

ENHANCING EARLY LITERACY SKILLS THROUGH PLUGGED GCOMPRIS-BASED DIGITAL LEARNING

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ABSTRACT

Early literacy is a foundational predictor of later reading development, yet many kindergarten children still experience difficulty recognizing letters, connecting letters with sounds, matching letters with meaningful images, and discriminating visually similar letter forms. This study examined the effect of Plugged GCompris-based digital learning on the early literacy skills of children aged 5–6 years. A quantitative quasi-experimental pretest–posttest control-group design was used with 20 children, comprising 10 children in an experimental group and 10 in a control group. Data were collected through observation and early-literacy tasks and analyzed using descriptive statistics, normalized gain (N-Gain), and the Mann–Whitney test. The experimental group obtained a mean N-Gain of 0.77 (SD = 0.20), whereas the control group obtained 0.14 (SD = 0.20). The experimental group also had a substantially higher Mann–Whitney mean rank (15.20) than the control group (5.80), and the original analysis reported a statistically significant between-group difference. Improvement was evident across alphabet recognition, letter–sound association, picture–letter matching, and visual discrimination. The findings indicate that well-aligned interactive digital activities can strengthen constrained early-literacy skills when used as a complement to teacher-guided instruction. The study is limited by its small, single-site sample and absence of delayed retention measurement, warranting larger and longer-term investigations.

Keywords: Digital Learning, Early Childhood Education, Early Literacy, Gcompris, Quasi-Experimental Study.

INTRODUCTION

Early literacy comprises the knowledge, skills, and dispositions that precede conventional reading and writing and provide the developmental platform on which later literacy is built. Its core components include alphabet knowledge, phonological and phonemic awareness, print-related knowledge, oral-language resources, and the ability to connect visual symbols with linguistic meaning. Whitehurst and Lonigan (1998) conceptualized emergent literacy as a continuum that develops before formal reading begins, while Piasta and Wagner (2010) showed through meta-analysis that systematic alphabet instruction can improve children’s alphabet outcomes. Similarly, the National Reading Panel meta-analysis reported by Ehri et al. (2001) demonstrated that phonemic-awareness instruction has meaningful effects on children’s reading development, particularly when sound awareness is connected to letters. These findings are directly relevant to kindergarten instruction because children aged five to six are expected to consolidate letter recognition, letter–sound mapping, and visual discrimination before entering more demanding stages of decoding and comprehension.

The importance of these foundational skills is also evident in recent Indonesian early-childhood research. Abdiah and Noranisa (2023) emphasize that emergent literacy extends beyond the ability to read and write formally and includes precursor competencies that arise through interaction and stimulation. Wulandari and Puspitasari (2023) found that children’s reading interest is positively related to early-literacy ability, while Kusumawardhani et al. (2025) highlight the contribution of the home literacy environment to preschool children’s beginning-reading skills. Curriculum-level innovation can also support literacy development; Ismawati et al. (2025) reported that a literacy-integrated school operational curriculum was feasible and effective for strengthening children’s literacy performance. Collectively, this literature positions early literacy as both a developmental and instructional priority and underscores the need for learning environments that provide frequent, meaningful, and developmentally appropriate practice.

At the same time, early-childhood learning is increasingly situated within a digital ecology. Touch-screen devices, computers, interactive media, and educational applications have become familiar tools in homes and schools. Their educational value, however, depends less on the presence of technology itself than on the quality of the learning design. Hirsh-Pasek et al. (2015) argue that effective educational apps should support active, engaged, meaningful, and socially interactive learning rather than simply deliver entertainment. Systematic reviews similarly indicate that young children can learn from interactive apps, although outcomes vary substantially according to content, scaffolding, and the match between digital features and learning objectives (Griffith et al., 2020; Herodotou, 2018). A meta-analysis by Kim et al. (2021) found a positive overall effect of educational apps on preschool-to-Grade-3 academic achievement, with particularly favorable effects for preschool children and for constrained skills such as those targeted in early literacy.

Research focusing more specifically on literacy shows both promise and important design cautions. Early work with electronic books found that digital presentation can support literacy when multimedia elements reinforce rather than compete with textual meaning (de Jong & Bus, 2002, 2003, 2004). Later syntheses reached a similar conclusion: multimedia and interactive features can improve vocabulary and story-related learning when they are congruent with instructional content, but irrelevant hotspots, games, or task switching may distract children and reduce comprehension (Bus et al., 2015; Takacs et al., 2014, 2015). Zucker et al. (2009) likewise concluded that electronic books can contribute to literacy and language outcomes, but the magnitude and consistency of effects depend on design and instructional context. More recently, Savva et al. (2022) confirmed through meta-analysis that electronic storybooks can positively affect language and literacy outcomes in children from pre-kindergarten through Grade 2.

Tablet and app research provides further evidence that interactive digital environments may be useful for emergent literacy. Neumann and Neumann (2014) reviewed the potential of touch-screen tablets for alphabet knowledge, print concepts, and emergent writing. In an Australian study, Neumann (2016) found associations between young children's tablet use for reading and writing and emergent-literacy performance. A later review stressed that the quality of literacy apps and adult scaffolding are critical conditions for productive use (Neumann & Neumann, 2017). Most importantly for the present study, Neumann (2018) conducted a tablet-based literacy intervention and found significant gains in alphabet knowledge, print concepts, and name writing, although not every literacy outcome improved. These findings caution against treating digital media as uniformly effective; rather, digital activities appear most beneficial when the interaction is directly aligned with the target skill and when adults structure children's attention toward relevant information.

This qualified view is reinforced by broader evidence. Cheung and Slavin (2012) found a positive but modest overall effect of educational technology on reading outcomes, suggesting that implementation features matter. Callaghan and Reich (2018) observed that many commercially labeled preschool educational apps do not consistently embody strong pedagogical principles. Griffith et al. (2020) similarly identified emerging evidence for learning from interactive apps but noted substantial heterogeneity across studies. More recent meta-analytic work shows that game-based learning can support cognitive, motivational, and engagement outcomes in early childhood (Alotaibi, 2024), while a systematic review by Liu et al. (2024) documents growing use of digital technologies to support young children's language and literacy. Jing et al. (2023), however, demonstrate that the relationship between screen media and young children's vocabulary development is sensitive to the form and context of media exposure. Together, these studies support purposeful, bounded, and pedagogically guided technology use rather than unrestricted screen exposure.

Within the Indonesian early-childhood context, digital literacy and media-based learning are also receiving increasing attention. Mulyati and Maesyaroh (2022) describe the growing use of audiovisual media and game applications for introducing literacy to young children. Aisyah et al. (2023) found that digital literacy learning modules can improve specific knowledge outcomes among early-childhood learners. Kurnia et al. (2024) reported that integrating a cloud-based literacy application into kindergarten learning supported listening focus and comprehension, and Ningrum et al. (2024) found that digital storybooks positively influenced young children's language skills. In a different instructional approach, Asbar et al. (2024) demonstrated that project-based learning can improve kindergarten literacy, illustrating that active and varied learning experiences are valuable regardless of whether the medium is digital or non-digital.

One digital tool with potential relevance to early-childhood literacy is GCompris, an open educational software suite containing game-like activities for young learners. Savana and Sundari (2022) specifically introduced GCompris to parents as an accessible educational game environment that can support children's learning activities. Its plugged, computer-based format enables children to interact with letters, sounds, images, and visual choices through repeated practice and immediate responses. These features correspond with the learning principles identified in the educational-app literature, particularly active engagement, feedback, and focused practice (Hirsh-Pasek et al., 2015; Kim et al., 2021). Nevertheless, the educational value of an app cannot be inferred from its interactive format alone. Avenido et al. (2025), for example, found that technology-based games could perform comparably to structured traditional instruction for alphabet knowledge but did not produce a statistically superior gain, reinforcing the importance of empirical evaluation of specific tools and contexts.

The practical problem motivating the present study was observed among children at Raudhatul Jannah Kindergarten. The children showed difficulties in consistently recognizing alphabet symbols, associating letters with their sounds, matching letters with corresponding images, and distinguishing similar letter forms. These difficulties represent constrained early-literacy skills that should be strengthened before children transition to more complex reading tasks. Conventional classroom activities were considered insufficiently varied to address all four indicators consistently, creating a gap between the expected development of early-literacy foundations and children's observed performance. Interactive digital practice was therefore examined as a supplementary instructional strategy rather than as a replacement for teacher-led literacy teaching.

Although the literature increasingly supports digital tools for early learning, three gaps remain relevant. First, much of the evidence concerns tablets, electronic storybooks, or broad categories of educational apps rather than Plugged GCompris specifically. Second, many studies emphasize vocabulary, story comprehension, or general engagement, whereas the present study focuses on four tightly specified foundational skills: alphabet recognition, letter-sound association, picture-letter matching, and visual discrimination of letters. Third, evidence from Indonesian kindergarten contexts remains limited relative to the international literature. The novelty of this study therefore lies in empirically testing Plugged GCompris as a focused early-literacy intervention in a quasi-experimental kindergarten setting. Accordingly, the study aimed to determine whether children receiving Plugged GCompris-based digital learning demonstrated greater improvement in early-literacy skills than children receiving conventional instruction.

METHOD

This study employed a quantitative approach with a quasi-experimental nonequivalent pretest-posttest control-group design. A quasi-experimental design was appropriate because the children participated in intact instructional groups rather than being randomly assigned

individually. The design enabled comparison of change in early-literacy performance between a group receiving Plugged GCompris-based digital learning and a group receiving conventional literacy instruction. The unit of analysis was the individual child, while group membership represented the instructional condition.

The participants were 20 children aged five to six years enrolled at Raudhatul Jannah Kindergarten. Ten children formed the experimental group and ten formed the control group. The experimental group received digital-based literacy activities using Plugged GCompris, whereas the control group continued with conventional literacy learning. The sample size and group composition are consistent with the reported N-Gain and Mann–Whitney results, each of which includes 10 children per condition.

The independent variable was Plugged GCompris-based digital learning, and the dependent variable was early-literacy skill. Early literacy was operationalized through four indicators that correspond to the learning problems identified at baseline: alphabet recognition, letter–sound association, picture–letter matching, and visual discrimination between similar or different letter forms. These indicators represent constrained foundational skills that are theoretically connected with later reading development (Ehri et al., 2001; Piasta & Wagner, 2010; Whitehurst & Lonigan, 1998). Their selection also aligns with research showing that well-designed literacy apps can support alphabet knowledge and other emergent-literacy outcomes (Neumann, 2018).

Data were collected through structured observation and early-literacy tasks administered before and after the instructional condition. During assessment, children were asked to respond to literacy stimuli representing the four indicators. Observation supported documentation of children’s performance and responsiveness during the tasks, while the literacy test provided comparable pretest and posttest outcome information. The same domains were assessed at both measurement points so that learning gains reflected change in the targeted competencies rather than a change in the construct being measured.

The research procedure consisted of three main phases. First, a pretest was administered to both groups to identify initial early-literacy performance. Second, the experimental group participated in Plugged GCompris activities that required interaction with alphabet symbols, sounds, images, and visual letter choices, while the control group participated in conventional literacy instruction. Third, both groups completed a posttest covering the same early-literacy domains. The procedure was designed to determine whether the digital condition produced a stronger pretest-to-posttest improvement than the conventional condition.

Data analysis combined descriptive and nonparametric inferential procedures. Descriptive analysis was used to summarize the pattern of pretest and posttest performance. N-Gain analysis was used to compare the relative magnitude of improvement between the experimental and control groups. Because the reported inferential analysis used a Mann–Whitney test, the between-group comparison was treated nonparametrically rather than with an independent-samples *t* test. Mean ranks and sums of ranks were examined to determine the direction of group differences in learning gain. Statistical interpretation focused on whether the experimental group demonstrated a consistently stronger gain pattern than the control group.

The methodological sequence is summarized in Figure 1. The figure highlights the common pretest and posttest measurement structure, the different instructional conditions experienced by the two groups, and the subsequent N-Gain and Mann–Whitney analyses.

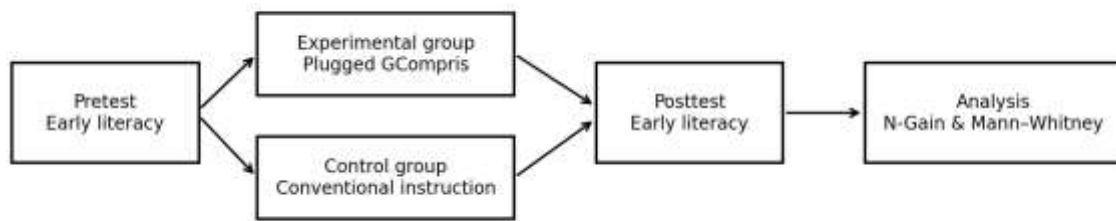


Figure 1. Research procedure for the quasi-experimental study

RESULTS AND DISCUSSION

Early Literacy Performance Before and After Intervention

Pretest observations indicated that children in both groups had relatively weak performance across the four targeted early-literacy indicators. Difficulties were particularly apparent when children had to identify letters consistently, connect a visual letter with its sound, select an image corresponding to a letter cue, or discriminate between visually similar letter forms. This baseline pattern is educationally important because alphabet knowledge and phonological awareness are among the most robust precursors of later reading achievement (Ehri et al., 2001; Piasta & Wagner, 2010). The pretest therefore confirmed the instructional relevance of focusing the intervention on these constrained skills.

Following the intervention, the experimental group showed stronger overall improvement than the control group. Children exposed to Plugged GCompris demonstrated more successful responses across alphabet recognition, letter–sound association, picture–letter matching, and visual discrimination. The control group also showed some improvement, which is expected when children continue to receive regular literacy instruction, but the magnitude of change was more limited. This pattern is consistent with the broader literature indicating that interactive apps can supplement early academic instruction when digital tasks directly rehearse the skills being assessed (Griffith et al., 2020; Kim et al., 2021; Neumann, 2018).

Learning Gain

Table 1. N-Gain analysis by instructional group

Group	N	Mean N-Gain	SD
Experimental	10	0.77	0.20
Control	10	0.14	0.20

As shown in Table 1, the experimental group obtained a mean N-Gain of 0.77 (SD = 0.20), compared with 0.14 (SD = 0.20) in the control group. The absolute difference of 0.63 in mean normalized gain indicates a markedly stronger learning improvement under the Plugged GCompris condition. The identical reported standard deviations suggest that the two groups had similar dispersion around substantially different mean gains. Although N-Gain should not be interpreted as a substitute for inferential testing, the descriptive contrast provides clear evidence that the experimental group experienced more pronounced pretest-to-posttest progress.

The size of this descriptive contrast is compatible with research showing that educational apps may be especially effective for constrained, directly practiced skills. Kim et al. (2021) found that app effects were larger when outcomes measured constrained skills, and Neumann (2018) reported improvements in alphabet knowledge after a tablet-based literacy intervention.

The present result extends this line of evidence to Plugged GCompris and to a four-indicator literacy framework. It also accords with the general finding that game-based learning can strengthen cognitive outcomes and engagement in early-childhood settings when learning goals are embedded within the game structure (Alotaibi, 2024).

Between-Group Difference

Table 2. Mann–Whitney ranks for N-Gain

Group	N	Mean Rank	Sum of Ranks
Experimental	10	15.20	152.00
Control	10	5.80	58.00
Total	20		

Table 2 shows that the experimental group had a mean rank of 15.20 and a sum of ranks of 152.00, while the control group had a mean rank of 5.80 and a sum of ranks of 58.00. The original analysis reported that this Mann–Whitney comparison was statistically significant, supporting the alternative hypothesis that Plugged GCompris-based digital learning affected early-literacy development. The rank pattern is also substantively strong: most of the higher gain scores were concentrated in the experimental group rather than being evenly distributed across conditions.

This result should be interpreted as evidence for the instructional condition tested in this sample, not as proof that any digital game will automatically improve literacy. International evidence repeatedly shows that the effectiveness of educational technology depends on the pedagogical alignment between interface features and learning goals. Cheung and Slavin (2012) found only a modest average effect of educational technology on reading, while Callaghan and Reich (2018) showed that many preschool apps marketed as educational do not consistently incorporate effective learning principles. The positive result in the present study is therefore most plausibly explained by the direct correspondence between GCompris activities and the four assessed skills rather than by digital exposure per se.

Interpretation of the Plugged GCompris Effect

Several mechanisms can explain why the experimental group improved more strongly. First, the application enabled repeated practice with immediately visible or audible consequences. Repetition is especially important for alphabet knowledge and letter–sound mappings because these associations must become increasingly stable and accessible. Piasta and Wagner (2010) show that explicit alphabet instruction produces measurable gains, while Ehri et al. (2001) demonstrate that phonemic-awareness instruction is more effective when sound work is connected to letters. In the present study, GCompris provided a digital environment in which children could repeatedly attend to these symbol–sound relationships, potentially increasing the amount of focused practice available within the instructional period.

Second, the multimodal format may have supported picture–letter matching and visual discrimination by coordinating visual and auditory information. Research on electronic storybooks shows that multimedia can improve learning when nonverbal information is congruent with the language or symbol being learned (Bus et al., 2015; Takacs et al., 2015). Takacs et al. (2014) further found that optimally designed multimedia stories can support story comprehension and vocabulary learning at levels comparable with adult-supported print experiences. The same principle is relevant to letter learning: when a displayed letter, its sound, and a corresponding image point to the same target, multiple information channels can reinforce

rather than compete with one another. The benefit depends on congruence; unrelated animation or game elements could instead draw attention away from the literacy target.

Third, the game-like structure likely increased children's willingness to remain engaged in repetitive literacy tasks. Young learners may find repeated letter practice monotonous when it is presented only through worksheets or teacher questioning. Game-based interfaces can transform repetition into a sequence of short challenges and responses. Alotaibi's (2024) systematic review and meta-analysis found broad positive effects of game-based learning on early-childhood outcomes, including motivation and engagement. Flewitt et al. (2015) similarly observed that well-planned iPad-based literacy activities could stimulate young children's motivation and concentration. Engagement is not an outcome equivalent to literacy achievement, but it can increase the time and attention children devote to literacy practice, thereby creating more opportunities for learning.

Fourth, the findings fit the science-of-learning framework for educational apps. Hirsh-Pasek et al. (2015) emphasize active engagement, meaningful content, and learning goals that are integrated into the interaction itself. Plugged GCompris requires children to respond rather than merely watch, and the target activities used in this study were tied to recognizable early-literacy objectives. This distinction between active interaction and passive exposure is important. Jing et al. (2023) show that screen-media effects on young children's vocabulary cannot be reduced to a simple amount-of-screen-time explanation; characteristics of the media experience and learning context matter. Likewise, Griffith et al. (2020) conclude that interactive apps can support early academic learning, but the evidence base is heterogeneous and should not be generalized indiscriminately.

The result also converges with evidence from tablet-based emergent-literacy research. Neumann and Neumann (2014, 2017) argue that touch-screen applications can support alphabet knowledge and emergent writing when app quality and scaffolding are appropriate. Neumann (2018) provided stronger causal evidence by showing that a literacy-app intervention improved several emergent-literacy skills in preschool children. The current study contributes a parallel finding using a plugged computer application rather than a tablet ecosystem. This is practically relevant for schools that have access to desktop or laptop computers but limited access to individual tablets. It suggests that the pedagogical affordances of digital literacy do not depend exclusively on mobile touch-screen technology.

The present findings are also consistent with Indonesian evidence on digital and innovative early-childhood learning. Mulyati and Maesyaroh (2022) describe the use of game-based and audiovisual digital media for early literacy; Aisyah et al. (2023) demonstrate that digital learning modules can support specific learning outcomes; Kurnia et al. (2024) report improved listening focus and comprehension through cloud-based literacy media; and Ningrum et al. (2024) show positive language outcomes from digital storybook use. At the same time, Asbar et al. (2024) show that project-based learning can also improve literacy. The comparison is important because it indicates that technology is one pathway among several forms of active learning. The instructional principle is to create rich, purposeful opportunities for children to manipulate symbols, connect meaning, communicate, and receive feedback.

Avenido et al. (2025) provide a useful counterpoint. In their quasi-experimental study of alphabet learning, technology-based games were effective but did not significantly outperform structured traditional teaching. This reminds educators that digital tools should be integrated because they add a useful instructional affordance, not because they are assumed to be inherently superior. A similar caution appears in early electronic-book research: de Jong and Bus (2002, 2003, 2004) found that the educational value of electronic materials depends strongly on how interaction is structured. When game elements distract from text, learning may be weaker; when interaction supports the target, digital presentation can be beneficial. The

current finding should therefore support blended literacy pedagogy in which teachers select GCompris activities strategically and continue to provide oral-language interaction, shared reading, writing, and concrete play.

The four literacy dimensions in this study also have distinct instructional implications. Alphabet recognition requires stable visual identification of letters across repeated encounters. Letter–sound association adds a phonological mapping requirement and should therefore be practiced with clear pronunciation and opportunities for children to produce sounds, not only select answers. Picture–letter matching can help connect abstract symbols to semantic cues, but images should be culturally and linguistically familiar. Visual discrimination requires careful attention to form, especially for letters that share similar features. Digital tasks can efficiently present multiple trials across these dimensions, but teachers remain essential for diagnosing errors, explaining confusions, and transferring app-based performance into broader literacy contexts.

From a practical perspective, the findings support using Plugged GCompris as a supplementary literacy station or small-group activity. Teachers can select activities that directly correspond to the target of the day, observe children’s response patterns, and follow digital practice with off-screen reinforcement such as letter cards, shared books, sound games, or emergent writing. This approach reflects the broader evidence that app effectiveness increases when technology is embedded within coherent instruction rather than used as an isolated reward or free-play activity (Kim et al., 2021; Liu et al., 2024). Adult mediation is particularly important for ensuring that children verbalize letter sounds, explain choices, and connect screen-based tasks with print and oral language.

The study has several limitations that define the scope of its conclusions. The sample included only 20 children from one kindergarten, limiting statistical power and generalizability. The quasi-experimental design did not use individual random assignment, so pre-existing group characteristics cannot be ruled out as alternative influences. The study assessed four constrained early-literacy outcomes but did not measure broader outcomes such as vocabulary, narrative comprehension, emergent writing quality, or later word reading. No delayed posttest was used, so the durability of learning gains is unknown. In addition, the study did not report detailed process measures of time on task, error patterns, teacher scaffolding, or children’s engagement, making it difficult to identify which specific GCompris features contributed most strongly to the observed effect. Future studies should use larger multi-site samples, more detailed intervention documentation, delayed retention measures, and comparisons among specific types of digital literacy activities.

CONCLUSION

This study shows that Plugged GCompris-based digital learning can strengthen foundational early-literacy skills among children aged five to six years when the digital activities are aligned with explicit literacy targets. The experimental group achieved a mean N-Gain of 0.77 compared with 0.14 in the control group and obtained a substantially higher Mann–Whitney mean rank, with the original analysis indicating a statistically significant between-group difference. Improvement was observed in alphabet recognition, letter–sound association, picture–letter matching, and visual discrimination of letters. These outcomes are consistent with international research showing that interactive educational apps and well-designed multimedia can support constrained early academic and literacy skills, while also reinforcing the principle that learning depends on pedagogical quality rather than technology alone. Plugged GCompris should therefore be positioned as a complementary instructional medium within teacher-guided, play-based, and print-rich kindergarten literacy practice. Because the evidence comes from a small single-site quasi-experiment and does not include delayed retention outcomes, the

findings should be generalized cautiously. Future research should involve larger and more diverse samples, specify intervention dosage and teacher scaffolding in greater detail, examine long-term retention and transfer to reading and writing, and compare GCompris with other evidence-based digital and non-digital literacy approaches.

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