



The Effect of Marble-Based Educational Games on Early Literacy Skills in 5–6-Year-Old Children

Arifah An Nur¹, Azizah Amal^{2*}, Sri Rika Amriani³

^{1,2,3} Universitas Negeri Makassar

Received: May 20th, 2026; Revised: June 29th, 2026; Accepted: July 1st, 2026; Published: July 13th, 2026

Abstract

This study examined the use of Marble-based educational games in supporting the early literacy skills of children aged 5–6 years at TK Negeri Kelurahan Rangas. A quantitative quasi-experimental method with a non-equivalent control group design was used. The sample consisted of 40 children, with 20 children in the experimental group and 20 in the control group. The experimental group received Marble-based educational game treatment for six meetings, while the control group participated in regular literacy learning. Data were collected through tests, observation, and documentation, and analyzed using descriptive statistics, the Mann-Whitney U test, and normalized gain (N-Gain). The results showed that the experimental group's mean score increased from 14.67 to 24.73, while the control group's increased from 13.87 to 19.13. The Mann-Whitney U test on post-test scores showed a significant difference between the two groups ($p = 0.029$). The N-Gain analysis also showed a higher improvement in the experimental group ($M = 0.6805$) than in the control group ($M = 0.5465$), with a significant difference between groups ($U = 126.500$, $Z = -2.011$, $p = 0.044$). Within the scope of this quasi-experimental, non-randomized design, Marble-based educational games were associated with greater improvements in early literacy skills. Therefore, Marble can be considered a potential alternative medium for early literacy learning when used with appropriate teacher guidance.

Keywords: early childhood, literacy, marble, educational games, digital media

Abstrak

Penelitian ini mengkaji penggunaan permainan edukatif berbasis Marbel dalam mendukung kemampuan literasi awal anak usia 5–6 tahun di TK Negeri Kelurahan Rangas. Penelitian ini menggunakan metode kuasi-eksperimen kuantitatif dengan desain non-equivalent control group. Sampel terdiri atas 40 anak, yaitu 20 anak pada kelompok eksperimen dan 20 anak pada kelompok kontrol. Kelompok eksperimen memperoleh perlakuan menggunakan permainan edukatif berbasis Marbel selama enam pertemuan, sedangkan kelompok kontrol mengikuti pembelajaran literasi reguler. Data dikumpulkan melalui tes, observasi, dan dokumentasi, kemudian dianalisis menggunakan statistik deskriptif, uji Mann-Whitney U, dan normalized gain (N-Gain). Hasil penelitian menunjukkan bahwa nilai rata-rata kelompok eksperimen meningkat dari 14,67 menjadi 24,73, sedangkan kelompok kontrol meningkat dari 13,87 menjadi 19,13. Uji U Mann-Whitney pada skor posttest menunjukkan perbedaan yang signifikan antara kedua kelompok ($p = 0,029$). Analisis N-Gain juga menunjukkan peningkatan yang lebih tinggi pada kelompok eksperimen ($M = 0,6805$) dibandingkan dengan kelompok kontrol ($M = 0,5465$), dengan perbedaan signifikan antarkelompok ($U = 126,500$, $Z = -2,011$, $p = 0,044$). Dalam ruang lingkup desain kuasi-eksperimen dan pembagian kelompok yang tidak dilakukan secara acak, permainan edukatif berbasis Marbel berkaitan dengan peningkatan kemampuan literasi awal yang lebih besar. Oleh karena itu, Marbel dapat dipertimbangkan sebagai media alternatif yang potensial untuk pembelajaran literasi awal apabila digunakan dengan bimbingan guru yang tepat.

Kata kunci: anak usia dini, literasi, Marbel, permainan edukatif, media digital.

Copyright (c) 2026 Arifa An Nur, Azizah Amal, Sri Rika Amriani

* Correspondence Address:

Email Address: azizah.amal@unm.ac.id

A. Introduction

Early childhood is a crucial period in human development because many basic abilities develop rapidly during this stage, providing the foundation for subsequent development. Appropriate stimulation is therefore needed to support children's language, cognitive, social, emotional, and physical development (Kasriyati et al., 2021). One ability that requires early stimulation is literacy. Early childhood literacy is not limited to formal reading and writing skills, but also includes recognizing letter symbols, understanding language sounds, developing vocabulary, listening, speaking, and understanding simple word meanings (Clay, 2001; Morrison, 2012; Snow et al., 1998; Teale & Sulzby, 1986). Whitehurst and Lonigan (1998) describe emergent literacy as a set of skills, knowledge, and attitudes that develop before conventional reading and writing and serve as a foundation for later literacy development. Children who receive limited literacy stimulation may experience difficulties in understanding instructions, communicating, and adapting to increasingly complex learning activities (Annas et al., 2024). Therefore, early literacy contributes to children's readiness to enter the next level of education because it is closely related to language, cognitive, social, and emotional development.

Early childhood literacy development needs to be implemented through approaches that correspond to children's developmental characteristics. Children aged 5–6 years learn most effectively through concrete experiences, social interaction, exploration, repetition, and play. From a cognitive-development perspective, children construct knowledge through direct experiences with their environment (Piaget, 1952). From a sociocultural perspective, children's language abilities develop through interaction and guidance from adults and peers (Insani, 2025; Vygotsky, 1978). Literacy learning in early childhood education should therefore not focus solely on memorizing letters or completing worksheets. It should involve engaging, interactive, and meaningful activities that allow children to recognize symbols, listen to language sounds, construct words, and understand meanings through guided play.

The development of digital technology presents both opportunities and challenges for early childhood literacy learning. Children are increasingly familiar with visual media, audio, animation, and digital devices. Interactive digital media can combine pictures, sounds, movement, and direct responses, thereby providing children with more varied learning experiences. Fitriani et al. (2022) explain that Android-based interactive media can create more active, less monotonous learning experiences by integrating visual, auditory, and interactive elements. Rasmani et al. (2023) similarly, it indicates that interactive multimedia can increase young children's attention, enthusiasm, and involvement during learning. Putri et al. (2024) further show that innovative digital platforms can be used to stimulate digital literacy among young children when the content is adjusted to their developmental characteristics.

However, literacy learning in early childhood institutions is still often dominated by conventional media such as whiteboards, picture books, flashcards, and worksheets. These media remain useful in supporting literacy instruction, but repetitive use without sufficient variation may cause children to become bored, lose concentration, and participate less actively. Mardhotillah (2022) indicates that interactive game-based media can provide more engaging reading experiences than learning activities that rely heavily on conventional tasks. This condition highlights the need for varied, interactive, and visually appealing learning media that correspond to the characteristics of children growing up in a digital environment.

Similar issues were found in literacy learning among children aged 5–6 years at TK Negeri Kelurahan Rangas. Based on initial observations and interviews with teachers, several children still experienced difficulties in basic literacy activities. These difficulties

were reflected in their inconsistent ability to recognize vowels and consonants, limited ability to combine letters or syllables into simple words, and difficulty understanding the meanings of simple words presented during learning activities. Some children also showed confusion when distinguishing letters with similar shapes or sounds.

Teachers reported that literacy learning was still largely supported by conventional media, including worksheets, flashcards, picture books, and the whiteboard. Although these media supported basic literacy instruction, their repetitive use made some children easily bored, less focused, and less motivated to participate. This situation indicates the need for media that provide more opportunities for active participation, sensory involvement, repetition, and immediate feedback during literacy activities (Fitriani et al., 2022; Rasmani et al., 2023).

One medium that can be used to stimulate early childhood literacy is Marble-based educational games. Marble, an abbreviation of the Indonesian phrase *Mari Belajar Sambil Bermain*, is a digital educational application that combines visual elements, audio, animation, and interactive games. Its literacy features include recognizing letters, distinguishing vowels and consonants, practising syllables, constructing simple words, matching words with pictures, and receiving immediate feedback. Through these features, children can gradually interact with letter symbols, language sounds, written words, pictures, and meanings.

Akmaluddin (2024) explains that Marble can help children recognize letters, distinguish vowels and consonants, spell syllables, and read simple words through visual, auditory, and interactive activities. Destiyanti et al. (2025) describe Marble as an educational game developed according to the principle of learning through play. Its design allows children to participate actively rather than merely receive information from the teacher. Janah and Ariyani (2022) also show that Android-based Marble games can function as practical learning media for young children and can be used both at school and at home. Karaman et al. (2018) further report that the mobile version of *Marbel Huruf* can facilitate access to reading materials and support children's involvement in reading activities. Fitri and Wirabrata (2023) also found that Marble-based learning media can support children's analytical and cognitive development through structured digital learning activities.

Several previous studies have shown that the Marble application can support the development of beginning reading skills, letter recognition, motivation to learn, and children's engagement. Yolanda and Damri (2022) found that the application supported the beginning reading abilities of children aged 5–6 years. Mardhiah (2023) similarly, researchers reported that Marble could support letter recognition, syllable learning, and beginning reading through interactive activities. Resiana and Asvia (2024) found that the *Marbel Huruf* application positively affected both learning motivation and letter recognition ability. Firdyanisa et al. (2024) also reported that the application supported the development of reading skills in early childhood. These findings indicate that Marble has potential as a complementary medium for early literacy learning.

Despite these findings, previous studies have tended to focus on specific outcomes, particularly beginning reading, letter recognition, or learning motivation. Research examining Marble-based educational games through a broader set of interconnected literacy indicators remains limited. Early literacy involves both code-related skills, such as letter recognition and word decoding, and meaning-related skills, such as vocabulary and language comprehension (Whitehurst & Lonigan, 1998). Therefore, examining letter recognition, word reading, and word-meaning comprehension together can provide a more comprehensive account of children's literacy development.

The novelty of this study lies in its focus on Marble-based educational games as a literacy learning medium for children aged 5–6 years through three interconnected indicators: naming vowels and consonants, reading words, and understanding word meanings. Naming vowels and consonants represents letter knowledge, reading words reflects beginning decoding, and understanding word meanings reflects an initial level of language comprehension. Unlike previous studies that primarily emphasized early reading, letter recognition, or learning motivation, this study examines literacy as a gradual process connecting letter symbols, language sounds, written words, pictures, and meanings.

The study was conducted at TK Negeri Kelurahan Rangas, where the use of marble-based educational games for literacy learning had not been systematically examined. The initial conditions at the school also indicated a need for more interactive literacy media that correspond to the developmental characteristics of young children. Based on this rationale, this study aimed to analyze the effect of Marble-based educational games on the literacy skills of children aged 5–6 years, particularly their ability to name vowels and consonants, read words, and understand word meanings.

B. Literature Review

1. Early Childhood Literacy

Early childhood literacy refers to children's developing ability to understand and use spoken and written language through listening, speaking, recognizing letters and speech sounds, beginning reading, and early writing activities. Literacy at this stage is not limited to the formal ability to read and write. It also includes children's ability to recognize relationships among printed symbols, sounds, words, pictures, and meanings (Morrison, 2012; Tompkins, 2014; Santrock, 2018).

Teale and Sulzby (1986) explain through the concept of *emergent literacy* that literacy begins to develop during the preschool years, before children receive formal instruction in reading and writing. This development occurs gradually through children's interactions with oral language, printed materials, stories, symbols, pictures, adults, and peers. In line with this view, Whitehurst and Lonigan (1998) define emergent literacy as a set of skills, knowledge, and attitudes that serve as developmental foundations for conventional reading and writing.

Early literacy comprises several interrelated components. Snow et al. (1998) identify phonological awareness, letter knowledge, vocabulary, oral language, print awareness, and narrative skills as abilities that support later reading development. Clay (2001) similarly, it emphasizes letter and symbol recognition, phonological awareness, vocabulary, listening skills, beginning reading, and language comprehension. These components show that literacy development involves both code-related skills, such as recognizing letters and connecting written symbols with sounds, and meaning-related skills, such as understanding vocabulary and information conveyed through language.

For children aged 5–6 years, early literacy contributes to readiness for formal learning because it provides a foundation for reading, writing, communication, and language comprehension at subsequent educational levels (Snow et al., 1998; Clay, 2001; Santrock, 2018). In the present study, literacy skills were measured through three indicators: naming vowels and consonants, reading words, and understanding word meanings. Naming vowels and consonants represents children's letter knowledge and recognition of printed symbols. Reading words reflects beginning decoding skills, whereas understanding word meanings reflects vocabulary knowledge and language comprehension. Therefore, the three indicators represent a progression from letter recognition to word reading and meaning construction.

2. Marble-Based Educational Games

Marble-based educational games are digital learning media designed to facilitate children's learning through play. The name *Marble* is derived from the Indonesian phrase *Mari Belajar Sambil Bermain*, meaning "Let's Learn While Playing." The application integrates educational content with interactive game elements, allowing children to participate actively in learning activities. In literacy learning, Marble provides activities such as recognizing letters, distinguishing vowels from consonants, combining letters into syllables, arranging syllables into simple words, reading words, and matching written words with corresponding pictures (Akmaluddin et al., 2024; Firdyanisa et al., 2024).

Marble's These activities support the gradual development of early literacy skills. Letter recognition and vowel–consonant classification activities help children identify and differentiate among printed symbols. Syllable and word-construction activities support beginning decoding, whereas word-picture matching helps children connect written forms to their meanings. Through these features, children engage with literacy content through visual, auditory, and interactive experiences rather than relying solely on printed worksheets or verbal instruction.

The main characteristics of Marble include colorful illustrations, animation, audio support, interactive games, and immediate feedback. Akmaluddin et al. (2024) explain that Marble assists children in recognizing letters, spelling syllables, and reading simple words through the integration of visual, auditory, and interactive elements. Yolanda and Damri (2022) further indicates that direct feedback provided through sounds, animations, or responses can help children recognize errors and reinforce their understanding during learning activities.

Destiyanti et al. (2025) describe Marble as an educational application developed according to the principle of learning through play. Its interactive and child-friendly design can encourage children's interest, motivation, participation, and engagement in early literacy activities. Firdyanisa et al. (2024) similarly, reports that the combination of visual, auditory, and interactive features makes Marble suitable for supporting letter recognition and beginning reading among young children.

Despite these benefits, Marble should not be treated as a replacement for teacher-led instruction or social interaction. Excessive or unsupervised use may cause children to focus more on animation, rewards, or entertainment features than on the intended literacy content. Digital activities may also reduce opportunities for direct communication and interaction when they are conducted individually for prolonged periods. Therefore, the use of Marble should be accompanied by teacher or parental guidance, clear learning objectives, appropriate time limits, and follow-up activities involving conversation, reading, or collaborative play (Mutiah, 2024). Under these conditions, Marble can function as a complementary medium for developing early childhood literacy.

3. Marble Games and Literacy Skills in Children Aged 5-6

Marble-based educational games are relevant to the literacy development of children aged 5–6 years because they present learning activities in a visual, auditory, interactive, and play-based format. Through the application, children can recognize letters, listen to letter sounds, distinguish vowels from consonants, combine letters into syllables, arrange syllables into simple words, read words, and match written words with corresponding pictures. These activities support the gradual development of literacy skills from recognizing printed symbols and decoding words to understanding their meanings.

The interactive features of Marble can also encourage children to participate more actively in literacy activities. Colorful images, sounds, animations, games, and immediate feedback can attract children's attention and help them identify whether their responses are correct or incorrect. When accompanied by appropriate guidance, these features may

strengthen children's motivation and engagement, and provide opportunities to practise early reading skills repeatedly. The source document similarly describes Marble as an interactive medium that provides direct feedback through sounds, animations, or scores and presents literacy learning through enjoyable play activities.

Previous studies have reported positive findings regarding the use of Marble in early literacy learning. Yolanda and Damri (2022) found that the Marble application improved beginning reading skills among children aged 5–6 years. Mardhiah (2023) also reported that its interactive features supported letter recognition, syllable learning, and beginning reading. Firdyanisa et al. (2024) indicated that the application supported the development of children's reading skills by integrating visual, auditory, and interactive elements. Meanwhile, Resiana and Asvia (2024) found that the *Marbel Huruf* application positively affected children's motivation to learn and letter recognition ability.

These findings suggest that Marble has potential as a complementary medium for developing early literacy. However, the cited studies do not all measure the same literacy components. Yolanda and Damri (2022) primarily examined beginning reading, whereas Resiana and Asvia (2024) focused on motivation and letter recognition. Therefore, evidence from these studies directly supports letter recognition and beginning word reading more strongly than understanding word meanings. In the present study, Marble is examined more broadly through three indicators: naming vowels and consonants, reading words, and understanding word meanings. The third indicator extends the focus of previous research by assessing whether children can connect the words they read with appropriate pictures or concepts.

C. Method

This study employed a quantitative approach with a quasi-experimental design. The design used was a non-equivalent control group design, which involved an experimental group and a control group without random assignment of individual children (Creswell & Creswell, 2018). The experimental group received treatment in the form of Marble-based educational games, while the control group participated in literacy learning using media commonly used by the teacher, particularly flashcards. Both groups were given pre-tests and post-tests to determine changes in children's literacy skills before and after the treatment.

The study was conducted at TK Negeri Kelurahan Rangas, Majene Regency. The population consisted of 53 children in Group B aged 5–6 years. From this population, 40 children were selected as the research sample using purposive sampling based on the criteria that they were aged 5–6 years, actively participated in learning activities, and needed literacy stimulation, as assessed by teachers and confirmed through initial classroom observations. The remaining 13 children were not included in the sample because they did not meet all of these criteria, particularly consistent participation during the research schedule and the need for literacy stimulation relevant to the study focus. The sample consisted of 20 children in the experimental group and 20 children in the control group.

The grouping of children was not conducted through random assignment. The experimental and control groups were determined based on the existing class arrangement and the learning conditions permitted by the school. One class was assigned to the experimental group and received a Marble-based educational game treatment, while the other class was assigned to the control group and received literacy instruction using flashcards and other conventional media commonly used by the teacher. Therefore, this study used a non-equivalent control group design because the groups were not randomly

formed. To examine the initial equivalence of the two groups, pre-test scores were compared before the treatment was implemented.

The treatment was conducted in six meetings after the pre-test and before the post-test. Each meeting lasted approximately 30–45 minutes. During the treatment, children in the experimental group were divided into three small groups to make the activity more manageable and to allow closer guidance. The teacher/researcher acted as a facilitator who prepared the device, opened the Marble application, selected the relevant literacy feature, explained the instructions, guided the children during the activity, and provided reinforcement after the game. The observers assisted in monitoring children's participation and recording their literacy performance based on the research indicators.

The first meeting focused on recognizing and naming the letters of the alphabet, both vowels and consonants. Children used the letter-recognition feature in the Marble application to identify vowels and consonants displayed on the screen. They were asked to name the letters shown and, with teacher guidance, distinguish between vowels and consonants. The second meeting strengthened children's ability to consistently name vowel and consonant letters. Children again interacted with the letter feature in Marble and were asked to mention the displayed letters aloud. The researcher provided guidance when children had difficulty identifying or pronouncing the letters.

The third meeting focused on reading words through syllable practice. Children used the syllable and word-construction features in Marble to arrange two to three syllables into simple words. After forming the words, they were asked to read them aloud. The fourth meeting was a reinforcement activity for letter recognition. Children repeated activities involving vowel and consonant identification through the Marble application to strengthen their consistency in recognizing, naming, and differentiating vowel and consonant letters.

The fifth meeting focused again on word reading. Children practiced arranging syllables into simple words and reading the words shown in the Marble application. The teacher/researcher guided children who still needed assistance in combining syllables and pronouncing the words. The sixth meeting focused on understanding word meanings. Children used the picture-word matching feature in Marble to connect written words with appropriate pictures. After matching the words and pictures, they were asked to explain the meanings of the words in simple language.

In the control group, children participated in regular literacy learning activities conducted by the classroom teacher. The activities included recognizing letters, reading simple words, and matching words with pictures using conventional media, particularly flashcards, worksheets, picture books, and the whiteboard. The researcher did not provide Marble-based treatment to the control group and only observed the learning process. This procedure was applied to ensure that the difference between the two groups lay in the use of Marble-based educational games in the experimental group and conventional literacy media in the control group.

The instrument used in this study was a literacy test for children aged 5–6 years. The test was administered through pre- and post-test activities using children's worksheets, with direct observation during the assessment. The instrument was developed based on three literacy indicators: naming vowels and consonants, reading words, and understanding word meanings.

The instrument consisted of seven items. The first indicator, naming vowels and consonants, consisted of three items: naming the vowel letters shown, naming ten randomly selected consonant letters, and distinguishing vowels from consonants when presented alternately. The second indicator, reading words, consisted of two items: arranging two to three syllables into simple words and reading the words shown. The third

indicator, understanding word meanings, consisted of two items: matching written words with appropriate pictures and explaining the meanings of the words read.

Each item was scored using a four-point scale: 1 = poor, 2 = fair, 3 = good, and 4 = very good. Therefore, the total score ranged from 7 to 28, with higher scores indicating better literacy skills. The scoring rubric specified the criteria for each score. For example, in the vowel-recognition item, a score of 1 was given when a child could not name the vowel letters correctly or could name only one vowel, while a score of 4 was given when the child could name all vowel letters correctly. In the word-reading item, a score of 1 was given when a child could not arrange syllables correctly, while a score of 4 was given when the child could arrange two to three syllables into simple words correctly and fluently. In the word-meaning item, a score of 1 was given when a child could not match words to appropriate pictures, while a score of 4 was given when the child matched all words to appropriate pictures without errors.

The instrument was validated by two experts, namely Fadhillah Afifah, S.Pd., M.Pd. and Faradillah Ruslana, S.Psi., M.Pd. The validation process assessed the clarity of instructions, language accuracy, suitability for children aged 5–6 years, and alignment with constructs. The validation was conducted in seven rounds, including revisions to the indicators, several items, the scoring rubric, the assessment table, and the research scenario. Following the final validation, the instrument was deemed suitable for use in the study.

The instrument was also tried out with 25 children outside the research sample. The validity test was conducted using Pearson Product-Moment correlation with SPSS version 25. The results showed that the correlation coefficients for the seven items ranged from 0.521 to 0.751, exceeding the *r*-table value of 0.396 at the 5% significance level. Therefore, all items were declared valid. The reliability test using Cronbach's Alpha produced a coefficient of 0.745, indicating that the instrument was reliable and appropriate for use in this study.

Data were analyzed using descriptive and inferential statistics. Descriptive statistics were used to characterize children's literacy skills using the minimum and maximum scores, mean, standard deviation, and the distribution of literacy ability categories. Before hypothesis testing, normality was tested using the Shapiro-Wilk test, and homogeneity was tested using Levene's test. Because the post-test data did not meet the assumptions of normality and homogeneity, hypothesis testing was conducted using the nonparametric Mann-Whitney U test at the 0.05 significance level. In addition, normalized gain (N-Gain) analysis was conducted to compare improvements in literacy skills between the experimental and control groups while accounting for differences in their initial abilities. The N-Gain score was calculated as $(\text{post-test score} - \text{pre-test score}) / (\text{maximum score} - \text{pre-test score})$. Since the maximum score of the literacy test was 28, this value was used in the N-Gain calculation. Because the N-Gain scores were not normally distributed, the Mann-Whitney U test was also used to compare N-Gain scores between the two groups.

D. Result

This study examined the use of Marble-based educational games in supporting the early literacy skills of 5–6-year-old children at TK Negeri Kelurahan Rangas. Data were obtained from the pre-test and post-test results of the experimental and control groups. The experimental group received treatment using Marble-based educational games, while the control group participated in regular literacy learning using conventional media commonly used by the teacher. Children's literacy skills were measured using three indicators: the ability to name vowels and consonants, read words, and understand word meanings.

1. Children's Literacy Skills Before Treatment

Pre-test results showed that the initial literacy skills of children in the experimental and control groups were still in the poor to good category. In the experimental group, 5 children (25%) were in the poor category, 6 (30%) in the adequate category, and 9 (45%) in the good category. Meanwhile, in the control group, 14 children (70%) were in the poor category, 3 (15%) in the adequate category, and 3 (15%) in the good category. No children were in the excellent category in either group.

Table 1. Distribution of children's literacy skills before treatment

Interval	Category	Experiment	Experiment %	Control	Control %
7-11	Poor	5	25%	14	70%
12-16	Adequate	6	30%	3	15%
17-22	Good	9	45%	3	15%
23-28	Very Good	0	0%	0	0%
Amount		20	100%	20	100%

Based on these data, the literacy skills of children in both groups had not yet reached the very good category before the treatment. However, the pre-test distribution also indicates that the two groups were not fully equivalent at baseline. The experimental group had a higher proportion of children in the good category, whereas the control group had a higher proportion of children in the poor category. This difference suggests that the experimental group had a slightly better initial literacy profile than the control group. This condition is consistent with the non-equivalent control group design, in which the groups were not formed through random assignment. Therefore, the interpretation of the treatment effect should consider this baseline difference. The post-test results need to be interpreted not only as the effect of the Marble-based educational game treatment but also in light of the children's initial literacy conditions before the intervention.

2. Children's Literacy Skills After Treatment

After treatment, post-test results showed an increase in literacy skills in both groups. In the experimental group, there were no children in the poor category; 2 (10%) were in the adequate category, 7 (35%) in the good category, and 11 (55%) in the excellent category. In the control group, there were no children in the poor or adequate category; 16 children (80%) were in the good category, and 4 children (20%) were in the excellent category.

Table 2. Distribution of children's literacy skills after treatment

Interval	Category	Experiment	Experiment %	Control	Control %
7-11	Poor	0	0%	0	0%
12-16	Adequate	2	10%	0	0%
17-22	Good	7	35%	16	80%
23-28	Very Good	11	55%	4	20%
Amount		20	100%	20	100%

These results indicate that both groups showed improvement after the learning activities. However, the experimental group showed a higher proportion of children in the very good category than the control group. This finding suggests that children who received Marble-based educational game treatment achieved higher post-test literacy performance than those who received conventional literacy learning. Nevertheless, this result should be interpreted in light of the baseline difference observed in the pre-test distribution.

3. Comparison of Post-test Average Scores

A comparison of mean scores shows that both groups experienced improvements in literacy skills. In the control group, the mean score increased from 13.87 in the pre-test to 19.13 in the post-test, a 5.26-point increase. Meanwhile, in the experimental group, the mean score increased from 14.67 in the pre-test to 24.73 in the post-test, a 10.06-point increase.

Table 3. Descriptive statistics of children's literacy skills

Group	N	Test	Minimum	Maximum	Mean
Control	20	Pre-test	7	22	13.87
Control	20	Post-test	17	28	19.13
Experimental	20	Pre-test	7	22	14.67
Experimental	20	Post-test	18	28	24.73

The data show that the average increase in literacy skills in the experimental group was higher than in the control group. This finding suggests that children who received Marble-based educational game treatment showed greater literacy improvement than those who participated in regular classroom learning. However, this interpretation should account for the baseline difference between the two groups, as the experimental and control groups were not randomly assigned.

4. Prerequisite Analysis Test

Prior to hypothesis testing, the data were analyzed using normality and homogeneity tests. The post-test results showed that the experimental and control group data were not normally distributed, as their respective significance values were less than 0.05.

Table 4. Results of the normality test

Group	Shapiro-Wilk Sig.	Information
Experimental	0.002	Abnormal
Control	0.003	Abnormal

The homogeneity test results indicate that the post-test data exhibit non-homogeneous variance, as the significance value of 0.022 is less than 0.05. Therefore, the hypothesis testing was conducted using the nonparametric Mann-Whitney test.

Table 5. Homogeneity Test Results

Data	Levene Statistic	Sig.	Information
Post-test	5.682	0.022	Not Homogeneous

5. Hypothesis Testing Based on Post-test Scores

Hypothesis testing was conducted using the Mann-Whitney test on the post-test scores of the experimental and control groups. The analysis showed that the experimental group had a mean rank of 24.48, while the control group had a mean rank of 16.53. The higher mean rank in the experimental group indicates that the literacy skills of children in the experimental group were better than those in the control group.

Table 6. Mann-Whitney test results

Group	N	Mean Rank	Sum of Ranks
Experimental	20	24.48	489.50
Control	20	16.53	330.50

Table 7. Mann–Whitney U test statistics

Test Statistics	Score
Mann-Whitney U	120.500
Wilcoxon W	330.500
Z	-2.187

Based on the results of the Mann-Whitney U test, the Asymp. Sig. (2-tailed) the value was 0.029. This value was lower than 0.05, so H_0 was rejected, and H_1 was accepted. Thus, there was a statistically significant difference in post-test literacy scores between children in the experimental group and those in the control group. These results indicate that children who learned through Marble-based educational games achieved significantly higher post-test literacy scores than children who participated in regular literacy learning.

6. Analysis Using N-Gain Scores

To strengthen the interpretation of the treatment effect, normalized gain (N-Gain) analysis was also conducted. This analysis was added because the pre-test distribution showed that the initial literacy abilities of the experimental and control groups were not fully equivalent.

Table 8. Descriptive statistics N-Gain

Group	Mean N-Gain	SD
Experimental	0.6805	0.38653
Control	0.5465	0.21361

The descriptive analysis showed that the experimental group obtained a higher mean N-Gain score ($M = 0.6805$, $SD = 0.3865$) than the control group ($M = 0.5465$, $SD = 0.2136$). This indicates that, descriptively, the increase in literacy skills was higher in the group that received Marble-based educational game treatment than in the group that participated in regular literacy learning.

Table 9. Results of the normality test N-Gain

Group	Shapiro-Wilk Sig.	Information
Experimental	<0.001	Abnormal
Control	<0.001	Abnormal

Before comparing the N-Gain scores between the two groups, a normality test was conducted using the Shapiro-Wilk test because each group consisted of 20 children. The results showed that the N-Gain scores were not normally distributed in both the experimental ($p < 0.001$) and control ($p < 0.001$) groups. Therefore, the difference in N-Gain scores between the experimental and control groups was analyzed using the nonparametric Mann-Whitney U test.

Table 10. Mann-Whitney test results

Group	N	Mean Rank	Sum of Ranks
Experimental	20	24.18	483.50
Control	20	16.83	336.50

Table 11. Mann–Whitney U test statistics

Test Statistics	Score
Mann-Whitney U	126.500
Wilcoxon W	336.500
Z	-2.011
Asymp. Sig.	0.044

The Mann-Whitney U test on the N-Gain scores showed that the experimental group had a higher mean rank (24.18) than the control group (16.83). The test produced a Mann-Whitney U value of 126.500, a Z value of -2.011, and an Asymp. Sig. (2-tailed) value of 0.044. Since the p-value was less than 0.05, there was a statistically significant difference in N-Gain scores between the experimental and control groups. This result strengthens the post-test comparison and indicates that Marble-based educational games were associated with greater improvements in children's literacy skills after accounting for their initial abilities.

E. Discussion

The results showed that Marble-based educational games were associated with greater improvements in the literacy skills of children aged 5–6 years in this quasi-experimental study. The experimental group showed a larger increase in mean scores than the control group, and the Mann-Whitney U test of post-test scores indicated a significant difference between the two groups after the intervention. Although the experimental group's pre-test mean was slightly higher than the control group's, the initial difference was not statistically significant. An additional analysis using normalized gain was therefore conducted to provide a clearer comparison of improvement relative to the children's initial scores. The experimental group obtained a higher mean N-Gain score ($M = 0.6805$) than the control group ($M = 0.5465$), and the Mann-Whitney U test on the N-Gain scores also showed a significant difference between the groups ($U = 126.500$, $Z = -2.011$, $p = 0.044$). These results indicate that the experimental group achieved greater literacy improvement, even after accounting for initial scores.

Nevertheless, the findings should be interpreted within the limitations of a quasi-experimental design without random assignment. The improvement cannot be attributed exclusively to the Marble application, as teacher guidance, repeated practice over six sessions, children's participation, and classroom conditions may also have contributed to the results (Aslan et al., 2024; Hald et al., 2026; Korur et al., 2025; Marcos-Bo & Belda-Medina, 2026; Yim, 2024). Within these limitations, the greater improvement in the experimental group may be related to the visual, auditory, interactive, and play-based features of Marble. Interactive multimedia that integrates pictures, sounds, animation, and direct responses can increase children's attention and involvement in learning activities (Fitriani et al., 2022; Rasmani et al., 2023). These characteristics are consistent with the learning needs of young children, who generally benefit from concrete, active, and exploratory experiences.

The improvement in the experimental group was reflected in the three literacy indicators measured in this study, namely vowels and consonants, reading words, and understanding word meanings. These indicators represent related stages of early literacy development, beginning with letter-symbol recognition, continuing with word decoding, and progressing toward meaning comprehension. Whitehurst and Lonigan (1998) distinguish emergent literacy into *inside-out skills*, which concern children's understanding of the written-language code, and *outside-in skills*, which concern vocabulary, oral language, and meaning. In the present study, naming vowels and consonants and reading words primarily represent code-related abilities, whereas understanding word meanings reflects children's developing language comprehension.

Marble supported the first indicator through visual and auditory displays, enabling children to observe letter forms and hear their corresponding sounds. Repeated activities involving the recognition, naming, and classification of vowels and consonants may have strengthened children's letter knowledge and awareness of relationships between written symbols and language sounds. Snow et al. (1998) identify letter knowledge and

phonological awareness as foundational components of early reading development, while Clay (2001) emphasizes that early literacy includes letter recognition, phonological awareness, vocabulary, listening, and comprehension. Teale and Sulzby (1986) likewise explain that literacy begins to develop before formal reading instruction through children's interactions with language, symbols, pictures, stories, and printed materials. From this perspective, Marble provided additional experiences through which children could interact with letters and sounds in an engaging format.

The findings also showed that children in the experimental group were active and enthusiastic during the learning process. This pattern may be related to Marble's play-based design. Children did not merely receive verbal explanations from the teacher; they were directly involved in selecting letters, arranging syllables, matching words with pictures, and responding to feedback from the application. Destiyanti et al. (2025) describe Marble as an educational game developed according to the principle of learning through play. Akmaluddin et al. (2024) also explain that the application combines visual, auditory, animation, and interactive elements to support children's participation in learning. These features may help maintain children's attention and encourage repeated engagement with literacy activities.

This active involvement is consistent with Piaget's view that young children construct knowledge through concrete experiences, direct activity, and exploration (Piaget, 1952). However, interaction with the application alone does not fully explain the learning process. From a sociocultural perspective, children's language development is also supported by interaction with adults and assistance provided within the learning environment (Insani, 2025). In this study, Marble functioned as a supporting medium, whereas the teacher and observers continued to provide instructions, clarification, encouragement, and assistance. Therefore, the observed improvement is more appropriately understood as the result of interaction among the digital medium, repeated literacy practice, and adult guidance.

Marble also supported the second indicator, namely, children's word-reading skills. The syllable and simple-word construction features provided opportunities for children to understand how letters and sounds can be combined into syllables and meaningful words. Children were not only asked to memorize individual letter names but were also guided to arrange linguistic units into recognizable words. Clay (2001) explains that beginning reading develops through children's growing ability to coordinate letter recognition, sound information, oral language, and meaning. Snow et al. (1998) similarly, identify letter knowledge, phonological processing, vocabulary, and oral language as interconnected foundations of reading development.

The findings regarding word reading are consistent with previous research on the Marble application. Yolanda and Damri (2022) reported that Marble supported the development of beginning reading skills among children aged 5–6 years. Mardhiah (2023) also found that the application supported letter recognition, syllable learning, and beginning reading through interactive activities. Firdyanisa et al. (2024) further reported that Marble was associated with the development of children's reading skills. These findings reinforce the potential of Marble as a supplementary medium for early reading instruction. However, its effectiveness may depend on the duration of use, the quality of adult guidance, children's initial abilities, and the alignment between the application activities and the intended learning objectives.

The third indicator concerned children's understanding of word meanings. Through word-picture matching activities, children connected written words to appropriate visual representations and were then asked to explain the meanings of the words in simple language. This activity extended literacy learning beyond pronouncing letters or reading

words. Early literacy also involves understanding that written symbols communicate meaning and refer to objects, experiences, or ideas. Clay (2001) explains that literacy development requires children to coordinate visual, phonological, linguistic, and meaning-related information. Whitehurst and Lonigan (1998) also emphasize vocabulary and language comprehension as central components of *outside-in skills*.

The picture-word matching feature may have helped children connect written words to concrete objects already familiar to them. This process is appropriate for children aged 5–6 years because visual representations can make written symbols more accessible and meaningful. Morrison (2012) explains that early childhood literacy involves using language and symbols to understand information and communicate ideas. Santrock (2018) similarly, it emphasizes that children develop literacy through experiences that help them connect symbols, sounds, language, and meaning. Therefore, the visual component of Marble did not function merely as decoration; it also served as a bridge between written words and children's existing knowledge.

The present study also extends the focus of several previous Marble studies. Yolanda and Damri (2022) primarily examined beginning reading, while Resiana and Asvia (2024) focused on learning motivation and letter-recognition ability. Firdyanisa et al. (2024) examined the development of reading skills. By including children's ability to match words with pictures and explain word meanings, the present study incorporated an early comprehension component that received less direct attention in those earlier studies. However, this indicator should be interpreted as a basic form of word-level comprehension rather than as comprehensive reading comprehension.

Marble provides colorful images, sounds, animations, games, and immediate feedback that may stimulate children's curiosity and maintain their involvement. Direct responses from the application can help children recognize whether their answers are correct and encourage them to repeat an activity. Yolanda and Damri (2022) explain that immediate feedback can help children identify errors and reinforce their learning. Akmaluddin et al. (2024) likewise, describe Marble as an interactive application that combines audio, visual, and animated elements with game-based responses to support early literacy activities.

However, the use of digital media should not be interpreted as a replacement for teachers' roles or direct learning experiences. In this study, the intervention was organized according to specific literacy indicators, implemented over six sessions, and accompanied by adult guidance. Children received explanations, repetition, assistance, and verbal reinforcement throughout the learning process. Thus, the improvement was not produced by digital exposure alone. Marble provided structured practice, while the teacher directed children's attention toward the intended literacy concepts.

The use of digital educational games in early childhood learning also requires several pedagogical considerations. Children may become more interested in colors, sound effects, animation, rewards, or scores than in the literacy content itself. They may also complete game tasks mechanically without understanding the underlying concepts of letters, words, or meaning. These risks were not directly measured in the present study, but they need to be considered when interpreting and applying the findings. For this reason, Marble should not be used as a stand-alone learning tool. Teachers and parents need to accompany their use with questions, verbal explanations, repetition, and follow-up activities.

The duration of digital device use should also be balanced by direct play, physical movement, conversation, storytelling, and interaction with peers and adults. After completing activities in the application, children can be asked to identify the same letters on physical cards, arrange movable letters to form words, locate objects represented by those words, or use those words in spoken sentences. These follow-up activities can help

transfer learning from the digital environment to broader language use and prevent children's attention from remaining focused only on the game features.

The findings have practical implications for classroom implementation. Marble is likely to be most useful when teachers select features that directly correspond to the intended literacy indicators. Letter-recognition activities should be accompanied by pronunciation and classification of vowels and consonants. Syllable games should be followed by oral reading and word construction. Word-picture matching should be expanded by including questions about the meaning, function, or use of the represented objects. This approach helps ensure that children not only complete digital tasks but also understand the literacy concepts embedded in them.

Overall, the results indicate that Marble-based educational games can serve as a relevant supplementary medium for literacy learning among children aged 5–6 years when used with appropriate teacher guidance. Both the post-test and N-Gain analyses showed greater literacy improvement in the experimental group than in the control group. The findings are also consistent with previous studies reporting that Marble can support letter recognition, learning motivation, and beginning reading skills (Yolanda & Damri, 2022; Mardhiah, 2023; Firdyanisa et al., 2024; Resiana & Asvia, 2024).

Nevertheless, because this study used a quasi-experimental design without random assignment, Marble should not be regarded as the only factor responsible for the observed improvement. Teacher mediation, repeated practice during the six sessions, children's familiarity with digital devices, and the classroom learning environment may also have influenced the outcomes. Marble is, therefore, more appropriately understood as a supporting medium that can enrich early literacy experiences when combined with adult mediation, verbal reinforcement, repetition, social interaction, and balanced play-based activities. The theoretical explanations and cited studies used in this discussion are drawn from the literature reviewed in the uploaded thesis.

F. Conclusion

This study shows that Marble-based educational games were associated with improved early literacy skills among 5–6-year-old children at TK Negeri Kelurahan Rangas. The experimental group increased from a pre-test mean score of 14.67 to 24.73 on the post-test, while the control group increased from 13.87 to 19.13. The Mann–Whitney test on post-test scores showed a significant difference between the two groups ($p = 0.029 < 0.05$), and the N-Gain analysis further indicated that the experimental group achieved a higher mean N-Gain score ($M = 0.6805$) than the control group ($M = 0.5465$). The Mann–Whitney test on N-Gain scores also showed a significant difference ($U = 126.500$, $Z = -2.011$, $p = 0.044$), indicating that the literacy improvement in the experimental group remained higher after considering the children's initial literacy abilities. These findings suggest that Marble can serve as a potential supporting medium for early literacy learning because its visual features, audio, animation, interactive gameplay, and immediate feedback help children recognize vowels and consonants, read simple words, and connect symbols, sounds, words, and images. However, the findings should be interpreted within the limitations of the quasi-experimental design, including the absence of random assignment, the limited sample size, and the study's implementation in only one early childhood education institution. Therefore, Marble should not be considered the only factor influencing children's literacy development or used as a stand-alone learning tool. Its use should be guided by teachers through verbal reinforcement, repetition, questioning, and follow-up play-based literacy activities. Further research is recommended to involve more participants, more diverse research settings, and a longer intervention period to obtain a

more comprehensive understanding of the role of Marble-based educational games in early childhood literacy learning.

References

- Akmaluddin. (2024). Studi Literatur Tentang Penggunaan Aplikasi Marbel Membaca Untuk Meningkatkan Kemampuan Membaca Peserta Didik. *Journal of Science and Research*, Vol 5 (3). <http://pusdikra-publishing.com/index.php/jsr>
- Annas, Baguna, I., Kobandaha, F., Abdjul, S. P., Yusuf, I. A. M., & Asipu, S. (2024). Tantangan dan solusi orang tua dalam membangun kecakapan literasi anak usia dini. *Jurnal Kajian Penelitian Pendidikan dan Kebudayaan*, 2(3), 242–253. <https://doi.org/10.59031/jkppk.v2i3.476>
- Aslan, D., Dağaynası, S., & Ceylan, M. (2024). Technology and geometry: Fostering young children's geometrical concepts through a research-based robotic coding program. *Education and Information Technologies*, 29(17), 22699–22721. <https://doi.org/10.1007/s10639-024-12747-3>
- Clay, M. M. (2001). *Change Over Time In Children's Literacy Development*. Heinemann.
- Creswell, J. W. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.
- Destiyanti, I. C., Darmayanti, & Afyati, S. N. (2025). Game Edukasi Marbel: Solusi Kreatif Dalam Meningkatkan Literasi Awal Anak Usia Dini. *Jurnal ATSAR UNISA Kuningan*, 4(1), 53–63.
- Firdyanisa, R. N. F., Samawi, A., & Maningtyas, R. D. T. (2024). Efektivitas aplikasi Marbel terhadap perkembangan. 2(2), 99–108.
- Fitri, E., & Wirabrata, D. G. F. (2023). Marbel application-based learning media to develop analytical skills in children aged 4–5 years. *Jurnal Pendidikan Anak Usia Dini Undiksha*, 11(3), 449–457. <https://doi.org/10.23887/paud.v11i3.67007>
- Fitriani, L., Destiani, D., Fatimah, S., & Novitasari, S. (2022). Perancangan media pembelajaran interaktif pengenalan Bahasa Inggris untuk pendidikan anak usia dini berbasis Android. *Algoritma*, 19(2), 537–546.
- Hald, G. M., Johnsen, D. B., Lange, T., Hald, A. N., Sander, S., & Øverup, C. S. (2026). Effects of the SES NXT intervention on mental health and well-being for children of divorce. *Npj Digital Medicine*. <https://doi.org/10.1038/s41746-026-02638-x>
- Insani, H. (2024). Strategi Efektif untuk Meningkatkan Keterampilan Berbahasa pada Anak Usia Dini Pemalu Melalui Pendekatan Teori Zona Perkembangan Proksimal (ZPD) Vygotsky. *Jurnal Pendidikan Anak Usia Dini*, 2(2), 14. <https://doi.org/10.47134/paud.v2i2.1272>
- Janah, S. M., & Ariyani, D. (2022). Pemanfaatan game edukasi Marbel Angka berbasis Android sebagai media pengenalan angka pada anak usia dini. *Jurnal Pendidikan Anak Usia Dini*, 6(2), 24–32.
- Karaman, J., Setyanto, A., & Sofyan, A. F. (2018). Analisis aplikasi Marbel Huruf versi mobile terhadap pembelajaran membaca di Desa Semanding Ponorogo. *INTENSIF*, 2(2).
- Kasriyati, D., Wahyuni, S., & Reswita, R. (2021). Pelatihan perencanaan dan penerapan media *loose parts* dalam pembelajaran anak usia dini bagi guru PAUD Kecamatan Rumbai

- Pesisir. *Wahana Dedikasi: Jurnal PkM Ilmu Kependidikan*, 4(2), 39. <https://doi.org/10.31851/dedikasi.v4i2.5906>
- Korur, F., Avcı, D. E., & Gürkan, Ş. (2025). Comparison of the Effects of Stories and Digital Stories Containing Refutation Texts on Conceptual Understanding and Correction of Misconceptions in Primary Science Education. *SAGE Open*, 15(4). <https://doi.org/10.1177/21582440251403736>
- Kristin Waruwu, P. (2026). Pengaruh Media Pembelajaran Interaktif Terhadap Motivasi Belajar Anak Usia Dini (0-6) TAHUN. *Journal of Golden Generation Education*, 2(1), 390–394.
- Mardhiah, S. (2023). Pengaruh penggunaan aplikasi Marbel untuk mengembangkan kemampuan membaca permulaan di TK Cinta Ananda. *Jurnal Eksperimental: Media Ilmiah Pendidikan Guru Madrasah Ibtidaiyah*, 12(2), 25.
- Mardhotillah, H. (2022). Pengembangan game interaktif berbasis Android untuk meningkatkan kemampuan membaca anak usia dini. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 6(1), 779–792. <https://doi.org/10.31004/obsesi.v6i1.1361>
- Marcos-Bo, M., & Belda-Medina, J. (2026). Student Engagement and Accuracy in AR-Supported Grammar Learning: An Exploratory Study in an EFL Context. *International Journal of Interactive Mobile Technologies (iJIM)*, 20(10). <https://doi.org/10.3991/ijim.v20i10.58749>
- Mauluddia, Y., & Yulindrasari, H. (2024). Peran Literasi Digital dalam Mendukung Perkembangan Anak Usia Dini melalui Pemanfaatan Teknologi. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, 8(5), 1209–1220. <https://doi.org/10.31004/obsesi.v8i5.6166>
- Morrison, G. S. (2012). *Early childhood education today*. Pearson Education.
- Mutiah, S. (2024). Pendidikan multikultural dalam permainan guli di Indonesia. *Jurnal Pendidikan, Kebudayaan dan Keislaman*, 3(1), 55–66. <https://doi.org/10.24260/jpkk.v3i1.2852>
- Piaget, J. (1952). *The Origins Of Intelligence In Children*. International Universities Press.
- Putri, N. E., Iriyanto, T., & Anisa, N. (2024). Stimulating early childhood digital literacy through the innovative Kiddyfun platform. *12(2)*, 272–280.
- Rasmani, U. E. E., Wahyuningsih, S., Nurjannah, N. E., Jumi atmoko, Widiastuti, Y. K. Y. W., & Agustina, P. (2023). Multimedia pembelajaran interaktif untuk guru PAUD. *Jurnal Obsesi*, 7(1), 10–16. <https://doi.org/10.31004/obsesi.v7i1.3480>
- Resiana, R. S., & Asvia, S. (2024). Pengaruh Aplikasi Marbel Huruf Terhadap Motivasi Belajar Dan Kemampuan Mengenal Huruf Di RA Nurul Huda Bayongbong Garut. *Jurnal Pendidikan Islam Anak Usia Dini (Anaking)*, 3(1), 119–125. <https://doi.org/10.37968/anaking.v3i1.707>
- Santrock, J. W. (2018). *Educational psychology* (6th ed.). McGraw-Hill Education.
- Snow, C. E., Burns, M. S., & Griffin, P. (1998). *Preventing reading difficulties in young children*. National Academy Press.
- Syafe'i, M., Sholihah, M., & Dzakia, F. A. (2025). Pentingnya Pengembangan Literasi Pada Anak Usia Dini. *Jurnal Caksana : Pendidikan Anak Usia Dini*, 8(1), 528–534. <https://doi.org/10.31326/jcpaud.v8i1.2389>
- Teale, W. H., Sulzby, E. (1986). *Emergent literacy: Writing and reading*. Ablex Publishing.

- Tompkins, G. E. (2014). *Literacy for the 21st century: A balanced approach* (6th ed.). Pearson Education.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.
- Whitehurst, G. J., & Lonigan, C. J. (1998). Child development and emergent literacy. *Child Development*, 69(3), 848–872. <https://doi.org/10.1111/j.1467-8624.1998.tb06247.x>
- Yim, I. H. Y. (2024). Artificial intelligence literacy in primary education: An arts-based approach to overcoming age and gender barriers. *Computers and Education Artificial Intelligence*, 7, 100321–100321. <https://doi.org/10.1016/j.caeai.2024.100321>
- Yolanda, S. T., & Damri, D. (2022). Efektivitas Aplikasi Marbel Berbasis Android dalam Meningkatkan Kemampuan Membaca Permulaan bagi Anak Disleksia di Sekolah Dasar. *Jurnal Basicedu*, 6(2), 1563–1569. <https://doi.org/10.31004/basicedu.v6i2.2261>