student activity score was 14 out of 32, or 43.75%. The study rubric placed both scores in the poor category. We use these values only to describe the starting classroom condition.

The two experts gave similar judgments about the reading test. Validator 1 gave 87.50%, and Validator 2 gave 86.67%. The mean result was 87.08%. This expert review supported the use of the test for the reading objectives in this study.

Reading Comprehension Results

Table 1. Descriptive Statistics for Pretest and Posttest Scores

Group	N	Minimum	Maximum	Mean	SD
Pretest Control	30	19.00	47.00	33.80	6.96
Posttest Control	30	28.00	59.00	45.77	7.35
Pretest Experimental	30	23.00	49.00	35.57	6.51
Posttest Experimental	30	40.00	60.00	52.77	5.79

The two classes started with close mean scores. The control group had a pretest mean of 33.80 ($SD = 6.96$), and the experimental group had a mean of 35.57 ($SD = 6.51$). The 1.77-point difference was not statistically significant, $t(58) = 1.02$, $p = .314$. This result suggests that the groups had similar average performance before the lessons.

Both groups improved after instruction. The control mean rose by 11.97 points, from 33.80 to 45.77. The experimental mean rose by 17.20 points, from 35.57 to 52.77. In raw scores, the experimental class therefore gained 5.23 points more than the control class.

The reported normality and homogeneity checks had significance values above .05. We therefore continued with parametric tests.

Table 2. Paired-Samples t-Test Results

Group	Mean Difference	t	df	p (2-tailed)
Control	11.97	6.074	29	< .001
Experimental	17.20	11.090	29	< .001

The paired-samples tests showed significant improvement in both classes, $p < .001$. This tells us that students in each group performed better at posttest than at pretest. The test does not, by itself, show whether the two groups improved by the same amount. For that reason, we also examined the direct group difference.

Table 3. Between-Group Comparisons

Assessment	Mean Difference (Exp - Ctrl)	t	df	p	Hedges' g
Pretest	1.77	1.02	58	.314	0.26
Posttest	7.00	4.10	58	< .001	1.04

At posttest, the experimental group scored 7.00 points higher than the control group, $t(58) = 4.10$, $p < .001$. Hedges' g was 1.04, which shows a large standardized difference. The result gives stronger evidence for a difference between the two instructional conditions than the paired tests alone. At the same time, the classes were intact groups, so the finding should be read as a group difference under the conditions of this study.

What May Explain the Difference?

The result is in line with earlier AR reading studies. Bursalı and Yılmaz (2019) reported better reading comprehension with AR-supported activities. Danaei et al. (2020) also found an advantage for an AR storybook, especially for implicit questions. Şimşek and Direkçi (2023) reported gains across several levels of comprehension. Our result follows the same general pattern, but we used AR inside a multiliteracy lesson rather than as a separate digital activity.

One reason may be the way students worked across modes. Multiliteracies asks learners to connect written, visual, and other forms of information (Cope & Kalantzis, 2009; The New London Group, 1996). In our lessons, the AR content appeared next to a relevant part of the reading. Students then had to compare the visual cue with the written passage. de-la-Peña et al. (2024) found that multimodal input can support digital reading comprehension among secondary students. That finding helps explain why the connection between modes may matter.

The activity also required students to do something with the information. They discussed main ideas, linked details, and made inferences. They were not simply watching an AR display. This distinction is important. Lai et al. (2019) found that AR can support science reading when the visual and verbal information are carefully connected. In a different context, Ebadi and Ashrafabadi (2022) also reported stronger reading comprehension among EFL learners who used AR. These studies suggest that AR is more useful when it supports a clear reading action.

There is also a limit. Extra digital information can create more mental work. Şimşek et al. (2025) showed that the duration of AR exposure can affect comprehension and cognitive load. Broader research reaches a similar conclusion: the effect of AR depends on the way the learning activity is designed (Garzón et al., 2020). More AR is not automatically better.

This point also connects with digital reading research. Clinton (2019), Delgado et al. (2018), and Singer Trakhman et al. (2023) all show that digital presentation can sometimes make comprehension harder. A screen, animation, or interactive feature may pull attention away from the text. In our view, AR should stay close to the reading goal. If a digital element does not help students understand, compare, infer, or evaluate information, it has little reason to be there.

The test in this study measured total reading comprehension. It included main ideas, interpretation, inference, and evaluation, but we did not report a separate posttest score for each area. We therefore cannot say which part improved the most. Future research can examine these components one by one. That would make the learning mechanism clearer.

We also did not treat motivation or engagement as outcome variables in the statistical analysis. Other AR studies have reported positive learner responses, and recent work continues to explore AR-supported reading experiences with children (Cai et al., 2022; Wang et al., 2026). Those studies are useful for context, but our main evidence here is the reading comprehension score.

For teachers, the practical point is straightforward. Start with the reading objective. Then add AR only where it helps students see a relation that is difficult to notice in the text alone. The teacher still needs to ask questions, guide discussion, and push students to explain their reasoning. AR supports the lesson. It does not replace the lesson.

CONCLUSION

We compared reading comprehension in two Grade 7th classes. Both classes improved, but the experimental class had a larger raw gain and a higher posttest mean. The posttest difference was statistically significant, $t(58) = 4.10$, $p < .001$, and the standardized difference was large (Hedges' $g = 1.04$). Under the conditions of this study, students who learned through the AR-assisted multiliteracy model performed better on the reading comprehension test. The main contribution is not AR by itself. The stronger point is the way AR was placed inside a multiliteracy lesson. Students read the text, viewed related visual information, compared the two, and used the connection to discuss meaning. This gives teachers a practical way to use digital media without moving the reading task to the background.

The study involved 60 students from one school and used intact classes, so the findings should be interpreted within that setting. The instrument check relied on expert content review, and future studies can add reliability and item-level evidence. Future research can also examine each reading component separately and test the model with more schools, longer teaching periods, and different types of AR content. For classroom use, the main rule remains simple: use AR when it helps students read more carefully, not merely because the technology is available.

STATEMENTS AND DECLARATIONS

Competing Interests. The authors declare no competing interests.

Author Contributions. MS led the research design, data collection, data analysis, and first manuscript draft. NBK and EP supervised the study, reviewed the method and interpretation, and revised the manuscript. All authors read and approved the final manuscript.

Ethics Approval. The study was conducted with permission from one of public school in Jakarta. Student identities were protected during data collection, analysis, and reporting.

Informed Consent to Participate. Participants received information about the study before data collection, and participation followed the school's consent procedures.

Consent for Publication. The manuscript does not contain identifiable participant information.

Data Availability. The data supporting the findings are available from the corresponding author on reasonable request, subject to participant confidentiality.

Use of Artificial Intelligence Tools. ChatGPT was used to support English-language editing, sentence restructuring, and reference checking during manuscript revision. The authors reviewed the final text and remain responsible for the accuracy and integrity of the manuscript.

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